Our products are safe (don't tell anyone!). Why don't supermarkets advertise their private food safety standards?

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Abstract

Large retail chains have spent considerable resources to promote production protocols and traceability across the supply chain, aiming at increasing food safety. Yet, the majority of consumers are unaware of these private food safety standards (PFSS) and retailers are not informing them. This behavior denotes a *pooling paradox*: supermarkets spend a large amount of money for food safety and yet they forget to inform consumers. The result is a pooling equilibrium where consumers cannot discriminate among high quality and low quality products and supermarkets give up the potential price premium. This paper provides an economic explanation for the paradox using a contract-theory model. We found that PFSS implementation may be rational even if consumers have no willingness to pay for safety, because the standard can be used as a tool to solve asymmetric information along the supply chain. Using the PFSS, supermarkets can achieve a separating equilibrium where opportunistic suppliers have no incentive to accept the contract.

Even if consumers exhibit a limited (but strictly positive) willingness to pay for safety, advertising may be profit-reducing. If the expected price margin is high enough, supermarkets have incentive to supply both certified and uncertified products. In this case, we show that, if consumers perceive undifferentiated products as "reasonably safe", supermarkets may maximize profits by pooling the goods and selling them as undifferentiated. This result is not driven by advertising costs, as we derive it assuming free advertising.

1. Introduction

In the last decade, large buyers – such as supermarkets – have put considerable effort in establishing private standards to ensure the safety of their products (Henson and Reardon, 2005). Yet, despite of the large investments, consumers seem to be mostly unaware of the very existence of these private food safety standards (PFSS) and supermarkets are not putting any significant effort in advertising and promotion (Hammoudi *et al.*, 2009; Fulponi, 2006; Grunert, 2005; Rozan *et al.*, 2004). This behavior denotes an apparent *pooling paradox*. Supermarkets invest a non-negligible amount of money to supply safer products but then they do not pursue a differentiation strategy as they do not advertise the standard nor inform consumers. Consumers' lack of information determines a pooling equilibrium where certified and uncertified products are sold for the same (or very similar) price and supermarkets give up the potential price premium.

The economic literature addressed the pooling paradox. For example, Rozan, Stenger and Willinger (2004) conclude that consumers perceive food safety to be a basic characteristic that they expect from all products and, hence, may not willing to pay a premium for it (see also Roosen, 2003; Giraud-Heraud *et al.,* 2009). These explanations postulate that PFSS are adopted for other reasons in addition to food safety, as there is no economic rationale in incurring in the cost of providing attributes that consumers do not want to pay for. In this regard, Fulponi (2006) provides an institutional analysis of PFSS and concludes that they can be used as a tool for governing the food system.

Our paper contributes to this literature providing a theoretical model explaining the paradox. We reached two main results. Firstly, we find that PFSS implementation may be rational even if the consumers' willingness to pay for safety is equal to zero, because the standard may be a tool to solve asymmetric information along the supermarket's supply chain. Secondly, we find that, even if consumers exhibit a limited (but strictly positive) willingness to pay for safety, advertising may reduce expected profits if the supermarket optimal strategy consists in offering consumers a mix of standard and non-standard products. This result is not driven by advertising costs, as we derive it assuming free advertising, and requires that the retailers' price margin is large and that consumers perceive undifferentiated products as "reasonably safe".

2. Food safety and private standard

Over the past few years, food safety and quality has become an important concern for the general public, policy makers, researchers, stakeholders involved into food production, transport and trading. Even though the topic has been extensively studied and debated, a number of food crises over the past decade has brought the issue right back into the national and international political debate. While much of the focus of the economics literature has been on the role of public food safety and quality standards both as policy instruments and as non-tariff barriers to trade, it is evident that private standards are playing an increasing role in the governance of agricultural and food supply chain. In particular, retailers have implemented new collective and private norms in order to improve food safety and reduce the risks related to microbial contamination and pesticide residues.

