How Should Food Safety Certification Be Financed?

John M. Crespi

Stéphan Marette

Contact : Stéphan Marette, INRA ESR BP01 78850 Grignon, France. Email: marette@grignon.inra.fr

John Crespi is a Ph.D. candidate in the Department of Agricultural and Resource Economics, University of California at Davis. Stéphan Marette is an economist at Institut National de la Recherche Agronomique, Département d'Economie-Grignon and THEMA-Paris X-Nanterre, France.

The authors are grateful for the comments of John Beghin, Jean-Christophe Bureau, Sylvette Monier, Richard Sexton, Tracy Turner and participants at a seminar in the Department of Agricultural and Resource Economics at the University of California at Davis. Support from the EU FAIR CT97-3481 project is acknowledged, but the content of the paper is the authors' responsibility.

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Abstract

An analytical framework where consumers are imperfectly informed about the safety of products is used to investigate the welfare effects of a public certification system. Several certification fees under alternative structures of certification cost are analysed. By maintaining competition among numerous sellers, voluntary certification financed by a per-unit fee is efficient (and sufficient) to signal product safety. However, mandatory certification linked with a fixed user fee may be necessary if a seller wields monopoly power. Further, certification by a single, private agency results in a distorted fee.

Keywords : Asymmetric Information, Labelling, Regulation, User Fees, Tax.

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Introduction

There is little debate that food safety is an important issue. In the United States alone, annual illnesses caused by seven of the most commonly ingested pathogens have been estimated to be from 3.3 to 12.3 million with 1,900 to 3,900 of these resulting in death. Likewise, estimates of annual economic losses due to foodborne illness have ranged from 3.3 to 27.2 billion dollars (Buzby and Roberts, 1996). Given the importance of food-safety inspections, the question remains what is the best way to finance an inspection program?

A recent study by the United States Department of Agriculture (USDA) found a variety of user financing schemes being used by food safety inspection agencies around the world (see MacDonald *et al.*, 1999). Some inspection agencies charge fixed fees regardless the number of units inspected, others charge per-unit fees, while still other agencies charge no fee, with the inspection costs borne indirectly by the public through taxes. Clearly, different fee mechanisms will have different welfare effects. This paper examines the effects of food safety certification when numerous sellers are unable to signal the safety of their products on their own and compares the different types of grading and inspection services offered by such public agencies as the Food Safety and Inspection Service, the Agricultural Marketing Service, the Food and Drug Administration, the Grain Inspection Packers and Stockyards Administration, just to name a few. Primarily, the issue of certification financing is analysed with emphasis placed on the welfare effects of different user fees. Like Segerson (1999), we also examine the question of voluntary versus mandatory certification.

Drawing on recent literature from industrial organization, an adverse-selection framework is proposed under Bertrand competition, where public, third-party certification provides food-safety information to imperfectly informed buyers. The paper focuses on a

situation with numerous sellers unable to certify their products. Our aim is to understand how certification should be financed taking into account the structure of the certification cost. We distinguish among three means of financing commonly used by public agencies: i) a fixed user fee, ii) a per-unit user fee, and iii) a public financing program borne by federal or state taxes. In order to make allowances for the complexity of the certification process, two types of certification cost structures are also distinguished: i) where the inspecting agency incurs a fixed cost of certification and ii) where the cost of certification depends on the number of units inspected.

Public certification and labelling

In agricultural markets, public agencies aim at mitigating potential inefficiencies resulting from imperfect information about quality or safety (private certification is considered at the end of this paper). Recently, the United States announced new initiatives to address the health risks from food borne diseases. Canada, France and the United Kingdom have also recently established new food agencies with broad mandates for health, safety and inspection responsibilities. Clearly, in the absence of quality certification or testing, consumers may have difficulty evaluating product characteristics. According to Nelson's classification (1970), such asymmetric information concerns *experience* characteristics if quality is revealed after purchasing, and *credence* characteristics if quality is not revealed even after purchasing. Credence goods are somewhat a particular case of experience goods, if the lag between consumption and quality detection is very long or if the origin of, say, a foodborne illness cannot be determined clearly. Safety may be considered under either category depending on how soon (if at all) symptoms occur after consuming an unsafe good.

Public institutions that certify product quality are thus very useful in providing

information to buyers via governmental grading systems.[1] Part of the existence of these institutions for third-party certification is explained by the cost and the complexity of laboratory or auditor services for reliably establishing a product's quality level. The cost to set up a certification process or to manage highly skilled inspectors is generally prohibitive for an individual producer. In this case, a variety of voluntary or mandatory measures imposed by the public regulator are useful for signalling quality or safety (via a label or a grading system) and/or improving the level of quality or safety (via a standard). For instance, the legislation for the Agricultural Marketing Act of 1946 that established the Agricultural Marketing Service (AMS) stipulates that the inspections and certifications by this particular branch of USDA are voluntary. On the other hand, the HACCP (Hazard Analysis Critical Control Point) in the US and in Canada, is a mandatory process that aims at targeting and reducing the safety risk for meat in farms, plants and slaughterhouses (see Hooker and Caswell, 1996).

