AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Liability Rules, Collective Organizations and the Provision of Food Safety

Rachael E. Goodhue
Agricultural and Resource Economics
University of California, Davis
One Shields Avenue, Davis, CA USA 95616
goodhue@primal.ucdavis.edu

Nancy McCarthy
LEAD Analytics, Inc.
5136 Nebraska Ave. NW
Washington, DC 20008
nmccarthy@leadanalyticsinc.com

Paper prepared for presentation at the EAAE 2011 Congress
Change and Uncertainty
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland

Copyright 2011 by Rachael Goodhue and Nancy McCarthy. All rights reserved.
Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Liability Rules, Collective Organizations and the Provision of Food Safety

There are many ways to improve food safety. It is well-recognized in the literature that private bilateral contracts, perhaps including third-party private certification, may substitute for or complement government regulation. However, these two options are not the only ones available. For example, in the last decade we have seen produce grower organizations using marketing orders or agreements to establish food safety duties among their growers—the most well known is the California Leafy Greens Marketing Agreement. These establish responsibilities for growers and change the relationship between producers and buyers. Informational asymmetries, for instance, may mean that traceability, and thus culpability, would be very difficult for either consumers or government agents to determine.

As a mediator of private self-regulation, the role of traditional collective marketing institutions, such as marketing agreements or marketing orders, in promoting food safety is still in its infancy. The aggregation of private interests adds an additional complexity to a standard "private" contract between two parties; for instance, finding common ground among heterogeneous players can be quite difficult. This is the source of another potential difference among government regulation, collective self-regulation and individual self-regulation. We review the types of collective organizations that have emerged and construct a theoretical model that includes critical factors influencing food safety incentives in order to identify when industry members have an incentive to engage in collective actions that improve food safety outcomes.

One important consideration appears to be the degree of ambiguity associated with the possibility of new government food safety regulation. How stringent will these regulations be? How costly? Will there be flexibility in attaining goals? Will government regulation pre-empt private initiatives? These questions are familiar ones for economists interested in food safety issues. Often there are no clear answers that can be quantified using standard approaches. An important complicating factor is the ambiguity regarding the effect of specific actions or sets of actions on food safety. We model these ambiguities using fuzzy sets.

Marketing orders and marketing agreements

In addition to voluntary farmer's cooperatives, there are two other mechanisms for producers and/or handlers to negotiate and enforce agreements related to food marketing, marketing orders and marketing agreement. These latter two instruments were authorized under the Agricultural Marketing Agreement Act (AMAA) of 1937, and were mainly established to maintain stable and (relatively) high prices for agricultural commodities in interstate commerce (National Agricultural Law Center, n.d.). The primary difference between marketing orders and agreements is that agreements only legally bind "handlers" that participate voluntarily, whereas marketing orders are legally binding on all producers in a geographic area covered by the marketing order (National Agricultural Law Center, n.d.).

For the purposes of this paper, we will focus on marketing orders. Marketing orders may be authorized at the state or federal level. Federal marketing orders are issued by the Secretary of Agriculture. Marketing orders are rather unique in that growers in a given industry in a specific region generally request marketing agreements and/or orders, which are then issued by the Secretary of Agriculture. In order to be implemented, marketing orders must be "approved" by either 2/3rds of affected growers, or growers of 2/3rd of affected volumes (7 USC §608(c)). Thus, the mechanism has aspects of self-regulation, but with required agency approval and with back-up by the courts since the regulations are legally binding (c.f. Crespi and Sexton, 2003).

Crespi and Sexton (2003) note that after early challenges to the law few substantive legal cases have been brought challenging the act until recently. Currently, the most controversial section of the law pertains to the generic advertising; with many cases being brought before the courts, and including three cases brought before the US Supreme Court on first-amendment grounds (Carmen, 2007). Though

results are somewhat conflicting, it would appear that generic advertising fee assessments are still allowed (do not violate the first amendment). There have also been some challenges to the inspection provisions found in the raisin marketing order, for example a series of related cases brought by Lion Brothers (*Lion Bros v. U.S. Dep't of Agriculture*, Not reported in F.Supp.2d, 2005 WL 2089809 (E.D. Cal. 2005); *In re Lion Raisins, Inc.*, 64 Agric. Dec. 27 (2005)(Decision and Order); *Lion Raisins, Inc., v. U.S. Dep't of Agriculture*, Case No. 1:05-CV-00640 OWW SMS, Not reported in F.Supp.2d, 2008 WL 783337 (E.D. Cal. 2008)).