Firms have an incentive to supply safer food, but the implementation of food safety standards can increase costs for firms. Nonetheless, firms have incentives to protect their reputation and might implement state of the art food safety practices without any pressure from the government. Some firms use international and private standards and certifiers in order to reduce the costs of verifying that suppliers are using safe production methods.

2.1 Private standards and food supply chain

In the context of global sourcing, it has become more common that downstream firms implement private food safety standards (voluntary) in order to improve the safety of final products. Private initiatives of standardization are mostly undertaken by big retails, processing industries and third part firms with high market power and a competitive strategy based on private standard to bind the company's reputation on quality products.

While many quality characteristics can easily be used by retailers to differentiate their products in the final market this is not straightforward with safety characteristics. Among the options available to firms we focus on two main strategies: pure private standards and collective standards. Firms can implement firm-specific private standards that are defined, controlled and used by an individual retailer (Chain-specific standards set by a single company, e.g. Tesco Nature's Choice and FilièresQualitéCarrefour) (Berdegué et al., 2005; Codron et al. 2005; Giraud-Héraud et al. 2006). Nevertheless, different types of collective standards have become progressively most important. In recent years several collective standards have been introduced by the food retailing industry, e.g. the BRC, IFS and Globalgap. These standards are business-to-business standard and the efforts are not communicated to consumers; the logo can only be placed on the pallets that will not be displayed at the point of sale.

Indeed private standards enables a group of retailers to obtain goods that fulfill a more stringent standard than what is produced in existing spot markets by creating new intermediary markets rather than using supply contracts and potentially costly firm-specific private schemes. Private standards function as instruments for the coordination of supply chains by standardizing product requirements over suppliers, which may cover wide geographical regions that cut across national boundaries. This becomes of greater importance as supply chains become more global and are exposed to differing regulatory, economic and regulatory environments. In turn, standards act to reduce the transaction costs and risks associated with procurement, in particular where high levels of oversight are required to ensure food safety and/or quality attributes are delivered.

A number of studies suggest that expected competitive advantages are important reasons for firms to embrace private standards (Henson and Caswell, 1999). But it is true that how the system of certification operates is the focus to understanding the allocation of costs and benefits throughout the supply chain. Certification is a process by which clients assess the compliance with defined standards and is typically undertaken by a third party agency that the client recognizes as 'competent'.

Standard protocols, such as GlobalGap and BRC, operate on a business-to-business basis and are not consumer-facing. In case supermarkets or retailers ask their suppliers for these certifications, compliance with private standards becomes an addition to the list of services which retails are asked to suppliers as a condition of sustained market access. The control costs necessary to private standards are transferred the grower and the exporter upstream the supply chain by supermarkets and retailers.

The supplier is fully responsible for supplying safe product, and the validation of safety systems should therefore be viewed as part of this responsibility. Final products on the market do not bear any logos to indicate that they are produced on a private standard scheme. Do consumers benefit from private food schemes? This question relates back to the question why consumers need private food schemes and whether official requirements and controls alone would suffice to guarantee food safety. As such consumers are not necessarily aware of the existence of standard and do not necessarily pay any price premium for it. Since there is no price premium for compliance with standard, supermarkets and retailers can well argue that they do not resort to private standard as a marketing strategy to attract consumers. In this sense, others food business operators can be suppliers of supermarkets and retails without incurring any extra costs.

3. The model

We developed a simple theoretical model to explain why a profit-maximizing supermarket may decide to implement a PFSS without extensive advertising to its customers. Our analysis concludes that PFSS can be used as a supply management tool, ensuring that suppliers comply with an incomplete contract with the buyer in the presence of asymmetric information. This result is independent of any impact that the PFSS may have on consumers. Furthermore, the theoretical model shows that a buyer facing stochastic prices, under specific conditions, maximizes profits by mixing products complying with the PFSS with other products during peak seasons. This strategy requires that consumers are not able to tell the difference between certified and uncertified products. Hence the advertising of the PFSS may not be efficient, since it makes consumer suspicious of uncertified, and potentially unsafe, food.