Recently, the Economic Research Service of the USDA examined how different governmental agencies around the world finance their inspection and grading services (MacDonald *et al.*, 1999). Our discussion draws upon this report, and the reader is referred to it for further details. Some inspection agencies charge fixed fees regardless the number of units inspected, others charge per-unit fees, while still other agencies charge no fee with the inspection costs borne indirectly by the public through taxes. Meat and poultry inspection user fees vary by country. EU members are obliged to recoup the entire cost of the inspection service through user fees, though the types of fees set are determined by the member states. For instance, Denmark bases its fees on the cost of production. In Canada, Japan, and

[1] Oftentimes, without third-party certification, it is more or less impossible for consumers to detect fraud. Consider the now well-known case of the Beech-Nut Nutrition Corp. From 1978 to 1982, Beech-Nut, the second largest US manufacturer of baby-food products, sold "apple juice" that contained mostly sugar and water and very little apple juice. (See the discussion in Carlton and Perloff, 1994, pp. 620-621.) The ruse was only detected when a Beech-Nut chemist blew the whistle. With third-party inspection, such a fraud might have been easier to detect.

Mexico, user fees cover part of the inspection costs with public financing for the remainder (p. 3). The type of fee used is often a combination of per-unit and fixed fee (i.e., lump sum fee). Per-carcass charges are levied in Argentina and Great Britain. Australia charges registration fees, and Canada charges hourly rates based on overtime pay scales and fixed fees for other categories such as lab testing. Japan charges fees for testing and overhead, and Mexico charges firms based on the official minimum salary for veterinarians.

Likewise, in the United States there is a combination of user fees that are assessed in the various departments and agencies that provide grading or inspection services. For example, the Food Safety and Inspection Service (FSIS) of USDA funded approximately 13.5 percent of its 1996 costs through the collection of $85 million in user fees (p. iii). Moreover, the Agricultural Marketing Service (AMS) of USDA charges hourly fees for grading, inspection and quality assurance, with adjustments made for volume. The AMS has separate testing charges. The Animal and Plant Health Inspection Service (APHIS) that provides veterinary, inspection and quarantine services for imported animals and animal products charges fees based on overtime rates and cost-based charges per animal or vehicle, and, like AMS, also uses fixed testing charges. The Food and Drug Administration (FDA) charges fixed application fees for new drugs but also collects annual fees for existent drugs and manufacturing plants. The Grain Inspection, Packers and Stockyards Administration (GIPSA) uses hourly inspection charges that vary by volume for its grain and rice inspection and weighing. GIPSA charges fixed fees for testing. The National Marine Fisheries Service likewise uses hourly charges for inspection but varies the fee according to location, time of day and the type of inspection. The Nuclear Regulatory Commission charges user fees based on hourly charges that cover the full cost of the inspection; license fees and annual fees are also charged.

These examples allude to the important link between fees and inspection costs.

MacDonald *et al*. argue that inspection fees "should reflect the incremental cost associated with providing [the] service," (p. 19) and provide their rationale against the use of lump-sum (FDA-like) fees that do not vary with plant output. Their reasoning is that, unlike pharmaceuticals development, in the case of, say, meat and poultry industries, fixed costs of production are "small shares of the total [cost], and gross profit margins are low enough that FDA-like fees would likely cause some plants to shut down. As a result, feasible meat and poultry inspection fees will likely have to be based on factors that vary with output (such as meat production or inspector hours) and will, therefore, primarily fall elsewhere than on the firm's owners." (p. 21).

There is a long history of research examining the effects of various cost structures on both consumer and producer welfare. Because a third-party certification on a product, like that of an inspection seal, is an advertisement of the product's quality, the effect of advertising costs on profit and welfare is related to our analysis. Dorfman and Steiner (1954), in determining how a monopolist sets prices and advertising to maximise profits, use a lump-sum advertising cost. Likewise, Nerlove and Waugh (1961) consider this same question with respect to a competitive industry that finances an industry-wide promotion program using a lump-sum tax. Alston, Carman and Chalfant (1994) reconsider both of these advertising scenarios and compare the results from a lump-sum financing scheme with those of a per-unit tax to fund the advertisement. Our paper also examines the effect of both lump sum and per unit fees to pay for the certification signal but differs from this studies because we explicitly consider the influence of different structures of certification costs in a context of imperfect information.

The second strand of literature is related to the role of grading and common labelling for sellers in agricultural and commodity markets (see Caswell and Modjuszka (1996)). This literature points out the mechanisms of quality disclosure. Segerson examines the conditions

under which a producer would be induced to voluntarily invest in food safety. Hollander, Monier and Ossard (1999) analyse the impact of a grading system, taking into account the competitive structure among sellers. Somewhat related to our study is that by Nimon and Beghin (1999) who study buyers' willingness to pay for eco-labels describing a product's content. Our study differs from these because we explicitly analyze the optimal way to finance the public certification that reveals product safety.

The model

We begin with a simple, stylized framework (robustness and extensions will be given later). Trade occurs in a single period. The set of n sellers is composed of n_h identical sellers selling safe products and $(n–n_h)$ identical sellers who produce harmful products. One may think of each seller as a processor using farm inputs with safety levels that have already been determined. Because we assume safety is determined exogenously, sellers' marketing costs do not differ whether the product is safe or unsafe: the same processing is performed on a safe farm product as on an unsafe one. We assume that the marginal cost of production is the same for every seller and equal to zero (setting marginal cost equal to zero does not change the analysis that follows but does simplify the discussion).

