Mandatory vs. Voluntary Approaches To Food Safety

by
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I. Introduction

Recent outbreaks of food-borne illnesses have raised concerns about the adequacy of protection measures designed to ensure food safety.[1] Illnesses can result from contamination introduced at a number of possible points, including the production stage, the processing stage, and the distribution and use stage. The first two of these are controlled by producers. In the third stage, users can affect safety as well, through, for example, proper washing and food preparation.

Incentives for producers to undertake protective measures can be provided either through the market (e.g., demand side shifts created through reputation or certification and labeling) or through public policy design (e.g., imposition of liability for damages, or direct regulation of processes or product quality).[2] While the federal government has a long history of regulation of food quality and safety,[3] there has been a trend toward increased regulation in recent years. For example, the USDA has recently required firms in food processing plants to implement Hazard Analysis Critical Control Point (HACCP) systems designed to improve food safety.[4] There is, however, a considerable debate about whether mandatory controls are necessary, since some firms had already chosen to implement HACCP systems voluntarily (Caswell and Henson 1997). The question is whether reliance on voluntary measures would lead to adequate consumer protection.[5]

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[1] See Antle (1995) for a discussion of issues related to food safety policy.

[2] Of course, market outcomes reflect public policies. Thus, the incentives created through public policy design can work through the market as well. See further discussion below.

[3] For a detailed list of references on food safety regulation, see Caswell (1988).

[4] See U.S. Food and Drug Administration (1995) and U.S. Department of Agriculture (1996). For discussions of HACCP, see Pierson and Corlett (1992), Mortimore and Wallace (1994), Unnevehr and Jensen (1996), Mazzocco (1996), Caswell and Hooker (1996), and Antle (1998). For a discussion of the benefits and costs of adopting a HACCP system, see GAO (1996) and Roberts et al. (1996).

[5] Caswell and Henson (1997) distinguish between "private" and "public" quality control systems, where private systems are voluntarily adopted by firms. In their terminology, the question is whether private systems are likely to lead to adequate protection.

To date there has been little formal discussion in the food safety literature of the choice between voluntary and mandatory approaches to consumer protection. However, this choice is not unique to food safety. A similar question has arisen in the context of environmental policy design,[6] and researchers have begun to model this choice explicitly in that context.[7]

Historically, control of environmental externalities has relied primarily on the use of regulatory mechanisms that impose requirements or restrictions on the operations of potentially polluting firms. While these regulations have generally been credited with generating significant reductions in emissions of environmental pollutants, there is also a consensus that comparable reductions could have been achieved at lower cost (e.g., Tietenberg 1985). The lack of flexibility embodied in most "command-and-control" regulations prevents firms from choosing cost-minimizing pollution control strategies. Recently, attention has been turning to the use of voluntary agreements as an alternative to traditional regulatory mechanisms for controlling pollution. The hope is that voluntary approaches will allow firms greater flexibility in meeting emission reduction goals and will hence achieve those goals at lower costs. There is a growing body of literature suggesting that under some conditions increased reliance on voluntary agreements would be desirable.[8]

This paper draws on the recent literature on voluntary agreements for environmental protection to examine the question of whether a voluntary approach to food safety is likely to lead to adequate consumer protection. We begin by delineating three alternative types of voluntary approaches, each involving a different role for the government. In the following section we present a framework that can be used to identify the factors that are likely to determine whether firms choose to undertake protective measures voluntarily. We then use a simple model of product safety to examine the conditions under which demand responses are likely to provide incentives for efficient investment in food safety. The results suggest that the market may work well to induce voluntary adoption of food safety measures for certain types of goods but not for others. The key distinguishing characteristic between the cases is the extent to which consumers and producers correctly perceive food contamination risks.

II. Types of Voluntary Approaches

In the context of environmental protection, a number of different types of voluntary approaches have been identified. Borkey and Glachant (1997)

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[6] See Davies et al. (1996) and EC (1996) for descriptions of voluntary environmental programs in the U.S. and Europe, respectively.

[7] See, for example, Segerson and Miceli (1997), Wu and Babcock (1996), Bosch et al. (1995), Stranlund (1995), and Carraro and Siniscalco (1996).

[8] See references in footnote 7.

identify three alternative approaches.[9] First, firms could make unilateral commitments to reduce environmental contamination. Under this approach, the initiative is taken by the firms or the industry as a whole. The government does not play an active role in determining the industry response. In the context of food safety, this would be comparable to firms voluntarily deciding to implement a HACCP system in response to market or public pressure, without any explicit prompting by the government. Similarly, firms could voluntarily change their product or production processes (e.g., switch to organic farming) in an effort to provide greater food safety to consumers. Producers who undertake voluntary changes might then develop a system of voluntary private certification.[10]

Under the second approach, environmental agreements are formally negotiated (one-on-one) between industry and public authorities. In such cases, the firm or industry agrees to undertake some environmental protection "voluntarily", usually in exchange for some concession granted by the government. This concession could take the form of a guarantee that the government would not impose mandatory standards on the firm.[11] Thus, the firm is essentially induced to participate through the threat of imposition of mandatory controls if a voluntary agreement is not reached (a "stick" approach). Alternatively, the firm could be induced to participate through positive inducements such as subsidies designed to help offset some of the costs associated with undertaking the protective actions (a "carrot" approach). In the context of food safety, the firm or industry might voluntarily agree to implementation of a HACCP approach in exchange for a forestalling of mandatory HACCP systems that would allow the firm less flexibility, or in exchange for some form of subsidy (e.g., tax breaks).