Relatively recently, these instruments have also addressed food safety, including provisions in the California Leafy Greens Marketing Agreement and Order, the proposed national Leafy Greens Marketing Agreement, as well as in pistachio and almond marketing orders (Carmen, 2007). It is not entirely clear that the AMAA actually authorizes food safety provisions[1] (O'Neill Institute, 2009). In August 2010, the US District Court of Appeals for the District of Columbia will allow a case brought by organic almond growers against enforcement of the pasteurization provisions in the almond marketing order. This case highlights the difficulty of reaching consensus in an industry with heterogeneous producer interests. However, as argued by Carmen (2007), to the extent that such provisions enhance consumer confidence and prevent costly recalls and/or demand shifts due to a food poisoning events, they do lead to more stable, orderly markets and higher prices, which are the key goals of the AMAA.

Less attention in the academic literature has been given to the use of marketing orders to devise and enforce commodity quality, which in turn could include safety provisions. We consider the circumstances under which producers would agree to legally binding commitments on food safety, given the type of regulation promulgated. In terms of regulation type, orders can contain very specific actions required by the producer, or contain broader, vaguer language regarding actions required on the part of growers. As discussed more fully below, it is costly to make agreements on precise regulations either where the necessary scientific information to draft precise rules is imperfect or where producers are highly differentiated. High costs result because simple, but precise, rules will over-burden some growers and under-burden others and/or because very detailed, grower specific rules are too time-consuming to construct or simply not possible to construct given the state of technical knowledge. More general "standards" allow growers to take least-cost actions consistent with meeting the standard. On the other hand, it is far simpler to monitor and enforce precise regulations than vague standards.

Grower heterogeneity in terms of the size of operation is another important consideration that can hinder the formation of a voluntary organization designed to promoted food safety. Heterogeneity can affect the formation of the organization in two ways. First, there may be economies of scale in food safety enhancement activities, due to different technology choices available to operations with sufficient volume. Second, fixed fees per operation, such as inspection or certification charges, have a disproportionate effect on small operations. One way of mitigating the latter is for large producers to subsidize small producers. In practice, per unit assessments are generally used to support marketing orders. When these assessments are used to fund producers' activities to satisfy operation-level requirements, small producers are, effectively, subsidized by larger ones. One example of such an activity is the development of good agricultural practices for strawberries and associated worker training methods and materials by the California Strawberry Commission, which are available to all growers without charge. This group is funded by a per unit assessment.

Crisp standards and fuzzy regulations

[1] The statute states that the terms may include "Limiting…" the quality of the commodity (7 U.S.C. §§ 608(c)(6)(A)), which might be construed to include limiting through food safety. Explicit allowance for food safety in food marketing orders was included in drafts of the 2008 Farm Bill, but was subsequently omitted since "conferees indicated that such programs already are authorized under the Agricultural Adjustment Act of 1935" (Becker 2008).

One of the key benefits to individuals of well-defined rules is reduced legal uncertainty, since such rules provide clear notice of what is and is not unlawful (c.f. Posner, 2007; Kaplow, 1992; Schlag, 1985). Monitoring and enforcement costs are also likely to be lower because: 1) settlements and pleas are more likely to occur since litigants are more likely to precisely estimate their chances of winning in court (Posner, 2007), 2) rules are less costly to adjudicate in court and should be handled more timely putting less pressure on court dockets (Posner, 1988), and 3) similarly situated litigants are more likely to be treated similarly by the legal system, providing stability to the legal system and bolstering the fairness of the system, at least *ex ante* (Schlag, 1985; Kennedy, 1976). However, it is more expensive to draft a well-defined and effective rule, and even a well-defined rule is likely to lead to both under- and over-inclusiveness (Posner, 2007; Kaplow, 1992). For instance, specifying that a certain technology be used in order to reduce a certain environmental harm may well lead to over-protection for firms that do not face high risks of causing that harm, and under-protection from firms that face very high risks of causing that harm[2].

The major benefit from fuzzy standards identified in the literature is the ability of the regulated entity to take into account individual-specific circumstances in order to reach the goals of the standard (Kaplow, 1992; Kennedy, 1976). Standards should then reduce the costs associated with under- and over-inclusiveness of rules. However, if the regulated person or firm believes he is complying with the spirit of the law, but is brought up in court anyway, type I and type II errors are more likely to occur (Fon and Parisi, 2007). The resolution to a bright-line rule is only dependent on the facts in evidence (so errors may still result given quality of the evidence), but resolution of a fuzzy standards further requires the factfinder to determine if the facts in evidence are "reasonable" or accord with some other vague and/or ambiguous standard. Thus, the gains from limiting under- and over-inclusiveness *ex ante* under a fuzzy standard are likely to be mitigated by greater type II errors if the matter is litigated *ex post*. Finally, rules reduce judicial discretion (Fon and Parisi, 2007; Sunstein, 1995). In the administrative agency context, Sunstein (1995) argues that rules should be the norm to limit discretion of the administrative agency, whose rulemaking powers have been delegated by Congress but whose personnel are not elected officials; Kaplow (1992) also gives an example of discretion given to the administrative agency's monitoring a vague definition of "toxic substances".