The specific quality of each commodity is known by each seller but is not observed by buyers or other sellers. Sellers simultaneously select a strategy to signal their products' safety. Buyers are risk neutral and want to purchase only one unit of the good, and no buyer would *knowingly* purchase a dangerous product.[2] $k > 0$ represents the quality level for a safe product, whereas an unsafe product has a quality level equal to zero. (Alternatively, one could consider the case where consumption of harmful products results in some disutility, represented by a quality level for unsafe products that is less than zero. Our assumption

[2] Our assumption of risk neutrality makes our demand and welfare conclusions more conservative: if buyers are risk averse, the desire for and the benefits from certification increase.

simplifies the algebra without fundamentally altering the economic mechanism that we want to illustrate.) For a safe product, consumers have a willingness to pay equal to θk, but they differ in their willingnesses to pay for safety, which is described by the uniformly distributed parameter $\theta \in [0,1]$. For the sake of simplicity and without loss of generality, the mass of consumers is normalised at unity. A consumer who buys one unit of the safe product at a price of p has an indirect utility equal to $\theta k - p$ (see Mussa and Rosen (1978)).

Following Nelson's classification, we presume that goods are *experience goods* so that buyers are able to determine safety after purchasing but cannot be certain of the product's origin. Such a condition would arise when agricultural products from a variety of processors are sold at the retail level with no brand designation. Many fruits, vegetables and meat products are sold in this way in grocery stores, for instance. This assumption, coupled with our assumption that safety is exogenously determined, means that reputation setting by firms would not be useful in this model; although, we do discuss such an extension at the end of the paper.

Perhaps through repeat purchases, buyers develop a prior probability of obtaining a safe product. For simplicity, we set this prior probability equal to the actual probability of obtaining a safe product among a choice of uncertified products: $\lambda = (n_h - n_c)/n$, where n_c is the number of safe sellers who choose to certify and is, thus, less than or equal to n_h. In this way, a buyer's information updating depends on a seller's strategy in signalling product quality, and we assume that third-party certification accurately signals product safety.

Assume that only a public agency is able to provide credible certification (the situation with a private middleman will be considered later). This public agency incurs fixed and/or variable costs to guarantee certification credibility. Fixed costs comprise the development costs for detecting safety along with the informative advertisement that

perfectly signals the product's safety.[3] The cost of facilities inspection depends on plant size along with the complexity of the production process. The inspection also entails variable costs if the certification requires control of products' performance (or content). Although many situations might include a combination of these different types of cost, we separate them in the analysis for the sake of simplicity. Two certification cost cases are considered: i) where the inspecting agency's cost of certification is independent of the number of units inspected (a fixed cost of certification), and ii) where the cost of certification depends on the number of units inspected. We also distinguish among three common means of financing the inspection cost: i) a fixed user fee, ii) a per-unit user fee, and iii) public financing paid for by taxpayers.

Certification is voluntary. Although many of the examples previously discussed concern mandatory programs, we make this assumption for three reasons. First, in some instances, there may be consumer demand for certification even when there is no governmental requirement. Second, we wish to ascertain whether some certification cost and financing combinations under voluntary certification lead to markets where every seller with a safe product chooses to certify and every seller with an unsafe product leaves the market. In other words, like Segerson, we ask whether mandatory certification is always necessary. Third, a model that leaves certification choice endogenous provides a regulator with the opportunity to move to a mandatory system should the need arise. A mandatory system, such as a minimum safety standard, may also be more costly than a voluntary system as the regulator must inspect all sellers in an industry. Our model follows the format of the 1946 Agricultural Marketing Act, in that, although participation is voluntary, firms may not opt out of the certification once the inspection has been made.

[3] See De and Nabar (1991) and Mason and Sterbentz (1994) for imperfect product testing. In these studies, the sellers' benefit from testing decreases because the consumers' willingness to pay declines as the reliability of a test decreases.

The single round of trading proceeds in three stages. In stage 1, the regulator selects its policy, namely whether or not to propose voluntary, public certification. In stage 2, producers simultaneously choose whether or not to certify the quality of their products with the certification results observed by every seller and every buyer. In stage 3, producers simultaneously set prices (Bertrand Competition).

A consequence of our assumptions is that sellers cannot individually indicate their product safety without third-party certification. Bagwell and Riordan (1991) demonstrate that if it is more costly to produce high quality than low quality and if there is a positive demand for low-quality products, high-quality seller(s) can be induced to reduce their sales (increase price) to signal a high-quality level. This entails a high-quality seller selecting a specific strategy that a low-quality seller(s) cannot afford (i.e., a separating equilibrium). In our model the cost is the same whatever the safety and there is no demand for unsafe products, which leads to the impossibility of own signalling by sellers (i.e., a pooling equilibrium). Moreover, as repeat purchases à la Milgrom and Roberts (1986) mean little if consumers have no knowledge of brands (i.e. product origin), sellers cannot signal their high quality by either a lower price or advertising. These reasons explain why sellers may resort to an independent institution(s) to certify quality. In other words, the intensity of competition among sellers leads to the absence of profit and impedes these sellers from signalling their level of safety.