Finally, the public authority could develop a voluntary scheme and then seek participation by individual firms. For example, the U.S. Department of Agriculture has historically used voluntary programs such as the Conservation Reserve Program (CRP) and more recently the Environmental Quality Incentives Program (EQIP) to induce farmers to withdraw environmentally damaging land from production.[12] These programs offer farmers payments in exchange for voluntary land retirements. Similar approaches could be used to induce farmers to switch

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[9] See also Baggott (1986) and Goodin (1986).

[10] A program of this type is the ISO 9000 series. See Hooker and Caswell (1997).

[11] This seems to be the inducement behind the U.S. Environmental Protection Agency's 33/50 Program and Project XL. See Davies et al. (1996) for an evaluation of the success of these and other EPA voluntary programs.

[12] For other examples in the context of agriculture (where subsidies have been common), see Babcock et al. (1996), Cooper and Keim (1996), Norton et al. (1994), Wu and Babcock (1996a), and Wu and Babcock (1995). For an analysis of farmer incentives to participate in such programs, see Segerson (1997a, 1997b).

to production practices that provide greater food safety. For example, the government could establish a program under which farmers are paid for acreage on which integrated pest management or organic farming techniques are used. Such a program could have the dual goal of reducing water pollution and reducing pesticide residues on food.

Of course, the need for government intervention, either through direct negotiation with individual firms/industries or through the establishment of general voluntary programs, depends on the incentives that firms face to undertake protective measures voluntarily in the absence of any intervention. In the following section, we present a simple framework for examining a firm's incentives to undertake voluntary food safety measures. This framework highlights the factors that can be significant in determining those incentives and hence in determining the likely effectiveness of reliance on voluntary measures.

III. A Framework For Voluntary Adoption

Figure 1 depicts the basic choice facing a firm[13] that has two alternative courses of action: (1) to undertake measures to ensure increased food safety voluntarily, or (2) not to take any initiative unless forced (or induced) to do so by government regulations or other forms of mandatory public policies.[14] This choice could be in the context of the first type of voluntary approach discussed above, where the firm takes the initiative to undertake voluntary measures without any explicit government program in place. Alternatively, it could be in the context of the third type of approach, where the firm makes a decision about whether or not to participate in a voluntary program that has been established by the government.[15] We do not consider explicitly the second type of agreement, under which the firm and the regulator negotiate or bargain one-on-one over a level of voluntary compliance.[16]

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[13] We present the framework in the context of an individual firm. In some cases, a group of firms or an industry may be faced with this choice. See Segerson (1997a) for a related model with multiple firms.

[14] This basic structure has been used in models of voluntary approaches to environmental protection. See Segerson and Miceli (1997), Segerson (1997a), and Segerson (1997b).

[15] We do not consider explicitly the government's decision about whether or not to establish such a program. That decision would clearly depend on the firm's anticipated reaction to the program, which is depicted in Figure 1. For a model that presents the regulator's choice explicitly in the context of environmental protection, see and Segerson and Miceli (1997) and Segerson (1997a).

[16] Segerson and Miceli (1997) present a model of this type of agreement in the context of environmental protection. They have shown that under some conditions agreements resulting from this type of negotiation may lead to low levels of protection. However, since environmental damages are imposed on third parties (rather than on the consumer of the product whose production created the

As shown in Figure 1, if the firm chooses to undertake protective measures voluntarily, there is some probability q ($0 \leq q \leq 1$) that a contamination episode will occur.[17] In most cases, we would expect the protective measures to reduce the likelihood of contamination but not to eliminate it completely. Thus, $q>0$. However, if those measures ensure a completely safe product, then $q=0$.