We apply a standard principal-agent setting to model the PFSS. The principal is a supermarket buying a product from farmers and selling it to the final consumers for an exogenous price P_R. The profit of the supermarket depends on a "critical attribute": if the attribute is missing the supermarket incurs in an expected profit loss D. Examples of such critical attribute are the compliance with the logistic requirement of the supermarket's supply chain (timeliness of the delivery, reliability, etc.) or the respect of public safety standards as imposed by the current regulation. A key feature of our model is that the critical attribute may or may not concern the quality or safety of the product. It is sufficient that a) the lack of the attribute determines an expected profit loss and b) the attribute is not freely observable by the supermarket.

The farmers act as the agents of the model. We assume that there are M farmers in the market, producing one unit of the product each. The farmers are homogenous except for the parameter c_i, representing their cost efficiency in delivering the critical attribute. The parameter is not observable by the supermarket and is uniformly distributed as $c_i \sim U[0, c_H]$. The distribution of the parameter is public knowledge. Each farmer can sell the unit of product to the spot market for an exogenous price P_M or deliver it to the supermarket for a price P_S. If the farmer decides to deliver to the supermarket, then he/she can deliver the hidden attribute or behave opportunistically.

We assume the existence of a spot market where an infinite number of small independent retailers compete with the supermarket. These independent retailers are passive players, buying one unit of the product from farmers for the price P_M and selling it to consumers for the price P_R. For simplicity, we impose a "no monopsony" assumption stating that the supermarket never acts as a monopsonist as there is always at least one independent retailer in the market.[1]

[1] We assume that M is large enough, so that n^* is always lower than M, where n^* is the profit-maximizing quantity traded by the supermarket. The assumption greatly simplifies the presentation of the results and does not affects the key findings. Furthermore, the absence of a monopolistic/monopsonistic retailer is consistent with observed reality.

[2] The parameter p determines the expected benefit from opportunism. It may summarize several factors such as unrecoverable down-payments made by the supermarket, the probability that the opportunistic behavior goes undetected (for example if the supermarket can observe only the aggregate profit loss), or the probability that the supermarket cannot reject the delivery (for example because it cannot find another supplier on a short notice). We restricted the

Prices P_R and P_M are assumed to be exogenously determined and stochastic. They follow a joint distribution such that the price margin $PM = P_R - P_M$ is distributed as a random variable with mean $E(PM)$ and variance σ^2_{PM}. We assume that, in the absence of advertising, the PFSS do not affect the consumers' willingness to pay for the goods so that the independent retailers and the supermarket are exposed to the same retail price. The price distributions are public knowledge and all players are risk-neutral.

We represent the supply contract using a simple principal-agent model. At time t_0 the supermarket offers n_C contracts to randomly selected farmers. The supermarket offers a price $P_M+\Delta$, where Δ is a price premium and requires the delivery of products with the critical attribute at time t_1. The n_C farmers under contract must decide if they will deliver the attribute or if they will behave opportunistically. The expected payoff from opportunism is $P_M+p\cdot\Delta$, with $p \in (0, 1)$.[2] Summarizing the strategy sets of the supermarket and the i^{th} farmers are, respectively, $S_S[n_C, n_M, \Delta]$ and $S_i[AR, OPP]$, where n_M is the quantity of product that the supermarkets buys on the spot market, AR and OPP are binary variables with AR=1 if the farmer accepts the contract and zero otherwise and OPP = 1 if the farmer behaves opportunistically and zero otherwise.

At time t_1 production is revealed. The n_C farmers under contract will deliver the products to the supermarkets and the other M-n_C farmers will sell their product to the independent retailers.

Assuming that the cost function is separable in the price of the product, the buyer expected payoff is:

(1) $$E(\pi_S) = n_C\left[E(PM) - \Delta - z\cdot D\right] + n_M\left[E(PM) - D\right] - C_S(n_C + n_M),$$

where n_C is the number of contracts offered by the buyer, which is equal to the quantity produced since each farmer produces one unit, z is the probability that a farmer behaves opportunistically. $C(n)$ is the buyer marketing cost function, which is assumed to be $C(n_C + n_M) = a\cdot(n_C + n_M)^2$.