No certification versus full information

To frame our model, we first consider the scenario where safety certification (either private or public) is unavailable. In this case, a pooling equilibrium emerges whereby all sellers charge the same price equal to marginal cost (equal to zero). n sellers offer their products, and consumers expect safety to be λk with $\lambda = n_h/n$, as each seller has the same probability of being selected. Because the maximum consumer's willingness to pay, λk (for $\theta = 1$), is

greater than price, trade occurs along the entire market interval: total demand, *Q*, is equal to one. Consumers' *expected* surplus (as well as total welfare since profits are zero) is

$$CS_1 = \int_0^1 \theta\lambda k \, d\theta = \lambda k/2 . \tag{1}$$

Now consider a second case where safety certification has no cost. We present this unrealistic case merely to provide a boundary for the scenarios that follow. The outcome of this situation is trivial. All safe sellers certify and, because of the certification label, buyers observe the certification result and can perfectly deduce product safety (goods are no longer experience goods). Notice that sellers with unsafe products have no incentive to signal their quality. If these sellers choose to certify the safety of their products, low-quality levels would be revealed and buyers would not be willing to pay for these unsafe products. Thus only sellers with safe products have an incentive to certify their products, and consumer surplus would be as that given in equation (1) with λ equal to one.

Having now provided a framework for our model, we shall next consider the three means most often used in the financing of public certification. In the analysis that follows, we determine the optimal method of financing given the type of cost faced by the certifying agency. We first consider fixed and per-unit certification costs financed through user fees and then compare the results when these costs are financed through general taxes.

Case 1: A fixed certification cost financed by a user fee

We first consider the case where the inspection agency incurs a fixed cost, *A*, independent of the number of sellers. Perhaps the certification requires an investment in a costly testing device, a cost that must be incurred regardless of the number of units or firms inspected. The public agency maximises welfare and balances its budget for certification. The regulator faces three decisions: 1) propose voluntary certification with a fixed user fee paid by those producers who certify, 2) propose voluntary certification with a per-unit fee imposed on

producers who certify or 3) do nothing (leading to a consumer surplus given by (1) due to the absence of certification). Before characterising the optimal choice, we describe each decision.

1) Financing under a Fixed User Fee. First, we allow voluntary labelling with a fixed user fee paid by producers. Because we only have two product types (safe and unsafe), under Bertrand competition, only one seller with safe products will emerge to pay the cost of certification A due to a positive profit on the segment of certified products (local monopoly).[4] If a second seller also certified, the homogeneity of the two goods would reduce price to marginal cost and both sellers would incur a loss equal to the user fee. For this reason, once a seller has emerged to certify, there is no incentive for any other seller to certify. Given such a situation, the regulator simply charges the certifier a user fee equal to A. The $(n-1)$ other sellers are able to post a price equal to marginal cost on the segment of uncertified products.[5] Now, since one seller with a safe product uses certification, consumers can distinguish between products without certification (with an expected safety $\lambda k = (n_h-1)k/n$) and products with certification (with an expected safety k). The result is that both types of products are bought. Because of the distribution of preferences, some consumers are willing to pay more for a certified product, whereas others prefer to take their chances on the segment of uncertified products. Denote the price of the certified products as p_h. Products without certification have prices equal to marginal cost, namely zero (due to the competition among sellers without certification). The consumer indifferent between buying a certified product

[4] This extreme result is linked to the Bertrand assumption. Note however, that under the Cournot competition with a positive fixed cost of certification, a limited number of safe sellers would be able to certify their products.

[5] Note that this result holds because the choice of certification in stage 2 goes before the choice of price (in stage 3). At the end of stage 2, only one safe seller is commited to the certification process because any more than this would result in negative profits under competition. In stage 3, the safe certifier may select a monopoly price. By retaining this assumption, we capture the fact that the fixed cost of certification results in real, local monopoly power for a lone, safe certifier. If choices of certification and price were concurrent (in stage 2), then only one seller would certify. However its profit would be equal to zero, as it would set price just high enough to balance its budget: $p_h[1-p_h/(k(1-\lambda))] - A = 0$ (where this profit is defined below). Indeed a certifying seller with a posted price $p > p_h$ would be replaced by a seller proposing a lower price with certification. It is possible

and buying an uncertified product is identified by the preference parameter $\tilde{\theta} = p_h / k(1-\lambda)$ (such that $\tilde{\theta}\lambda k = \tilde{\theta}k - p_h$). The demand for certified products is $Q_h = 1 - p_h/(k(1-\lambda))$ and the demand for uncertified products is $Q = p_h/(k(1-\lambda))$.

The seller with certification chooses p_h to maximise its profit, $\Pi_h = p_h Q_h - A$, resulting in an equilibrium price $p_h^* = k(1-\lambda)/2$ and a profit of

(2) $$\Pi_h = k(1-\lambda)/4 - A .$$

Consumers' surplus is

(3) $$CS_2 = \int_0^{\tilde{\theta}} \theta\lambda k \, d\theta + \int_{\tilde{\theta}}^1 (\theta k - p_h) d\theta = k(3\lambda + 1)/8 .$$

The overall welfare is $W_2 = CS_2 + \Pi_h = k(3 + \lambda)/8 - A$. One seller with safe products will certify its products, as soon as its profit, Π_h, is non-negative, namely when $A \leq k(1-\lambda)/4$. The certified seller's monopoly power is attenuated by competition on the uncertified products' segment. This is the case when λ is relatively large (i.e., n_h is large so consumers have not had much experience with unsafe products in the past), because some consumers may prefer to take their chances with uncertified (and lower priced) products. As λ approaches one, the monopolist's price and profit approach the competitive levels.