Comparing the effects of rules and standards on the functioning of the legal system as a whole, a number of authors have posited that standards are more likely to be preferred where the regulated entities are more heterogeneous (c.f. Fon and Parisi, 2007; Kaplow, 1992; Kennedy, 1976). While fuzzy standards reduce under- and over-inclusiveness, from society's point of view, type I and type II errors are also costly and should be considered when comparing fuzzy standards to bright-line rules. There has been less attention in the literature in analyzing and comparing the likely difference in these two sources of error across rules versus standards. Fon and Parisi (2007) evaluate the difference between the two where legal rules might become obsolete due to changes in the external environment; they hypothesize that standards would be preferred in contexts subject to frequent external changes that would make well-specified rules obsolete.

While the Fon and Parisi (2007) model assumes that increasing specificity of the legal rule increases its value in terms of reduced legal uncertainty, the implicit value function leaves open exactly how rules become "more specific", and does not explicitly address the relationship between rule specificity and compliance costs on the part of those subject to the regulation. As such, the model is divorced from the literature on public enforcement and optimal compliance. There is a very large

[2] An example is provided by the U.S. coal industry. Western coal is cleaner than Eastern coal; a law that required a specific technology for all firms would lead to similar increased costs for all firms, an "over-reduction" of pollution for Western firms and an "under-reduction" of pollution at Eastern firms. If the goal is to reduce regional (or national) pollution, then allowing two technologies would lead to the same total reduction at lower cost.

literature on optimal fines and inspection rates, beginning with Becker (1968), with a great many extensions to the original model including Goroupa (1997), and Polinsky and Shavell (2000). What these models have in common is that it is assumed that the rule itself is well-defined and completely understood by the regulator as well as those regulated, e.g. a fixed amount of emissions per some unit output over some time interval. While the parties may have asymmetric information over either their culpability in the damages and/or the total damage, there is no vagueness or ambiguity in interpreting the standard on which the private party's guilt or innocence will depend (c.f. Innes, 2004). McCarthy (2010) takes an initial step in tying together the optimal fine and rule specificity literature. The author models the regulatory agency's decision whether to choose a well-defined rule versus a fuzzy standard, given heterogeneous firm behavior and adjudication errors. Results indicate that the regulatory agency will prefer well-defined rules where heterogeneity is lower, and where asymmetric information is greater *ex ante* but where costs of gathering evidence *ex post* are relatively low. Additionally, firms with larger potential damage are likely to prefer well-defined rules vis-à-vis small damage firms, and all firms are likely to prefer well-defined rules where type 1 errors are high.

In this paper, we also combine insights from the optimal regulation literature and the rule-precision literatures. Here, however, the focus is on incentives for homogeneous firms to voluntarily devise internally agreed-upon food safety regulations (e.g. through proposing a marketing order which is subsequently legally binding on all relevant producers/handlers). A well-defined set of rules would specify in detail the actions to be undertaken by all relevant parties. A fuzzy standard, however, might look something like the "Good Agricultural Practices" (GAP) guidelines developed by the USDA. The GAP manual in fact begins by noting that guidelines were developed specifically so that individual farmers or handlers could structure their own actions based on their unique circumstances while still maintaining "good" practices. The regulator can choose to accept and enforce the voluntarily devised agreement or instead choose whether or not to set a simple but well-defined rule. In the model developed below we consider the incentives for the group to voluntarily devise rules given the liability they are subject to if damage occurs, and compare these rules with the regulator's optimal choice under varying levels of information available.

Conceptual Framework

This analysis compares the choices of two firms and a regulator regarding the provision of food safety. Two types of firm heterogeneity are considered. In the first, firms are heterogeneous in terms of their market shares, capturing heterogeneity in fixed costs. In the second firms are heterogeneous in terms of their market shares and the cost of providing any specific action that affects food safety, capturing heterogeneity in both fixed and variable costs.

The [0,1] interval is the set of all actions A that affect food safety. Actions can be considered bundles of specific food safety practices. There are two potential food safety outcomes: a bad event occurs, and a bad event does not occur. The realized outcome is affected by A. All parties observe A; no costly monitoring is required.[3] The relationship between A and the resulting food safety outcome is not precise. This is one of the two sources of ambiguity included in the model. To represent this situation we define A's membership in two fuzzy sets, SAFE and UNSAFE. A's degree of membership in SAFE, μ_{SAFE}, represents the extent to which A is thought to improve actively one or more aspects of food safety. A's membership in not SAFE, the complement of safe, equals $1-\mu_{SAFE}$. It can be interpreted as the extent to which it's possible that A has no positive effect on food safety. A's degree of membership in UNSAFE, μ_{UNSAFE}, represents the possible extent to which A reduces actively one or more aspects of food safety. A's membership in not UNSAFE, the complement of UNSAFE, equals $1-\mu_{UNSAFE}$. It can be interpreted as