Farmer i's expected payoff is:

(2) $$E(\pi_i) = \begin{cases} E(P_M) \text{ if sells to an independent retailer} \\ E(P_M) + \Delta - c_i \text{ if delivers the attribute} \\ E(P_M) + p\cdot\Delta \text{ if behaves opportunistically} \end{cases}$$

From equation (2), the farmer's individual rationality (IR) constraint requires $\Delta \geq 0$ and the incentive compatibility (IC) constraint is satisfied if $c_i < (1-p)\Delta = \bar{c}$.

Since the cost parameter c_i is uniformly distributed, the probability of contracting an opportunistic farmer (i.e, with $c_i > \bar{c}$) is $z = \max\left[1 - \frac{(1-p)\Delta}{c_H}, 0\right]$ and the problem of the buyer is:

$$\max_{\Delta, n} E(\pi_S) = n_C\left[E(PM) - \Delta - \frac{c_H - (1-p)\Delta}{c_H}D\right] + n_M\left[E(PM) - D\right] - a\cdot(n_C + n_M)^2$$

subject to:

[2] The parameter p determines the expected benefit from opportunism. It may summarize several factors such as unrecoverable down-payments made by the supermarket, the probability that the opportunistic behavior goes undetected (for example if the supermarket can observe only the aggregate profit loss), or the probability that the supermarket cannot reject the delivery (for example because it cannot find another supplier on a short notice). We restricted the parameter to the interval (0,1) because for p=0 there is no incentive for opportunistic behavior. For $p \geq 1$ the model is undetermined, as there is no incentive for delivering the attribute. In this case, the key findings of this paper can still be derived using an infinitely repeated game, under the assumption that the supermarket can punish the opportunistic farmers by refusing to offer them contracts forever.

(a) $\Delta \geq 0$

(b) $\Delta \leq \frac{c_H}{1-p}$

(c) $n_C \geq 0, n_M \geq 0$

where inequality (a) is the farmer's IR constraint, inequality (b) states the buyer is rational and does increase the price premium beyond the level corresponding to z =1, inequalities (c) are the usual non-negativity constraints on quantities. The farmer IC constraint has been substituted into the objective function.

The supermarket's optimal strategy depends on the sign of the derivative of the objective function with respect to Δ:

$$\frac{\delta E(\pi_S)}{\delta\Delta} = n_C\left[\frac{(1-p)D}{c_H} - 1\right] = n_C\left[D - \bar{\Delta}\right],$$

where $\bar{\Delta} = \frac{c_H}{1-p}$, i. e., the incentive price for the most inefficient farmers.

If D is larger than $\bar{\Delta}$, the derivative is always positive and the marginal benefit of reducing the probability of opportunistic behavior is greater than the marginal cost of increasing the price premium. In this case, constraint (b) is binding, the buyer offers the optimal price premium $\Delta^* = \bar{\Delta}$ and no farmer has incentive to behave opportunistically. If D is smaller than $\bar{\Delta}$, the derivative is negative and the buyer maximizes profits by setting the price premium to zero and incurring in the loss of D for each unit of product (i.e., acting as an independent retailer). The strategy of the buyer is driven by the relative magnitude of the expected profit loss from the opportunism and the price premium. If the expected loss is large, the buyer uses contracts (and incentive pricing) to organize the supply chain. If the expected loss is small, the buyer organizes the transaction using the spot market. If the price margin is negative the supermarket exits the market. Table 1 reports the supermarket's optimal strategy $S_S\left[\Delta^*, n_C^*, n_M^*\right]$ and the corresponding payoff π^*.