The payoffs from undertaking protective measures voluntarily depend on the associated costs and benefits. Let C_v denote the additional cost the firm incurs as a result of undertaking the measures voluntarily. The magnitude of C_v reflects the fact that voluntary adoption keyed to performance standards allows the firm maximum flexibility in choosing the means by which those standards will be met. We would thus expect C_v to represent the minimum cost of ensuring a particular level of product safety. Let S represent the amount of the subsidy, if any, that the firm receives as a result of voluntary adoption of food safety measures. The magnitude of the subsidy that the government might be willing to pay to induce voluntary adoption will depend on a number of factors, including the social cost of raising the funds necessary to finance the subsidy and the expected benefit from voluntary adoption.[18] Let B_v denote the benefit that the firm receives from voluntary adoption. B_v will reflect not only revenue (net of production costs) from the sale of its product, including any increase in revenue due to increased demand for the product because of its increased safety, but also any public relations benefits (e.g., increased current or future demand because of increased "good will" toward the firm). Finally, let L denote the firm's expected loss as a result of a contamination episode. The magnitude of L will reflect a number of factors, including the magnitude of the actual damages to the victim, the liability rule that is

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externality), the firm does not internalize any of the external costs through the market. As will be seen below, in the context of food safety where the damages are borne by the consumer of the product, the market can sometimes provide a mechanism for internalizing some of those damages. Given this, we would expect the outcome of a bargaining between firms and the government over voluntary measures to lead to greater levels of protection than would have been the case in the absence of any internalization.

[17] Because our interest is in firm-level incentives, we focus here on contamination that can occur during the production or processing stages. We do not explicitly consider the role that consumers can play in determining damages through use of safe handling procedures. Instead, we simply interpret q as the probability of contamination given some level of care taken by consumers to avoid ingestion of contaminated food. We note, however, that the level of care that is likely to be taken by consumers will depend on a number of factors, including the information they have regarding potential contamination and the liability rule in place. See further discussion below.

[18] See Segerson and Miceli (1997) for a model that explicitly incorporates the government's decision regarding the magnitude of a subsidy for voluntary measures for environmental protection.

operative, the likelihood the source of the contamination is detected and the firm is held liable, and the severity of the public response (e.g., reduced future purchases due either to a perceived reduction in the safety of the product or to consumer boycotts as manifestations of public outcry).[19]

Given these costs and benefits, the firm's payoff from voluntarily undertaking the protective measures is B_v+S-C_v-L if contamination still occurs and B_v+S-C_v if no contamination occurs. Thus, the expected payoff is simply B_v+S-C_v-qL.

If the firm does not undertake voluntary measures, or equivalently chooses not to participate in a voluntary government program, then there is some probability r ($0 \leq r \leq 1$) that the regulator will impose mandatory controls or standards. If the imposition of mandatory standards is guaranteed if a voluntary approach is not adopted, then r=1. Alternatively, if there is no threat of imposition of mandatory standards, then r=0. More generally, the firm might expect that there is some likelihood of mandatory standards, i.e., it might perceive r to lie in the open interval (0,1).

We assume that the outcome of the voluntary measures (if adopted) is the same as the outcome of the mandatory standards that might be imposed. For example, if the protective measure under consideration is a HACCP system, we assume that a HACCP system adopted voluntarily would provide the same level of food safety as a possible mandatory system. Alternatively, if the voluntary measures are keyed to performance standards, we assume that any mandatory measures that might be imposed would be designed to ensure the same level of performance.[20] This essentially assumes that the target level of performance is the same regardless of whether the protection stems from voluntary measures or mandatory policies. Thus, we do not allow the possibility that the firm could forestall mandatory controls by undertaking a level of protection less than the target level set by the government.[21]

In the context of Figure 1, the above assumption implies that the probability of contamination would be the same for mandatory and voluntary standards. Thus, as shown in Figure 1, if the firm does not undertake voluntary measures and the government responds with mandatory standards, a contamination episode will still occur with probability q. If contamination occurs, the firm's payoff is B_m-C_m-L, where B_m is the benefit of meeting the mandatory standard and C_m is the associated cost. The payoff when no contamination occurs is simply B_m-C_m. If the mandatory standard is identical to the one that might have been

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[19] Caswell and Henson (1997) argue that the loss of reputation and market sales are likely to be of more importance to firms that the direct damage costs imposed through liability.

[20] This is not necessarily the case when firms negotiate with regulators over levels of protection. See Segerson and Miceli (1997).

[21] This assumption could be easily relaxed by allowing the probabilities of contamination to differ for the two approaches.

chosen voluntarily, then the direct market benefits of meeting the standard should be the same regardless of whether the standard was met voluntarily. In other words, the quality of the product will be identical and hence the direct consumer benefits (as reflected in willingness-to-pay) will be identical. However, the firm is not likely to receive much in the way of public relations benefits (e.g., good will) from meeting a mandatory standard. Since these public relations benefits are included in B_v, we would expect $B_v \geq B_m$. Similarly, since C_v represents the minimum cost of meeting the standard, C_m cannot be less than C_v, i.e., $C_m \geq C_v$. The actual magnitude of C_m will depend on the nature of the mandatory controls, as well as the transactions costs associated with meeting the mandatory standard. If those controls specify not only a performance standard but also a process or design standard, i.e., they also specify how the performance standard is to be met, then it is possible that the standard will not be met in a least cost way.[22] Conversely, if the mandatory controls simply take the form of a performance standard, they allow the firm maximum flexibility in deciding how to meet the standard. In this case, the firm would still be free to choose the least cost method. Even in this case, however, if compliance with the mandatory controls generates significant transactions costs, we would expect $C_m > C_v$.