[3] While in practice marketing agreements and marketing orders assess their members' volume-based fees in order to undertake auditing activities, including this reality in the model would not alter its qualitative results.

the extent to which it's possible that A has no negative effect on food safety. For example, washing produce may reduce contamination by certain agents. On the other hand, aggregating produce into large batches for washing may spread contamination by other agents. Essentially, because no one has complete scientific information both of these fuzzy sets and their complements should be included in the decision-making analysis. For example, rules specifying that cows not be pastured within distance of fresh produce fields are generally thought to make food no more UNSAFE. However, the active effect (SAFE) is not known with much precision at all, although presumably greater distances are safer.[4] Jim Prevor, a produce industry member and commentator, writes "The reality is that we know very little about food safety. Nobody knows the migration rate of E. coli O157 or how far a filth fly can carry a pathogen. In the absence of definitive answers, food safety on the farm is a continuum, not an absolute." (Prevor 2010).

Information. All players observe whether or not a food safety failure occurs. Firms know the membership of each A in the fuzzy sets SAFE and UNSAFE and the actions undertaken by all firms. The regulator can determine the firm's action costlessly ex post if a bad event occurs. The regulator has only imprecise information regarding the firm's action, modeled as knowledge regarding its membership in the fuzzy set SAFE. Effectively, the regulator identifies the "most possible" contribution of the firm's action to the realization of the bad event, based on imperfect and ambiguous information. The degree of ambiguity is different for firms and regulators.

Consequences of food safety failure. We characterize a bad event as a cost incurred by members of society outside the MO, such as foodborne illness. If a bad event K occurs, its magnitude is fixed and also denoted by K. In addition to these direct costs, there is a negative, multiplicative price shock γ, which reduces firms' profits. (For convenience, we assume that this shock is realized contemporaneously, allowing us to utilize a static framework.) The existence of this price shock provides the possibility that a private incentive for firms to engage in a positive A exists. A affects the likelihood that the event occurs, Pr(A). We obtain a crisp probability of the occurrence of a bad event by using a defuzzification rule defined over μ_{SAFE} and μ_{UNSAFE}.

Profit maximization. For convenience, we will refer to the industry group as a marketing order or MO. The individual firms and the MO choose A in order to maximize profits. Both firms and the MO are assumed to act perfectly competitively in the market for output. We assume that A is separable from all other production decisions and set all other production costs to zero, normalize quantity to 1, and normalize price in the absence of a negative food safety event to 1 and the price reduction when a negative food safety event occurs is δ(A), so that the expected price is 1-δ(A). Given these assumptions, profits are defined as $1 - c(A) - d(A)$, where *c(A)* is the cost of undertaking A and *d(A)* is the expected cost of damage payments associated with bad outcomes. The function *c(A)* is assumed to be strictly convex, and c(0)=0. Damages *d(A)* depend on the legal doctrine.

Social welfare. When assessing the firm's degree of negligence, the regulator wishes to maximize expected social welfare, defined as the profits of the firms/MO less the effect of bad events on consumers net of damages paid to consumers by the firm responsible. While this formal specification is somewhat unconventional within the law and economics literature, it is intended to capture the informal sense of whether or not an action is "reasonable." Practically, it is not possible to ensure that a bad event will never occur. Thus, determining reasonableness requires balancing various considerations. Maximizing social welfare is simply one way of specifying how the regulator will undertake this balancing.

Liability rules. The regulator specifies the liability rule governing negative food safety events, e.g. whether strict liability will apply or whether a negligence standard will apply. Under strict liability, firms will pay damages whenever a bad event occurs, regardless of what actions they take to improve food

safety. If a negligence standard is chosen, the regulator also sets standards that determine which actions will be found negligent.[5] Strict liability requires that the firm fully compensate affected members of society whenever a bad event occurs, regardless of A. As such it corresponds to a crisp rule over outcomes. Under negligence, the regulator evaluates the firm's action *ex post* and determines whether or not the firm must compensate affected consumers[6]. As such it corresponds to a fuzzy standard over actions. For simplicity, we assume that damages paid exactly equal the damages imposed on affected consumers under both liability rules.

As discussed previously, under a strict liability standard the firm is culpable regardless of the actions it has taken to reduce the likelihood of a negative food safety event. Under strict liability, there is no need for the regulator to assess the firm's action. Under a negligence standard the regulator must determine the firm's culpability. We model the determination of culpability under the negligence standard as the regulator's assessment of the extent to which the firm's chosen A is "not safe," which we define as equal to 1- μ_{SAFE}. This definition can be interpreted as follows: the firm's culpability depends on the reasonableness of the contribution of its action to actively (positively) affecting food safety, but does not depend on the passive contribution of the action to not making food less safe.