2) Financing under a Per-Unit Fee. Now we turn to a voluntary label financed by a per-unit fee imposed on the producers.[6] A per-unit fee is collected by the certifying agency on each sold unit of goods. In this case, competition leads all sellers with safe products to use certification. Because producers have per-unit costs equal to the fee and the demand they face is elastic, sellers can simply pass on the per-unit fee, *t*, to consumers leading to an

to show that such a game, in fact, will not change the results in case 1, which follow.
[6] Results are similar with an ad-valorem fee under Bertrand competition.

equilibrium price t.[7] Therefore, with no other barriers to entry, all safe producers would choose to certify. Any producer avoiding certification would be perceived by consumers as selling an unsafe product. While, we maintain that no consumer would knowingly purchase an unsafe product, the fee of t, may make some consumers prefer to purchase nothing as opposed to purchasing the certified product. The consumer indifferent between buying a certified product and buying nothing is identified by the preference parameter $\tilde{\theta} = t/k$ (such that $\tilde{\theta}k - t = 0$), which leads to a demand for safe products of $Q_h' = 1 - t/k$. The public agency balances its budget such that the gross benefit, tQ_h', resulting from a per-unit fee t equals the fixed cost of certification A: the regulator determines t such that

$$t(1 - t/k) = A \,. \tag{4}$$

When the public agency's fixed cost of certification is high, such that $A > k/4$, this budget constraint cannot be satisfied and the budget will not be balanced. In this case, benefits do not cover costs, and the public agency will not propose a certification label. When the fixed cost of certification is $A \leq k/4$, a positive fee may be selected if consumers benefit from certification. In this case, the regulator limits the price distortion resulting from taxation by choosing the lesser root of equation (4) and imposes a tax level of

$$\bar{t} = \left(k - \sqrt{k^2 - 4Ak}\right)\!/2 \,. \tag{5}$$

Let θ_0 denote the consumer indifferent between purchasing nothing and purchasing the safe product at a price of $\bar{t}$ such that $\theta_0 k - \bar{t} = 0$, or $\theta_0 = \bar{t}/k$. The consumers' surplus (as well as total welfare since profits are zero) is equal to

[7] The incidence of the fee is due to our choice of a per-unit cost of production. Another scenario may be that some of the assessment is passed on to consumers and the rest is passed back to the farm-input supplier. If the farm supply is fixed, as might be the case in a short-run analysis, then the farmer bears the entire burden of the assessed fee. In either case, all sellers with safe products will choose to certify so the analysis that follows does not change.

(6) $$CS_3 = \int_{\theta_0}^{1} (\theta k - t)\, d\theta = \left(k + \sqrt{k^2 - 4Ak}\right)^2 / 8k \, .$$

Here, all safe sellers certify their products, post a price $\bar{t}$, and have zero profits. What is important to realise is that despite the price distortion, the per-unit fee does not further distort the competitive structure of the market as in the case with a fixed certification fee. When the fixed cost of certification is $A \leq k/4$, a positive fee may be selected if consumers benefit from certification, namely if $CS_3 > CS_1$, with CS_1 given in equation (1). This inequality holds when λ is relatively low, as some consumers avoid taking chances with uncertified products. Specifically, for $\lambda < 1/4$, then $CS_3 > CS_1$ whatever the value of $A < k/4$. For $\lambda \geq 1/4$, then $CS_3 > CS_1$ for $A < k\lambda^{1/2}(1-\lambda^{1/2})$.

The optimal decision for the regulator is clear. In the case where the cost of certification is fixed, a per-unit fee is preferred to a fixed user fee if consumers' surplus increases with certification.[8] In other words, if $CS_3 > CS_1$, and the regulator can cover its costs (i.e., $A \leq k/4$), proposing a voluntary label financed by a per-unit fee is welfare improving. Note that, by implementing a per-unit fee, mandatory labelling is unnecessary since all sellers with safe products voluntarily certify their products.

Case 2: Per-unit certification cost financed by a user fee

Suppose now that the certifying agent incurs a per-unit cost for every unit inspected and certified. This case is probably closest to reality for many of the inspection agencies we discussed above. In many cases, costs to the regulator are composed chiefly of an inspector's wage. The more products to be examined, the greater the cost to the certifier from the hiring of additional inspectors. A is now a per-unit cost and the certifying agent faces a total cost of

AQ where Q represents the total number of units certified. Clearly it matters not whether the public agency charges a fixed fee or a per-unit fee to cover its certification costs as these are now equivalent. (In the case of a public regulator that wishes only to balance its budget, if it inspects q units at one firm, it will incur a cost of Aq and to recoup this cost will charge the inspected firm Aq, or A per unit inspected.) The regulator sets a per-unit fee of A, and all sellers with safe quality choose to certify. Unlike the first scenario, the regulator will provide certification services for any $A \leq k$.[9] In this case, consumer surplus is as given in equation (7) with θ_0 found as before (with A replacing t) such that $\theta_0 = A/k$:

$$CS_4 = \int_{\theta_0}^{1} (\theta k - A) d\theta = (k - A)^2 / 2k \,. \tag{7}$$

If $CS_4 > CS_1$ (i.e. for $\lambda < [(k-A)/k]^2$), the public agency proposes voluntary certification financed by a per-unit fee equal to A.[10] Once more, mandatory labelling is unnecessary due to competition and consumers' demand for safe products.