If the firm does not adopt the measures voluntarily and the government does not impose a mandatory standard, then no protection measures are put in place. As a result, the probability of contamination is higher than it would have been with the standards. Let p denote the probability of contamination without controls, where $p > q$. Without controls, the firm's payoff is B_o-L if contamination occurs and simply B_o if it does not. In this case, B_o reflects the revenue from the sale of the product, given the higher probability of contamination.

A comparison of the expected payoffs from the tree depicted in Figure 1 suggests that the firm will choose to undertake the protective measures necessary to meet the given standard voluntarily if and only if[23]

(1) $$\mathbf{B_v+S-C_v-qL \geq r[B_m-C_m-qL] + (1-r)[B_o-pL]}.$$

To understand the implications of (1), we consider some special cases. First, suppose that the government plays no role in promoting food safety. In other words, it offers no subsidies and there is no threat of direct regulation, implying S=r=0. In this case, (1) reduces to

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[22] Food safety controls have historically focused primarily on process-related requirements. Recently, however, there has been a shift in the nature of some regulation, toward granting more flexibility to firms. See Caswell and Henson (1997), Caswell and Hooker (1996), and Unnevehr and Jensen (1996) for related discussions.

[23] This assumes that firms are risk neutral, or that they are able to diversify risks through the purchase of insurance or other risk spreading mechanisms.

(2) $$\mathbf{B_v - C_v - qL \geq B_o - pL},$$

or, equivalently,

(2') $$\mathbf{(B_v - B_o) + (p-q)L \geq C_v}.$$

This condition implies that the firm will undertake protective measures voluntarily (without any government inducement) if and only if the market benefits of doing so plus the reduction in expected damages the firm will have to pay exceeds the cost of the voluntary measures.

Suppose instead that a mandatory standard is inevitable if protective measures are not adopted voluntarily, i.e., r=1. In this case, the firm will adopt the measures voluntarily if and only if

(3) $$\mathbf{B_v + S - C_v \geq B_m - C_m}.$$

Note that this condition is independent of L, since the firm's expected loss is the same regardless of whether the protection is undertaken voluntarily or imposed by the government. In addition, given $B_v \geq B_m$ and $C_v \leq C_m$, condition (3) always holds, even without any subsidies, i.e., even with S=0. Thus, the firm will always undertake the measures voluntarily if mandatory controls are certain, since it can reap a potential public relations benefit and possibly incur lower costs by doing so.

The framework presented here suggests that the decision about whether to adopt voluntary measures depends on the interaction between a number of factors, including (I) the expected change in net revenues (through shifts in demand), (ii) the likelihood that mandatory controls will be imposed if a voluntary approach is not successful, (iii) the cost differential between meeting the standard voluntarily and being forced to meet it (perhaps in a more costly way), (iv) the legal rules regarding the payment of damages for injuries from contamination, and (v) the availability of any direct financial inducements from the government. For example, as expected, voluntary adoption is more likely in markets where consumer demand for the product is sensitive to product safety. Likewise, the mere threat of possibly less flexible and hence more costly mandatory standards can induce voluntary adoption. The greater the threat is, the more likely is voluntary adoption. However, this incentive requires that there be some potential gain from voluntary adoption, in the form of either reduced compliance or transaction costs or increased public "good will" from voluntary adoption. If there is no threat of regulation and demand is unresponsive to product safety, then the firm will undertake voluntary measures only if the expected reduction in damage payments exceeds the expected costs. Of course, if firms are not required to pay damages,[24] then in the absence of a responsive market or the background threat of regulation, they would face no incentive to invest in voluntary food safety measures.

IV. The Role of the Market

As noted above, two key determinants of the decision to undertake protective measures voluntarily are the expected changes in the net revenue that would be earned by the firm and the expected loss that the firm would incur with and without those measures. However, depending on the structure of the market and the nature of the product and damages, these two determinants may not be independent. The crucial issue in determining their independence is whether consumers correctly perceive the potential hazards associated with consumption of the product and hence adjust their willingness-to-pay for the product accordingly.

Antle (1998) distinguishes among three different categories of goods, depending on the information about the safety of the good that is available to consumers.[25] The first category is search goods. This includes goods for which the consumer is able to obtain information about the safety of the good either through inspection or through readily available information about the product. For such goods consumers have near perfect information about product safety before purchasing the good. The second category is experience goods, which includes goods for which the consumer can obtain information about the product safety through repeated purchases or through reputations established by purchases by others. While the information set of the consumer may not be complete at the time of the initial purchase, in long run equilibrium the consumer will have near perfect information about product quality. Because of the information that is available to consumers, we would expect the demand for both search and experience goods to be responsive to changes in product safety.[26]

The third category of goods is credence goods, where information about product safety cannot be discerned by the consumer, even after repeated consumption of the good. For such goods, the demand for the product will not be responsive to changes in product safety since consumers will be

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[24] Failure to pay for damages might result either from the lack of an explicit designation of firm liability or because of imperfections in the application of the relevant liability principle. See further discussion below.