In theory, a negligence claim can be enforced in the absence of a standard set by the regulator. There would simply be a case-by-case determination regarding the "reasonableness" of firms' actions. In practices, standards such as Good Agricultural Practices (GAPs) send signals to firms and adjudicators, and should influence the enforcement and imposition of fines. Here we impose a specific structure, and require that the "standard" set by the regulator is the actual standard applied to determine negligence. In practice, not meeting GAPs would most likely be sufficient to establish a presumption of liability, as modeled here, but meeting GAPS would not be sufficient to establish no liability.

Timing. The model evaluates the incidence of various institutional combinations. As such, it is a static model. Firms' expectations regarding the regulator's ex post assessment of culpability are assumed to be consistent with the regulator's assessment. A natural next step is to examine a two-period model. The second period would assess the incidence of the institutional combination chosen by the regulator in the first period in order to maximize expected social welfare. In a two-period model the regulator's welfare-maximizing assessment of culpability would need to be examined for time consistency. An approach that could be implemented within a static model would be for firms to have fuzzy beliefs regarding the regulator's assessment of the reasonableness of any A.

Simulation model specification

The conceptual framework is operationalized within a simulation model using the following specifications and parameter values. As defined above,

(1) $A \varepsilon [0,1]$.

The cost of A is a convex function,

(2) $c(A)=A^C$, C=2.

As A increases the possibility that it increases the degree of food safety increases,

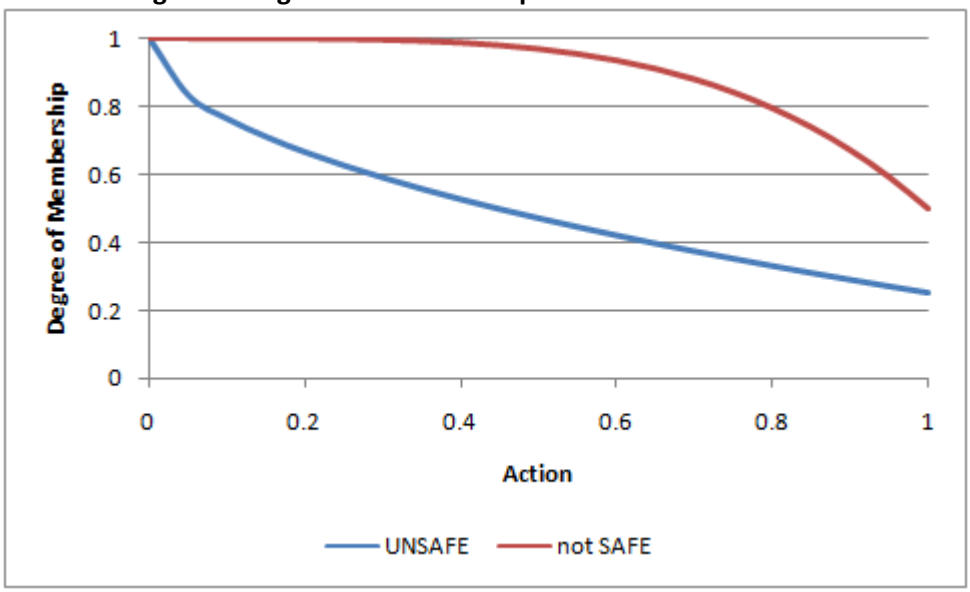
[5] As developed more fully below, we presume the regulator can fine firms for causing damage, either under strict liability or negligence. The model specified in this paper is a simplification of very complex enforcement mechanisms. Currently, the FDA has only limited authority to assess civil monetary fines (Washington Legal Foundation, 2003); however, the FDA has imposed fines based on common law concepts of restitution and disgorgement – technical legal terms we need not address here. The FDA has other enforcement mechanisms, including issuing warning letters, injunctions, seizure, and criminal prosecutions (Pollard & Duvar, n.d.).

[6] Essentially, this assumption captures cases where the regulator makes and assessment and the firm pays the fine; that is, the firm never contests the regulators' assessment. Firms might contest the assessment, causing a suit to be filed either in an administrative action or an Article III court. This potentially important consideration is beyond the scope of this analysis.

(3) $\mu_{SAFE}(A)=SA^s$, S=0.5 and s=Cb=4;
while the possibility that it makes food more unsafe decreases.
(4) $\mu_{UNSAFE}(A)=1-UA^u$, U=0.75 and u-0.5.