Table 1: Supermarket's optimal strategy in the absence of PFSS

	Optimal strategy			
	Exit	Act as indep. retailer	Exit	Contracts
Range	$D < \bar{\Delta}$ $E(PM) < D$	$D < \bar{\Delta}$ $E(PM) \geq D$	$D \geq \bar{\Delta}$ $E(PM) < \bar{\Delta}$	$D \geq \bar{\Delta}$ $E(PM) \geq \bar{\Delta}$
Δ^*	0	0	$\bar{\Delta}$	$\bar{\Delta}$
n_C^*	0	0	0	$(2a)^{-1}\left[E(PM) - \bar{\Delta}\right]$
n_M^*	0	$(2a)^{-1}\left[E(PM) - D\right]$	0	0
π_S^*	0	$(4a)^{-1}\left[E(PM) - D\right]^2$	0	$(4a)^{-1}\left[E(PM) - \bar{\Delta}\right]^2$

3.1 The PFSS as supply management tools.

In this section we show that the buyer can improve profits by imposing a PFSS to farmers, even if the standard itself does not affect consumer demand. In the typical literature about PFSS, the buyer benefits from the adoption of the standard because of consumers' willingness-to-pay for quality and safety. In our model, we show that the PFSS can be used as a self-selecting device ensuring that opportunistic farmers have no incentive to subscribe the contract with the buyer.

We assume the adoption of the standard requires that farmers bear an observable implementation cost K, which is equal for all farmers. The payment of the cost K is a pre-requisite for being offered a contract. In this setting the expected payoff for the i-th farmer is:

$$(3) \qquad E(\pi_i) = \begin{cases} E(P_M) \text{ if sells to the spot market} \\ E(P_M) + \Delta - c_i - K \text{ if delivers the attribute} \\ E(P_M) + p \cdot \Delta - K \text{ if behaves opportunistically} \end{cases}$$

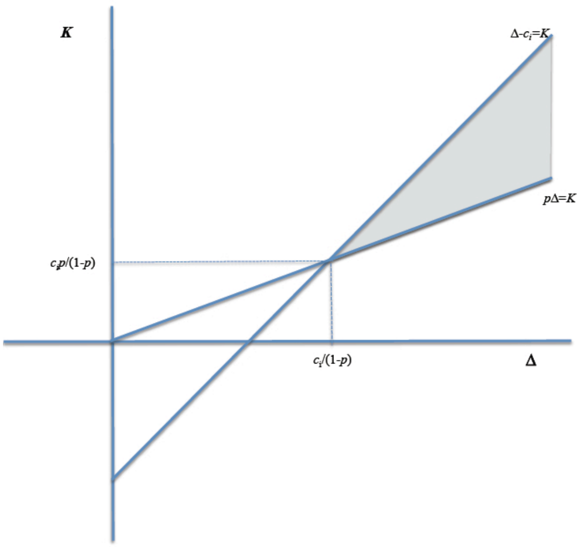
We assume also that the function $K=f(\text{PFSS})$, linking the implementation cost to the technical provisions of the PFSS, is public knowledge. The supermarket can set the implementation cost K strategically, in order to create a separating equilibrium where the inefficient farmers opt out of the contract. Therefore if a PFSS is adopted the strategy of the supermarket is defined as the set $S_B\{n_C, n_M, \Delta, K\}$.

The separating equilibrium requires that the expected payoff is negative if the farmer behaves opportunistically and positive otherwise, i.e., $\Delta - c_i - K \geq 0$ and $p \cdot \Delta - K \leq 0$. These conditions are satisfied for any pair:

$$(4) \qquad \tilde{\Delta} \geq c_i (1-p)^{-1} \text{ and } \tilde{K} \in \left[p \cdot \tilde{\Delta}, \tilde{\Delta} - c_i\right].$$

Figure 1 illustrates the result in the contract space. The shaded area represents the pairs of Δ and K that prevent farmers from adopting opportunistic behavior.

Figure 1: Representation of the efficient contract in contract space. The dimensions of the contract are the price premium (Δ) and the implementation cost of the PFSS (*K*).