In these last two sections, we underscored the importance of a per-unit fee under competition. Note that if the agency faces a combination of the two types of costs, it may balance its budget while imposing the per-unit fee. For instance, if the certification agency incurs a fixed cost, A and a variable cost a (depending on the number of units tested), then the certification agency will select a per-unit fee such that the budget is balanced, namely $t(1 - t/k) = A + a(1 - t/k)$, with $(1 - t/k)$ equal to the total demand for safe products. The importance of the voluntary process is clear. With an appropriate selection of per-unit user fees, the competitive process itself compels firms with safe products to choose certification.

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[8] It is easy to check that $CS_3 > W_2$ when $CS_3 > CS_1$ (i.e., when λ is relatively low). For larger values of λ, the welfare with a fixed user fee, W_2, may be greater than the welfare with a per-unit fee, CS_3. However, in such a case, certification is meaningless because for such large values of λ, welfare without certification, CS_1, is greater than W_2.

[9] Recall that consumer preferences have been normalized so that the highest willingess to pay is $\theta = 1$.

Public financing of the certification cost

We now consider the case where the certification cost (either fixed or per-unit) is financed by public financing, with a lump-sum tax on all taxpayers, rather than by charging a user fee to those consumers or producers who directly benefit from the certification. Recall that in the situation of perfect information (where all safe sellers certify and no consumer buys an unsafe product), there will not be any welfare loss from the consumption of unsafe products and consumers benefit from competition. In this case consumer surplus would be

$$CS_5 = \int_0^1 \theta k \, d\theta = k/2 \, . \tag{8}$$

Now, let the regulator's certification cost, A, be financed by public funding. Notice that A can represent either the case of a fixed cost incurred by the certifying agency or the total cost $A \cdot Q$ from a per-unit cost incurred by the certifying agency. In the latter case, $Q = 1$ since demand will be along the entire unit interval, thus $A \cdot Q = A$.

Under public financing, total welfare is $CS_5 - \delta A$ where δ is a multiplier that represents the opportunity cost of public funds (see Ballard *et al*. (1985)). If δ is not too large, the regulator proposes public financing for certification when $CS_5 - \delta A > CS_1$, because this means of financing overcomes the market distortion from a consumption tax.

However, raising revenues for certification imposes distortionary costs on the economy, such that δ is generally greater than one (a government may also shun public financing to limit an increasing bureaucracy (see Niskanen (1968)). If this opportunity cost is very high, then the certification cost will be financed through user fees on those agents (producers and consumers) that directly benefit from trade and the safety information, as laid

[10] Because the per-unit cost is not a function of k, it is possible to re-write the relationship $\lambda < [(k–A)/k]^2$.in terms of the price elasticity of demand at A. At a price of A, demand for safe products is given by $Q = 1 – A/k$, which is used to derive the price elasticity of demand (in absolute value) η. Simple manipulation reveals that safety has the relationship $k = A(1+\eta)/\eta$. Therefore, $CS_4 > CS_1$ for $\lambda < [\eta/(1+\eta)]^2$.

out in cases 1 and 2.

Obviously, we can not be certain what the opportunity cost of public financing is, but consider the case where there is no tax distortion from public financing, that is, $\delta = 1$. The results are as follows. With fixed certification costs (case 1), public financing (via a lump-sum tax) is more efficient than user financing with a per-unit fee: $CS_5 - A > CS_3$. However, with the cost of certification depending on the number of units inspected (case 2), a per-unit fee leads to greater welfare than that under public financing: $CS_5 - A < CS_4$. Note that if the agency faces a combination of the two types of costs, then the certification agency will be (optimally) financed by public financing for an amount equal to the fixed cost and will impose a per-unit fee equal to the variable cost of certification.

In the sections that follow, we present two short extensions. First, we look at the case where a monopoly exists in the production of goods and then we consider the case where a monopoly exists under private certification.

Extension 1. Certification for a single seller

Assume now that there is a single seller whose products are safe with some probability $\mu \in [0,1]$. If the seller does not certify its products, it charges the same (monopoly) price on all of its output regardless of an individual product's safety. Consumers expect safety to be μk, implying a demand $Q = 1 - p/\mu k$. The seller maximizes its profit pQ, resulting in a monopoly price under uncertainty $p_u = \mu k/2$ and a profit of

$$\Pi_u = \mu k/4 \tag{7}$$

The consumers' expected surplus is $CS_u = \int_0^1 (\theta \mu k - p_u) d\theta = \mu k/8$, and total welfare is $W_u = CS_u + \Pi_u = 3\mu k/8$.