Figure 1 plots 1- $\mu_{SAFE}(A)$ and $\mu_{UNSAFE}(A)$ for all A. The specified membership functions describe a case where firms need to undertake a relatively high A to increase safety and decrease membership in not SAFE, but all positive As reduce the degree of UNSAFEness. In such a case the regulator is likely either to consider a firm culpable unless it engages in a fairly large A (required to have any effect on safety), or to not consider it culpable at all (A=0 is reasonable), depending on the costliness of a bad event relative to the costliness of A.

Figure 1. Degrees of membership in not SAFE and UNSAFE



In order to obtain the probability that a bad event occurs, the memberships in these two sets are defuzzified using the following rule:
(5) $Pr(A)=((1-\mu_{SAFE}(A))+\mu_{SAFE}(A))/2$.
Finally, two additional parameters must be defined: K=2 and γ=0.5. The analysis used 21 values for A, in increments of 0.05 from 0 to 1 inclusively.

Modeling a marketing order: heterogeneous firms

By design, the modeling framework excludes the possibility that firms can benefit from cooperating over any aspect of production of marketing besides food safety-related activities. Thus, the only way by firms can increase their joint profits through cooperation is by adjusting their amount of food safety activities. We consider two types of firm heterogeneity while maintaining a constant market size. In the first case firms are heterogeneous in terms of their market shares while c(A) is the same for both firms and the firms must pay the same damages if a bad event occurs and the legal doctrine requires damages. In the second case firms are heterogeneous in terms of their profits from production and food safety activities, but must pay the same damages. Loosely speaking, the first case can be interpreted as a food safety action being a fixed cost, and the second as it being a variable cost.

In either case, if the firms form a marketing order they choose their actions in order to maximize joint profits, subject to the legal regime.[7] Given the model specification, the only way in which a MO

[7] A food safety-oriented marketing order could be introduced into the basic framework in many additional ways. For example, economies of scale in research might lead to a reduction in the cost of food safety actions, or an increase in efficacy. Differentiation based on food safety may command a premium over competing products

could do so is through its members' choices of A. We consider two types of MOs. In the first, the MO sets minimum standards for its members. In the second, MO members are subject to a common standard. We assume that firms cannot renege on their agreed-upon action choices in either type of MO, nor can they choose an action that is greater than that required by the common standard MO. Equivalently, we assume that the MO can enforce its action choices costlessly. Firms have the option of forming a MO regardless of the liability rule in effect.

Voluntary marketing agreements regarding food safety practices can be loosely characterized as collective efforts to engage in greater efforts to promote food safety than undertaken by others in the industry. In this two-firm framework, an incentive to undertake a voluntary marketing agreement corresponds to one firm choosing to undertake a higher action in the Nash equilibrium.

Table 4. Profit-maximizing actions and social welfare by legal regime: Asymmetric firms (base values 0.5,1.5), revenues only

Regime	Market structure	Actions	Profits	Social welfare
No liability	Competitive	0.05, 0.10	1.01,3.02	2.017
	Individual standard MO	0.15,0.15	1.00,3.04	2.024
	Common standard MO	0.15,0.15	1.00,3.04	2.024
Strict liability	Competitive	0,0	1.00,3.00	2.000
	Individual standard MO	0,0	1.00,3.00	2.000
	Common standard MO	0,0	1.00,3.00	2.000
Negligence (R=0.5)	Competitive	0.5,0.5	0.83,2.99	1.973
	Individual standard MO	0.5,0.5	0.83,2.99	1.973
	Common standard MO	0.5,0.5	0.83,2.99	1.973
Negligence ($R_{not\ SAFE}$=0)	Competitive	0.15,0.15	1.00,3.04	2.024
	Individual standard MO	0.15,0.15	1.00,3.04	2.024
	Common standard MO	0.15,0.15	1.00,3.04	2.024
Welfare maximization (no damages)	Asymmetric	1,1	1.01,3.03	2.344
	Symmetric	1,1	1.00,3.04	2.344

Results

Table 4 reports firms' actions and profits and social welfare under competition and MOs for five regimes: no legal responsibility to pay damages, liability, negligence with an arbitrary R=0.5, negligence with a rule based on maximizing social welfare based only on information regarding each action's membership in SAFE ($R_{not\ SAFE}$), and the actions that maximize social welfare.[8] Firms are heterogeneous in market shares only. Firm 2 is three times as large as firm 1. Given the model specification, neither type of marketing order increases social welfare under liability or negligence doctrines. In fact, social welfare is unaffected. Thus, when the government implements either a crisp rule or a fuzzy standard there is no social benefit of implementing a MO. There are no benefits to the firms, either. However, if

regardless of whether or not a bad event occurs, or reduce the magnitude of the price shock associated with a bad event due to higher consumer confidence in the actions undertaken by the marketing order.