[25] See also Darby and Karni (1973).

[26] Theoretical models of the effect of food safety on consumer demand are presented in Smallwood and Blaylock (1991) and Choi and Jensen (1991). Researchers have examined historical responses to changes in food safety information (see, e.g., van Ravenswaay and Hoehn (1991) for a study of Alar residues on apples). In addition, surveys have been used to estimate changes in demand due to perceived changes in food safety. See, for example, Preston et al. (1991), and a number of studies presented in Caswell (1995).

unaware of those changes.

To see the relationship between consumer demand and changes in product safety, consider a simple model of product safety.[27] We use the following notation. Let:

y = the amount of the good bought and sold;

q = probability that a given unit of the product is "not-safe", e.g., that it is contaminated by microorganisms, or has dangerously high levels of pesticide residue, where $0 \leq q \leq 1$;[28]

B(y) = the gross consumer benefits from consumption of y units of the good, with $B'(y)>0$, $B''(y)>0$;

P(q) = the price per unit of the good, with $P'(q) \leq 0$;

C(q,y) = the cost of producing y units of the good with the associated probability of contamination q, where $C_q<0$, $C_y>0$ and $C_{qy}<0$;[29]

D = damages from consumption of one unit of the good if it is contaminated;[30]

s = the share of the damages borne by the firm, where $0 \leq s \leq 1$;[31]

α = scale factor capturing the consumer's under or over-estimation of damages;[32] and

ß = scale factor capturing the firm's under or over-estimation of damages.

Clearly, if both consumers and producers correctly perceive the damages from contamination, then α =ß=1. We would expect this to be the case for search goods and in long run equilibrium for experience goods as well. However, for credence goods, it is possible to have α different from one.

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[27] The development here follows the traditional model of product liability originally proposed by Landes and Posner (1985). It is essentially a model of accidents between sellers and consumers. See Shavell (1987) for a general form of the model.

[28] Hence I=1/(1-q) can be viewed as an index of product safety, where q=0 implies a perfectly safe product (I=1) and q=1 implies a perfectly unsafe product (I=infinity).

[29] This specification of the cost function implicitly assumes that output and safety are joint products for the firm, as suggested by Antle (1998).

[30] We assume that per unit damages are fixed, given contamination. An alternative approach would be to allow the level of contamination (and hence the level of damages) to vary with investment in product safety. Under risk neutrality, the qualitative implications of the analysis would not change by relaxing the assumption in this way.

[31] The magnitude of s will be determined by the liability rule in place, the nature of the damages (e.g., acute vs. long term chronic), and the characteristics of the firm (e.g., the firm's asset base). See further discussion below.

[32] Alternatively, the consumer (or producer) could over or under-estimate the probability of contamination. The qualitative results would be similar to those presented here. For a model of this form of misperceptions, see Spence (1977). For a discussion of consumer perceptions in the context of pesticide residues, see Ott et al. (1991).

If the consumer were totally unaware of any potential contamination, then $\alpha=0$. If producers are also unaware of potential contamination, then $\beta=0$ as well.

The socially efficient values for y and q maximize the true expected net benefit from production and sale of the good given by

$$B(y) - C(q,y) - qDy. \tag{4}$$

The last term in (4) is the expected damages from consumption of y units of the good. Note that total expected damages can be reduced in two ways, either through an increase in product safety, i.e., an decrease in q, or through a reduction in consumption. For example, the expected damages from consumption of contaminated seafood can be reduced either through increased care in processing and handling or through decreased consumption. Likewise, the expected damages from ingestion of pesticide residues can be reduced either through a reduction in residue per unit of production or by a reduction in the consumption of foods with residues.

Maximization of (4) yields the following efficiency conditions:

$$B'(y) - C_y - qD = 0 \tag{5}$$

and

$$-C_q - Dy = 0. \tag{6}$$

These are the usual marginal benefit equal marginal cost conditions for an interior solution. We should note, however, that in some cases the efficient outcome may be a corner solution, with respect to either y or q. For example, if D is extremely large, it may be efficient to produce a product that is completely free of that risk (i.e., a product with q=0). If this is extremely costly, it may be efficient not to produce the product at all ($y^*=0$). For many cases, though, it is likely to be efficient to reduce the risk of contamination but not necessarily to eliminate it completely (unless this can be done at a reasonable cost).[33]

Given the efficient levels of output and safety, the question is whether the market equilibrium will yields these levels. Under risk neutrality,[34] the

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[33] While we assume interior solutions throughout, our qualitative conclusions would continue to hold when the efficient output or safety level is a corner solution.