Certification. For brevity, we focus on the case where the public inspection agency

incurs a fixed cost A. First, we allow voluntary labelling with a fixed user fee paid by the producer and equal to A. Because consumers will only purchase that portion of the monopolist's products that pass inspection, the demand for these certified products is $Q_h = 1 - p_h/k$. The seller maximises its profit given by $p_hQ_h - A$, resulting in a price $p_h^* = k/2$ and a profit of $\Pi_h = k/4 - A$. With $\tilde{\theta} = p_h^*/k$, consumers' surplus is $CS_c = \int_{\tilde{\theta}}^{1}(\theta k - p_h)d\theta = k/8$ and the overall welfare is $W_c = CS_c + \Pi_h = 3k/8 - A$. The seller with safe products will certify its products, as soon as its profit, Π_h is greater than Π_u given by (7). This corresponds to a situation where $A \le k(1-\mu)/4$. Note that for $A > k(1-\mu)/4$, total welfare could increase with certification over welfare in the absence of certification. In particular, welfare under certification, W_c, is always greater than welfare without certification, W_u, when $A \le 3k(1-\mu)/8$.[11] However, for $k(1-\mu)/4 < A \le 3k(1-\mu)/8$, the monopolist does not certify its products, even though it is socially optimal for it to do so (the monopolist only considers its profit, not social welfare). Nevertheless, because the monopolist's profit is always positive for $k(1-\mu)/4 < A \le 3k(1-\mu)/8$ as long as $\mu \ge 1/3$, a regulator should impose mandatory certification. (For μ < 1/3, a regulator can not implement mandatory certification when $k/4 < A \le 3k(1-\mu)/8$, because the seller's profit with certification is then negative.)

Extension 2. Certification with a private middleman

Here we briefly examine the issue of private certification. Some processes of certification require basic *R&D.* The lack of inspection technology by private agents provides one justification for public certification, particularly in the case of food safety. However, for some industries, technology and knowledge are available and a private middleman may develop a credible system of certification. For example, the International Standard Organisation (see ISO, 2000), Underwriters' Laboratories (with its "UL Approved" label) or the various organic food certifiers in the US act as private middlemen. The cost of certification may explain why private certification activity is generally very concentrated. The key issue, then, may be to foster competition among middlemen to limit their rent capturing.[12] In our context, the development of credible certification may entail some important sunk cost, an exclusive license to provide certification services, or a patent on inspection technology that impedes competition among middlemen.

For brevity, we consider the single case where there exists numerous sellers and a fixed cost of certification independent of the number of sellers. Using the same methodology as above, it is possible to show the following results. If a single private certifier exists, this private middleman will choose to charge a per-unit fee for certification services. Specifically, it chooses t to maximise its profit $t(1-t/k)-A$, which results in a higher fee than that derived by the public regulator in equation (5). The optimal fee chosen by the

[11] When the fixed cost of certification is $A \leq 3k(1-\lambda)/8$, it is easy to show that the fixed user fee leading to welfare, W_c, is always greater than welfare, $W_t = 3[k+(k^2-8Ak)^{1/2}]^2/32k$, resulting from a per-unit fee. This welfare W_t is computed as follows. With a per-unit fee, t, the monopolist maximises its profit $(1-p/k)(p-t)$ resulting in the monopoly price $p_m=(k+t)/2$, and the public agency balances its budget such that $t(1-p_m)=A$. When the fixed cost of certification is $A \leq k/8$, the regulator could impose a per-unit fee of $t_t = [k-(k^2-8Ak)^{1/2}]/2$, leading to W_t. Indeed, as the monopoly distorts its quantity/price choice, the per-unit fee needs to be higher to offset lower sales and maintain the regulator's balanced budget compared to the situation with competition. (This effect also occurs under Cournot competition with very few sellers with safe products. The lower the number of safe sellers, the lower is the competition intensity (with lower quantities selected by sellers). As sellers with safe products are more numerous, the per-unit fee necessary to balance the budget decreases.) In fact the per-unit fee leads to a greater dead-weight loss than under a fixed user fee. By implementing a per-unit fee, mandatory labelling is necessary when the cost of certification is high since the monopolist wields market power that may contradict the social interest.

middleman, namely $t = k/2$, results in a greater dead-weight loss than that arising from the per-unit fee set by the public regulator. Because of this distortion, the public may prefer having a public agency providing inspection services with the goal of maximising welfare. A second solution, however, is simply to allow competition in the certification sector. If more than one middleman is able to enter the market, because certification services are homogeneous, competition leads to the same fee as that set by the public agency.

Other extensions

In defining the analytical framework, very restrictive assumptions were made for simplicity. Results are robust if we consider the following extensions. (*i*) Under Cournot competition, the per-unit fee maintains competition while a fixed user fee limits the number of sellers able to certify their products, resulting in an oligopoly on the segment of certified products. Thus the per-unit fee is generally preferred by the public regulator. (*ii*) If sellers select their level of safety through some investment or effort (i.e., moral hazard), third-party, voluntary certification provides sufficient incentive for sellers to choose safe products. (*iii*) Under repeat purchases (where consumers can identify and remember the brands they purchase), a private or public agency needs to defend its reputation.[13] The costs of certification presented in this paper could also be interpreted as the public agency's costs of setting up and maintaining a reputation. (*iv*) If sellers have the same imperfect information on their safety level as buyers do, the per-unit fee maintains competition and gives an incentive for all sellers (with the same probability of proposing safe products) to certify their products. (*v*) It is conceivable that a demand for unsafe, or simply, lower quality products might exist. In this case, the model can be extended with some lower quality level greater than zero, but less than

[12] Biglaiser (1993) underlines how middlemen may provide worthwhile information, while Spulber (1996) notes that the market power of middlemen may outweigh any positive effect coming from information disclosure.

k. One could also use this extension to examine the role of differential marginal costs reflecting the two quality levels, as in the case of eco-labeling or organic certification.