[8] In some instances there are multiple symmetric competitive equilibria. We report only the equilibrium with the largest As. These equilibria are closest to the MO solutions.

firms are not legally responsible for paying damages under any circumstances, either type of MO increases social welfare. In this case, firm 1 must be to agree to form the MO.

Another comparison of note is that, relative to the case of no liability, welfare is reduced by the introduction of strict liability, or of negligence based on an arbitrary standard. Welfare is not improved by the use of negligence based on a standard using the regulator's best available information. Effectively, the voluntary formation of a marketing order in the absence of liability results in the same level of social welfare as the best-performing liability rule does. If firms are sufficiently heterogeneous, they may, in this case, have an incentive to form a MO under a fuzzy negligence standard. These final results are consistent with industry members' arguments that they should be allowed to institute collective voluntary arrangements, rather than be subject to regulation. Note also that even though welfare is the same, the distribution of welfare differs. Industry profits are greater under the MOs than under the negligence doctrine, and the costs to consumers are correspondingly greater.

Table 5 provides the same information as Table 4 when firm 2 is 12.3 times as large as firm 1. In this case the formation of a marketing order improves welfare under a negligence doctrine when the regulator specifies $R_{not\ SAFE}$. Holding all else equal, a greater difference in firms' market shares makes it more likely that a MO will increase social welfare. As in the previous case the formation of a marketing order improves welfare in the absence of liability. Under the remaining regimes social welfare is again unaffected. As in the previous case, the formation of a MO in the absence of liability results in welfare at least as large as under the liability rules.

Table 5. Profit-maximizing actions and social welfare by legal regime: Asymmetric firms (0.15,1.85), revenues only

Regime	Market structure	Actions	Profits	Social welfare
No liability	Competitive	0.05,0.10	0.30,3.73	2.017
	Individual standard MO	0.15,0.15	0.30,3.75	2.020
	Common standard MO	0.15,0.15	0.30,3.75	2.020
Strict liability	Competitive	0,0	0.30,3.70	2.00
	Individual standard MO	0,0	0.30,3.70	2.00
	Common standard MO	0,0	0.30,3.70	2.00
Negligence (R=0.5)	Competitive	0.5,0.5	0.07,3.74	1.973
	Individual standard MO	0.5,0.5	0.07,3.74	1.973
	Common standard MO	0.5,0.5	0.07,3.74	1.973
Negligence ($R_{not\ SAFE}$=0)	Competitive	0.05,0.10	0.30,3.73	2.017
	Individual standard MO	0.15,0.15	0.30,3.75	2.020
	Common standard MO	0.15,0.15	0.30,3.75	2.020
Social welfare maximization (no damages)	Asymmetric	1,1	-0.58,4.15	2.344
	Symmetric	1,1	-0.58,4.15	2.344

Tables 6 and 7 report the same information as tables 4 and 5 for the second type of firm heterogeneity: firms are heterogeneous in their net revenues from production and pay the same fine if they are responsible for a bad event. Introducing heterogeneity in costs has two effects, as seen when comparing tables 5 and 3. First, unlike in table 3, in table 5 the formation of a MO of either type increases welfare

when the regulator chooses his negligence standard (fuzzy standard) based on his information regarding membership in the fuzzy set SAFE as well as when firms are not liable. Second, the action choices of an individual standard MO and common standard MO differ in both regimes where the formation of a MO increases welfare. The smaller firm, firm 2, is required to undertake a larger A. This occurs because the price shock resulting from a bad event due to his choice of A imposes a larger cost on firm 2 than the reverse case. Notably, the smaller firm's profits and welfare are larger under a common standard MO than under an individual standard MO, while the larger firm's profits are smaller. Table 6 also demonstrates that the regulator can obtain as least as high a level of social welfare by allowing firms to form a MO as by imposing either a crisp rule or a fuzzy standard, as was the case when firms were heterogeneous only in their market shares.

Table 6. Profit-maximizing actions and social welfare by legal regime: Asymmetric firms (base values 0.5,1.5), revenues and costs

Regime		Actions	Profits	Social welfare
No liability	Competitive	0.10,0.10	1.01,3.03	2.023
	Individual standard MO	0.25,0.15	1.00,3.05	2.024
	Common standard MO	0.15,0.15	1.01,3.03	2.031
Strict liability	Competitive	0,0	1.00,3.00	2.00
	Individual standard MO	0,0	1.00,3.00	2.00
	Common standard MO	0,0	1.00,3.00	2.00
Negligence (R=0.5)	Competitive	0.5,0.5	0.95,2.86	1.973
	Individual standard MO	0.5,0.5	0.95,2.86	1.973
	Common standard MO	0.5,0.5	0.95,2.86	1.973
Negligence ($R_{not\ SAFE}$=0)	Competitive	0.10,0.10	1.01,3.03	1.023
	Individual standard MO	0.25,0.15	1.00,3.05	2.024
	Common standard MO	0.15,0.15	1.01,3.03	2.031
Social welfare maximization (no damages)	Asymmetric	1,1	0.89,2.67	2.34
	Symmetric	1,1	0.89,2.67	2.34