[34] The assumption of risk neutral consumers is perhaps quite restrictive in the context of food safety, where some of the possible outcomes from consumption of contaminated food may not be easily insured against. (See Antle (1998) for a discussion of risk aversion in the context of food safety.) Risk aversion can be introduced into product safety models (see, e.g., Spence 1977). However, with risk aversion there are two potential distortions in the model, one from the damages associated with contamination and the other from the inefficient allocation of risk.

consumer chooses a consumption level of y to maximize the perceived expected net benefits from consumption, i.e., to solve

(7) $$\mathbf{Max\ \ B(y) - Py - (1\text{-}s)q\alpha\ Dy},$$

where the last term in (7) is the perceived expected damages that will not be compensated by the firm and hence will be borne by the consumer. For an interior solution, the choice of y solves:

(8) $$\mathbf{B'(y) - P - (1\text{-}s)q\alpha\ D = 0}.$$

Similarly, the firm chooses the levels of y and q to maximize perceived expected profit,[35] i.e., to solve[36]

(9) $$\mathbf{Max\ \ P(q)y - C(q,y) - sq\beta Dy},$$

yielding the following first-order conditions:[37]

In this case, to achieve an efficient solution, one generally needs two policy instruments, one to create the correct incentive for risk reduction and the other to ensure efficient risk allocation. If transfer mechanisms are available to ensure efficient risk allocation, then risk reduction incentives can be modeled as though the parties were risk neutral (see Miceli and Segerson 1995). If only one instrument (e.g., a single liability rule) is available, then the instrument must be designed to address both distortions. Unless it can simultaneously satisfy both objectives, a first-best outcome will not be possible.

[35] This is clearly a stylized model of producer behavior. A more detailed model would distinguish explicitly between alternative strategies that firms could use in response to consumer demand for food safety (see Caswell and Johnson 1991).

[36] This specification assumes that the only losses the firm might incur as a result of a contamination episode are those related directly to victim damages (D). We do not explicitly incorporate potential losses due, for example, to consumer boycotts or other manifestations of public outcry. In practice, these costs could far outweigh any direct liability payments the firm would have to make (Caswell and Henson (1997)), and inclusion of them would yield greater incentives for investment in food safety. We also model a single producer. In reality, the production and processing of a product might involve a chain of producers. For example, pesticide residues on food stem from the production activities of pesticide manufacturers and the use activities of farmers. See Segerson (1990) for an explicit consideration of safety incentives in a model involving a chain of producers.

[37] We assume here that the firm is perfectly competitive in its output market. Imperfect competition would add still another source of distortion into the analysis, which would generally require an additional policy instrument for efficiency or analysis of second-best outcomes. Note, however, that to the extent that the firm overproduces the good due to imperfect internalization of damages (see below), the existence of market power and the associated underproduction incentives would be efficiency improving. See Barnett (1980) for a related discussion in the context of environmental externalities.

(10) $$\mathbf{P(q) - C_y - sq\beta D = 0}$$

and

(11) $$\mathbf{P'(q)y - C_q - s\beta Dy = 0}.$$

Clearly, if s=0 or ß=0, implying that the firm does not expect to make any damage payments (either because it is unaware of the damages or thinks it will not be forced to pay for them), and P'(q)=0, implying that demand is unresponsive to food safety (as might be expected, for example, with credence goods), then the firm will have no incentive to invest in reducing q. Thus, the incentive to invest in food safety measures stems either from the expectation of damage payments and/or the responsiveness of demand.[38]

Condition (8) implies that in equilibrium

(12) $$\mathbf{P(q) = B'(y) - (1\text{-}s)q\alpha D}.$$

Substituting this into (10) yields

(13) $$\mathbf{B'(y) - (1\text{-}s)q\alpha D - C_y - sq\beta D = 0},$$

or equivalently,

(13') $$\mathbf{B'(y) - C_y - [(1\text{-}s)\alpha + s\beta]qD = 0}.$$

We first consider the implications of these conditions for the equilibrium level of output. Consider first the case where there are no misperceptions, i.e., α =ß=1. As noted above, this might be the case for search or experience goods for which food safety is readily discernable to both the producer and the consumer. Comparing (13)' to (5) implies that in this case, for a given level of q, the firm will choose the efficient output level regardless of the value of s. In other words, the equilibrium output level is efficient (given q) and independent of whether the firm compensates the consumer for some or all of the damages from any contamination that occurs. This is the standard "irrelevance" result from the literature on products liability (Landes and Posner, 1985).