If the pair [Δ, *K*] satisfies conditions (4), the probability *z* of incurring in opportunistic behavior is zero, because the inefficient farmers have no incentive to join the contract. The supermarket expected payoff adopting the PFSS is:

$$(5) \qquad E(\pi_S \mid PFSS) = n_C\left[E(PM) - \Delta\right] + n_M\left[E(PM) - D\right] - a(n_C + n_M)^2$$

and the problem of the principal is:

$$\max_{\Delta, n_C, n_{SM}, K} E(\pi_B \mid PSQS) \text{ subject to:}$$

$$(a)\ n_C \leq \frac{(1-p)\Delta}{c_H} M$$

$$(b)\ \Delta \geq 0,\ n_C \geq 0, n_M \geq 0$$

where $\frac{(1-p)\Delta}{c_H} = \frac{\Delta}{\bar{\Delta}}$ is the share of producers that are willing to accept the contract, since farmers with $c_i>(1-p)\Delta$ have no incentive to join. Constraint (*a*) states the price premium Δ must be high enough to elicit supply. Because the supermarket's only incentive to pay a price premium is eliciting supply, at the optimum the constraint is satisfied with equality.

The solution of the maximization problem gives two possible optimal strategies, depending on the value of the parameter *D*.[3] The results are summarized in Table 2. If *D* is large enough, the supermarket organizes the supply using contracts only. If *D* is small, the supermarket uses a mix of contracts and spot-market purchases. In this latter case, the supermarket sets a small price premium, elicits a small supply for contract production and uses the spot market up to the optimal production level.

Table 2: Supermarket optimal strategy if the PFSS is adopted

	Optimal strategy	
	Mix contracts and spot market (PFSS/Mix)	Contracts only (PFSS/Contract)
Range	$\lambda \cdot E(PM) > D$	$\lambda \cdot E(PM) \le D$
Δ^*	$D/2$	$\varphi \cdot \bar{\Delta}$
n_C^*	$D(2\bar{\Delta})^{-1} M$	$\varphi \cdot M$
n_M^*	$(2a)^{-1}[E(PM)-D]-n_C^*$	0
π_S^*	$\frac{[E(PM)-D]^2}{4a}+\frac{D^2}{4\bar{\Delta}}M$	$\frac{M \cdot E(PM)^2}{4(\bar{\Delta}+a \cdot M)}$

With $\varphi = \frac{E(PM)}{2(\bar{\Delta}+a\cdot M)}$, $\lambda = \frac{\bar{\Delta}}{\bar{\Delta}+a\cdot M}$.[4]

Simple (yet tedious) algebra shows that the PFSS strategies always dominate the no-PFSS strategies. The intuition behind this result is straightforward as the optimal strategy without PFSS lies in the set of the admissible solutions for a supermarket using PFSS. Therefore, the level of expected of the profits from PFSS strategies is at least the same as the no-PFSS strategies. The adoption of the PFSS solves the information asymmetry at no cost for the principal, as the adoption cost is paid by the farmers.

Compared to the no-PFSS strategies, the supermarket must pay a smaller information rent to the farmers and gains higher profits. This result was obtained under general assumptions: the existence of a critical attribute, asymmetric information regarding farmers' efficiency and the delivery of the attribute, the possibility of imposing ex-ante an observable cost with the PFSS. The PFSS increases expected profits even if consumers have no willingness to pay for the increased quality and safety attributes of the certified products.

This conclusion provides an explanation for the pooling paradox. If the supermarket cannot charge a price premium, there is no incentive to advertise. Yet, we can still observe PFSS, as they are a device solving information asymmetry along the supply chain.

[3] Noticeably, if the PFSS is adopted, the exit strategy is strictly dominated by the contract strategy, since $\varphi \cdot \bar{\Delta} < E(PM)$. Once the information asymmetry is solved, contracting always offer profit opportunity.

[4] φ is the optimal share of farmers that are offered a contract in the PFSS/Contract strategy, $\lambda/2$ is the optimal share of $E(PM)$ that is offered to farmers as price premium. Because of the no-monopsony assumption, both φ and λ are bound in the interval [0,1).

4. To advertise or not to advertise.

In this section we relax the assumption that consumers are not willing to pay a premium for the certified products. We show that advertising does not necessarily increase expected profits even if consumers exhibit strictly positive willingness to pay for safety and advertising cost is zero. The intuition behind this conclusion is straightforward: if the supermarket's profit-maximizing strategy is mixing certified and uncertified products, under specific conditions (that will be derived later on in the paper) it is possible that advertising reduce the expected profits on the uncertified products more than it increases the returns on the certified products.