Conclusion

The analysis in this paper was motivated by several food safety programs. Using a simple single-period model based on asymmetric information that also takes into account the crucial link between the structure of certification costs and the shape of fees, we showed the advantage of a (voluntary) per-unit fee that maintains competition among safe sellers. If the opportunity cost of public financing is high, then when either the certification cost is fixed or depends on the number of units inspected, a per-unit fee results in the greatest welfare gains, not only because of the information gains to consumers, but also because such a fee fosters competition among safe sellers.

On the question of voluntary versus mandatory certification, we find that if there is more than one seller of a safe product, voluntary certification financed by a per-unit fee is sufficient, because competition incites all such sellers to certify their products. The fact that Segerson, who used a very different model from ours, also found that voluntary certification could be sufficient is instructive. We did find, however, that if there is only one seller with safe products, mandatory certification is needed if the cost of certification is high. Moreover, in this monopoly case a fixed user fee more efficient than a per-unit fee in improving welfare.

As an aside, we also considered the case where certification is performed by private organisations. If there is only a single private agency (e.g. if the government grants an exclusive license) then a monopoly allocation by this agent results in the imposition of a welfare distorting per-unit user fee. However, when private certifiers compete for

[13] Note that a single seller may also directly signal safety through price or by public certification. In this case,

certification, welfare under private certification is the same as that under public certification.

Public intervention is crucial in agricultural markets because sellers may be unable to signal the safety of their products on their own. Our results are important in policy issues as they may legitimise some public actions to maintain competition with certification.

there is an arbitrage between a private signal with a necessary rent for assuring a credible revelation and a competititve structure among sellers where third-party certification is necessary for safety disclosure.

References

Alston, J.M., H.F. Carman, and J.A. Chalfant. (1994). "Evaluating Primary Product Promotion: The Returns to Generic Advertising by a Producer Cooperative in a Small, Open Economy." *Proceedings from the NEC-63 Spring '94 Conference*: 145-167.

Bagwell, K. and M. Riordan (1991). "High and Declining Prices Signal Product Quality." *American Economic Review*, 81:224-239.

Ballard C., J. Shoven and J. Whalley (1985). "General equilibrium computations of the marginal welfare costs of taxes in the United States." *American Economic Review*, 75: 128-138.

Biglaiser, G. (1993). "Middlemen as Experts." *Rand Journal of Economics*, 24 (2): 212-224.

Buzby, J.C, and T. Roberts (1996). "ERS Updates U.S. Foodborne Disease Costs for Seven Pathogens." *Food Review*, 19(3): 20-25.

Carlton, D.W. and J.M. Perloff (1994). *Modern Industrial Organization.* 2nd ed. HarperCollins College Publishers, New York.

Caswell, J. and M. Mojduszka (1996). "Using Informational Labeling to Influence the Market for Quality in Food Products." *American Journal of Agricultural Economics*, 78: 1248-1253.

De, S. and P. Nabar (1991). "Economic Implications of Imperfect Quality Certification." *Economic Letters*, 37: 333-337.

Dorfman, R. and P.O. Steiner. (1954). "Optimal Advertising and Optimal Quality." *American Economic Review*, 44: 826-836.

Hollander, A., S. Monier, and H. Ossard (1999). "Pleasures of Cockaigne: A Story of Quality Gaps, Market Structure, and Demand of Grading Services." *American Journal of Agricultural Economics*, 83: 501-511.

Hooker, N. and J. Caswell (1996). "Voluntary and Mandatory Quality Management Systems in Food Processing." Department of Resource Economics, University of Massachusetts, Massachusetts, USA.

ISO (2000), International Organisation for Standardisation, http:\\www.iso.ch, Geneva, Switzerland.

MacDonald, J., F. Kuchler, J. Buzby, F. Lee, and L. Aldrich. (1999*). User-Fee Financing of USDA's Meat and Poultry Inspection.* United States Department of Agriculture, Economic Research Service, Agricultural Economic Report Number 775. Washington, D.C.

Mason, C. and F. Sterbentz (1994). "Imperfect Product Testing and Market Size." *International Economic Review*, 35: 61-86.

Milgrom, P. and J. Roberts (1986). "Price and Advertising Signals of Product Quality." *Journal of Political Economy*, 94: 796-821.

Mussa, M. and S. Rosen (1978). "Monopoly and Product Quality." *Journal of Economic Theory*, 18: 301-317.

Nelson, P. (1970). "Information and Consumer Behavior." *Journal of Political Economy*, 78: 311-329.

Nerlove, M. and F.V. Waugh. (1961). "Advertising Without Supply Control: Some Implications of A Study of The Advertising of Oranges." *Journal of Farm Economics*, 43: 813-837.

Nimon, W. and J. Beghin (1999). "Are Eco-Labels Valuable? Evidence from The Apparel Industry." *American Journal of Agricultural Economics*, 81: 801-811.

Niskanen, W.A. (1968). "The Peculiar Economics of Bureaucracy." *American Economic Review*, 58: 293-305.

Segerson, K. (1999). "Mandatory Versus Voluntary Approaches to Food Safety." *Agribusiness*, 15(1): 53-70.

Spulber D. (1996). Intermediation and Market Microstructure. *Journal of Economic Perspectives*,10(3): 135-152.