Suppose, however, that the good is a credence good with α =0, implying that the consumer is unaware (and unable to discover) the food safety hazards associated with consumption of the product. In this case, even if the firm is fully aware of potential damages (i.e., ß=1), it will overproduce (and the consumer will over consume) the good whenever it

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[38] This is consistent with the result in the previous section. See, in particular, (2').

does not bear the full damages from contamination, i.e., whenever $s<1$. The magnitude of s will be determined by two factors: (i) the liability rule in place, and (ii) the likelihood that the firm will actually be held liable for damages, given that liability rule. Even under a rule of strict liability, where the firm would be legally responsible for all damages, it may not actually pay those damages. Whether it would actually pay for damages fully will depend on the incentives that the consumer has to sue for damages,[39] the probability of a successful suit given the contamination,[40] and the availability of firm assets to pay damage awards.[41] Thus, even with a rule of strict liability, we would expect $s<1$. Certainly, a negligence rule would imply $s<1$ (for non-negligent firms) as well.

Finally, it should be clear that if the producer is also unaware of the potential hazard, i.e., if $\beta=0$ as well, then the firm will overproduce the good.[42]

Consider next the decision regarding investment in food safety measures. Condition (8) implies that

$$\mathbf{P'(q) = -(1-s)\,\alpha\, D \leq 0}. \qquad (14)$$

In other words, the responsiveness of demand to changes in q depends on both s and α. If the consumer does not perceive the product to have any food safety concerns ($\alpha=0$), or s/he knows that any damages from consumption of contaminated foods will be fully compensated by the producer ($s=1$), then the demand curve will not shift in response to changes in product safety ($P'(q)=0$). However, any positive perception of uncompensated damages will cause the demand curve to shift down.

Substituting (14) into (11) gives the following condition for the choice of q, given y:

$$\mathbf{(1-s)\,\alpha\, Dy - C_q - s\beta Dy = 0,} \qquad (15)$$

or equivalently,

---

[39] The incentives of a plaintiff to sue depend upon the expected award and the litigation costs that s/he would incur. With high litigation costs, even if the aggregate damage for all individuals is high, a victim may choose not to sue if that individual's damages are relatively low.

[40] In some cases, it may be difficult to prove causation and hence legal liability. This is likely to be the case, for example, when damages result from long term exposure to toxic substances such as pesticide residues on food.

[41] Firms with limited assets may not have the resources to pay damages for which they have been held legally liable. See Shavell (1986).

[42] Antle (1998) characterizes this as "symmetric imperfect information" since neither producers nor consumers are aware of the potential damages from consumption of the product.

(15') $$\mathbf{- C_q - [(1\text{-}s)\ a\ + s\text{ß}]Dy = 0}.$$

Again, in the absence of misperceptions, i.e., if a =ß=1, the firm's choice of q will be efficient, regardless of the value of s. However, if a =0, then even if producers fully anticipate potential damages (ß=1), efficient investment in food safety measures will not occur whenever s<1, i.e., whenever producers are not expecting to pay the full amount of damages. Of course, if producers are not aware of damages either (the case of symmetric imperfect information where a =ß=0—see Antle 1998) or they do not expect to pay for any damages (s=0), then the firm will have no incentive to invest in any protective measures.

V. Conclusion

The recent trend toward increased government regulation of food safety stands in contrast to the trend toward greater reliance on voluntary approaches in other areas of government involvement in the private sector, such as environmental protection. In most pollution control contexts, damages are to third parties (rather than consumers of the firm's product) and hence there is less opportunity for market forces (i.e., demand responses) to provide incentives for voluntary adoption of protective measures.[43] Instead, the inducement for voluntary adoption has come primarily from financial incentives (e.g., subsidies) or the threat of imposition of possibly more costly mandatory controls. In the context of food safety, however, there is a greater potential for the market to provide adoption incentives when consumers are aware of the safety characteristics of individual products. In this paper we presented a simple framework for examining a firm's incentives to adopt adequate food safety measures voluntarily, and the role of the market in providing those incentives.

The results suggest that, in the absence of any explicit government role, the efficiency of both the output and the safety decisions of the firm hinges on the information available to both consumers and producers and the likelihood that firms would actually be held liable for damages resulting from a contamination episode. If both consumers and produces correctly perceive the damages from contamination, then both decisions will be efficient regardless of whether the firm is likely to pay full compensation for damages or not. Thus, for search and experience goods, in equilibrium we could expect the market to provide efficient incentives for food safety even in the absence of a well-functioning liability system. We should note,

[43] Demand might still be responsive to how "green" a firm's product is. In fact, this provides the impetus for the use of eco-labelling. However, since environmental damages from production are not borne primarily by users of the product, the responsiveness of demand stems primarily from consumer demand for environmental protection in general rather than the demand for self-protection, as in the food safety context.

however, that, while the assignment of liability may not affect the output and safety decisions of firms, it could have other important effects. For example, if consumers are not compensated for damages, they will have greater incentives to take whatever steps they can to reduce the likelihood and magnitude of contamination. For example, they will have a greater incentive to use safe handling and food preparation practices.[44] However, when the possibility of contamination is not completely eliminated, then a rule of no liability imposes significant risk on consumers, which may be very costly. If consumers are risk averse and unable to diversify the risks associated with consumption of contaminated food, then the optimal assignment of liability would balance risk allocation and incentives for safe handling and preparation by consumers.[45]