Assume that in a differentiated market, where consumers are informed about PFSS, the expected price margin of the uncertified product is $E(PMU) = E(PM) - Z$ and the expected price margin of the certified products is $E(PMC) = E(PM) + Z \cdot \beta$, with $Z>0$, $\beta \geq 0$ and $E(PM)$ is the price of the good in a pooling equilibrium. In our modeling, the parameter Z represents the "safety concern effect" and it is the discount that consumers require to buy products that are advertised as "less safe". The product $Z\beta$ is the "value-added effect" and denotes the consumers' willingness to pay for the improved food safety.[5] We want to show that it exists a strictly positive value β^* such that for any $\beta \in [0,\beta^*]$ advertising is not a dominant strategy, even if advertising is free. This result implies that it exists a set of market conditions such that free advertising is not profit-enhancing even if consumers have a strictly positive willingness to pay for PFSS.

Table 3: Optimal strategy for an advertising supermarket

	Optimal strategy Mixing contracts and spot market (ADV/Mix)	Contracts only (ADV/Contract)
Range	$E(PM) > \frac{D+Z}{\lambda} + \frac{M \cdot a}{\bar{\Delta}} Z \cdot \beta$	$E(PM) \leq \frac{D+Z}{\lambda} + \frac{M \cdot a}{\bar{\Delta}} Z \cdot \beta$
Δ^*	$0.5\left[D + Z(1+\beta)\right]$	$\Phi\bar{\Delta}$
n_C^*	$\frac{D + Z(1+\beta)}{2\bar{\Delta}} M$	ΦM
n_M^*	$\frac{E(PM) - Z - D}{2a} - n_C^*$	0
π_S^*	$\frac{\left[E(PM) - D - Z\right]^2}{4a} + \frac{M\left[D + Z(1+\beta)\right]^2}{4\bar{\Delta}}$	$\frac{M\left[E(PM) + Z\beta\right]^2}{4\left(\bar{\Delta} + a \cdot M\right)}$

With $\Phi = \frac{E(PM) + Z\beta}{2\left(\bar{\Delta} + a \cdot M\right)}$

To show this result we find the supermarket's optimal strategy, conditioned to advertising, and then we compared the expected profits with the no-advertising case, as reported in Table 2. Our goal is to show that it exists a non-empty set of parameter values such that $E(\pi_s \mid ADV) \leq E(\pi_s \mid PFSS)$, where the right-hand side of the inequality represents the expected

[5] The parameter β may be interpreted as the consumers' perception of food safety in the absence of advertising. $\beta=0$ implies that, in the absence of advertising, the consumers consider all products as safe and they take safety as granted. In this case, the only effect of the advertising is to make them aware of the existence of unsafe products. High values of β, instead, imply that the consumers are aware that products might be unsafe and the PFSS can increase the value of the product. The parameter Z can be interpreted as a measure of consumers' concern for safety and quality. The higher the value of Z, the more valuable the certified products are compared to the uncertified products.

profits without advertising and the left-hand side is the expected profits with advertising, which are defined as:

$$E(\pi_S \mid ADV) = n_C\left[E(PM) + Z\beta - \Delta\right] + n_M\left[E(PM) - Z - D\right] - a(n_C + n_M)^2$$

Similarly to the no-advertising case, the advertising supermarket must maximize the objective function under the constraints:

(a) $n_C \leq \dfrac{(1-p)\Delta}{c_H} M$

(b) $\Delta \geq 0,\ n_C \geq 0, n_M \geq 0$

Table 3 reports the solution of the optimization program.

The comparison of the results in Table 2 and Table 3 shows that the ADV/Contract strategy weakly dominates the PFSS/Contract strategy in the admissible parameter range. If the supermarket offers only certified products, free advertising increases profits unless either Z or β are equal to zero.