While the market may work well to induce voluntary adoption of food safety measures for search and experience goods, the above results also suggest that it will not work well for credence goods. In particular, if consumers are unaware of or even simply underestimate potential damages, then even when producers are fully aware, anything less than full liability will lead to overproduction of the good and under provision of food safety. Since in practice it is unlikely that firms will always be held fully liable even under a strict liability rule (due, for example, to the difficulty of proving causation for credence goods), it is unlikely that firms would invest in an efficient level of protection simply in response to market forces. Thus, in the case of credence goods, adequate consumer protection is likely to be achieved only with some form of government intervention. However, this does not necessarily imply that mandatory regulations must be imposed. As shown in Section III, even in the absence of market-driven incentives for investment in food safety, firms might still choose to invest voluntarily if induced to do so by a "carrot" or "stick." Through either government-financed inducements or the threat of possibly more costly mandatory controls, firms can be induced to undertake protective measures voluntarily. If this approach is unsuccessful, however, the government must be prepared to follow through on its threat and impose mandatory standards if adequate food safety is to be ensured.

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[44] See Weaver (1995) for a model of consumer mitigation of food risks.

[45] This follows from the standard results in the literature on efficient risk sharing. See, for example, Shavell (1979).

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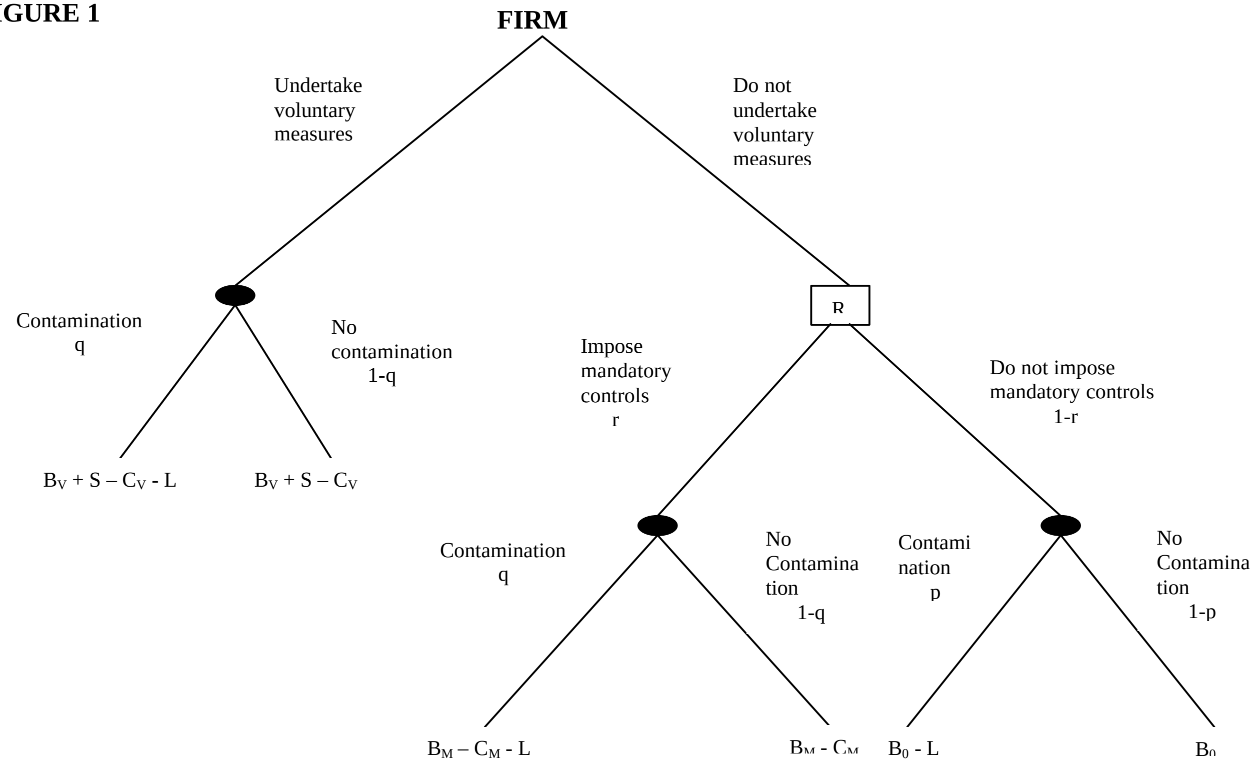
FIGURE 1


FIRM
Undertake voluntary measures
Do not undertake voluntary measures
Contamination q
No contamination 1-q
R
Impose mandatory controls r
Do not impose mandatory controls 1-r
B_V + S – C_V - L
B_V + S – C_V
Contamination q
No Contamination 1-q
Contamination p
No Contamination 1-p
B_M – C_M - L
B_M - C_M
B_0 - L
B_0

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