The strategy ADV/Mix weakly dominates the strategy PFSS/Mix only if β is large enough compared to $E(PM)$. In fact, the difference in the expected profits is:

$$E(\pi_s \mid ADV/Mix) - E(\pi_s \mid PFSS/Mix) = \frac{Z}{2a}\left[\frac{(2D+Z)(\bar{\Delta}+Ma)+\left[2D+Z(2+\beta)\right]Ma\beta}{2\bar{\Delta}} - E(PM)\right].$$

The difference is negative for any:

(6) $$E(PM) > \frac{(2D+Z)(\bar{\Delta}+Ma)+\left[2D+Z(2+\beta)\right]Ma\beta}{2\bar{\Delta}},$$

which means that for high values of the expected price margin, the profit loss from the reduction in the sale price of the uncertified products more than offsets the profit gain from the increase in the sale price of the certified goods.

Noticeably, inequality (6) implies that the threshold value of β^* that makes advertising profitable is strictly positive. In fact, for β =0, the strategy ADV/Mix dominates the strategy PFSS/Mix if and only if:

$$E(PM) < \frac{(2D+Z)(\bar{\Delta}+Ma)}{2\bar{\Delta}},$$

but the values of $E(PM)$ which satisfy the inequality are outside the admissible parameter space for the ADV/Mix strategy. Therefore β^* must be greater than zero. This result implies that a strictly positive consumers' willingness to pay for safety is not a sufficient condition for advertising to be profitable.

Basic algebra shows that a similar result holds for the range $E(PM) \in \left[\dfrac{D(\bar{\Delta}+a\cdot M)}{\bar{\Delta}}, \dfrac{(D+Z)(\bar{\Delta}+a\cdot M)+MaZ\beta}{\bar{\Delta}}\right]$, where the optimal strategies are PFSS/Mix in the absence of advertising and ADV/Contract if the supermarket advertises the PFSS.

Our simple model shows that if the expected price margin is high, the supermarket may have incentive to sell a mix of certified and uncertified products. As consumer cannot tell the two kinds of goods, advertising (e.g., labeling or promotion) is necessary to implement a product-differentiation strategy. Our model shows that product differentiation may allow the supermarket to extract profit from consumers' willingness to pay for safety, but may reduce profits on the sales of the uncertified products, if consumers demand a discount on the potentially unsafe goods. If the latter effect prevails on the former, advertising reduces expected profits. The model shows that advertising is not rational if the expected price margin is high and the consumers' consider the undifferentiated products "reasonably safe" (i.e., β is small). This conclusion offers an explanation of the pooling paradox: if the above mentioned conditions are met, we can observe PFSS's, because of their value of supply management tools, but we do not observe advertising, as the supermarkets have no incentive to promote product differentiation.

Conclusions

Supermarket are actively promoting their PFSS among suppliers, yet they do not put any significant effort to bring the improved food safety to consumers' attention. Our paper presented a theoretical model explaining this apparent paradox. We found that the supermarket behavior can be rational if consumers' willingness to pay for quality does not exceed a threshold $Z\beta^*$ that is a function of the expected price margin and other parameters. In particular, our theoretical model supports two major conclusions. Firstly, we showed that PFSS can be used to solve asymmetric information problems. Consequently, their scope goes beyond exploiting consumers' demand for safety, as they can be used as institutional arrangement to organize the supply chain. In this context, the adoption of PFSS is rational even if consumers have no willingness to pay for safety.

Secondly, we showed that advertising the PFSS (and the higher quality of the certified products) might reduce supermarkets' profits, under specific circumstances. If the expected price margin is high enough, supermarkets have incentive to mix certified and uncertified products. In such instances and if consumers' willingness to pay for safety does not exceed $Z\beta^*$, supermarkets may benefit from pooling the goods and selling them as undifferentiated. In this way they avoid the losses from selling uncertified (and potentially unsafe) products.

These two results provide a possible economic justification to the existence of unadvertised PFSS and they suggest that the adoption of such standards is not driven by the concern for consumer safety only. Efficient management of the supply chain is a key issue too.

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