Comparing tables 6 and 7, a greater degree of heterogeneity in firms' revenues increases the instances in which a MO increases social welfare. As before, either type of MO increases welfare when firms have no liability and when the regulator chooses the negligence standard based on his information regarding the fuzzy set SAFE. In addition, under the arbitrary negligence standard an individual standard MO increases welfare. Firm 1, the smaller firm, would have to be compensated in order to agree to form the individual standards MO under two of the three regimes.

The increase in the heterogeneity of the firms complicates the comparison of the social welfare obtained from firms forming a MO and the regulator imposing a liability rule. Here, forming an independent standard MO results in the highest level of social welfare under all regimes except for strict liability. (Under a crisp strict liability rule there is no welfare gain to forming either type of MO.) Excluding strict liability, the total welfare that results from forming an independent standard MO is independent of regime. A common standard MO increases social welfare relative to the competitive case when firms are not liable, or liable under negligence with a standard based on the regulator's

information. In contrast, the welfare gain to implementing an individual standard MO is greater under negligence with an arbitrary standard of 0.5 than under these two regimes.

Table 7. Profit-maximizing actions and social welfare by legal regime: Asymmetric firms (0.15,1.85), revenues and costs

Regime		Actions	Profits	Social welfare
No liability	Competitive	0.1,0.1	0.3026,3.73	2.064
	Individual standard MO	1,0.25	0.19,4.02	2.441
	Common standard MO	0.15,0.15	0.3034,3.74	2.082
Strict liability	Competitive	0.0	0.30,3.70	2.000
	Individual standard MO	0,0	0.30,3.70	2.000
	Common standard MO	0,0	0.30,3.70	2.000
Negligence (R=0.5)	Competitive	0.5,0.5	0.29,3.53	1.973
	Individual standard MO	1,0.5	0.20,3.89	2.440
	Common standard MO	0.5,0.5	0.29,3.53	1.973
Negligence ($R_{not\ SAFE}$=0)	Competitive	0.1,0.1	0.30,3.73	2.064
	Individual standard MO	1,0.25	0.19,4.02	2.441
	Common standard MO	0.15,0.15	0.30,3.74	2.082
Social welfare maximization (no damages)	Asymmetric	1.0,0.35	0.19,4.00	2.469
	Symmetric	1,1	0.27,3.30	2.344

Implications and future research

The results of this analysis has a number of implications for future research. First, reducing ambiguity by improving the quality of the regulator's information doesn't always improve social welfare. Consequently, improving inspection processes or developing specific standards may not be the best use of limited government resources addressing food safety. Researching new technologies or, under some conditions, encouraging the formation of voluntary industry organizations designed to enhance food safety may have a greater impact. Regarding the latter, the analysis showed that MO formation will never reduce, and may improve, welfare relative to imposing either a strict liability rule or a fuzzy negligence standard. Furthermore, in some cases growers may choose to form a voluntary marketing agreement that would improve social welfare. In some cases, such a MO may require transfers to implement. While transfers between private parties due to per unit assessments to fund marketing order activities may not be sufficient to induce implementation of the MO, additional transfers by the government to small growers may do so.

There are a number of caveats regarding this analysis. As is so often the case, these caveats suggest directions for future research. First, the results are dependent on parameter values, functional forms, and the definitions of fuzzy set memberships and the defuzzification rule. Sensitivity analysis is required to address the robustness of the findings to these definitions. One particularly important definition to examine is that of ambiguity in the regulator's fuzzy negligence standard. Second, the analysis does not consider moral hazard. A related assumption is that the analysis conflates growers and shipper/processors. These assumptions may affect conclusions of the paper; however, given the ambiguity inherent in food safety and food safety regulation their effects may be less important than in

"crisp" models. Third, the analysis is restricted to two firms who are assumed to comprise the entire market. Limiting the analysis to two firms implies that any sort of collective organization includes all suppliers. Increasing the number of firms would enrich the analysis of the role of voluntary organizations considerably. Finally, the analysis uses a static framework. Including a dynamic framework would allow for the possibility of induced innovation in food safety provision activities.

The existing model provides another potentially fruitful direction for further research. There are many differences in the availability and efficacy of food safety provision activities for fresh and processed foods. Many of these differences can be represented in terms of the memberships of activities in the SAFE and UNSAFE fuzzy sets. Comparing these differences will enable the analysis of the effects of MO formation and different liability regimes in markets with different food safety characteristics based on empirical observation.

References

Becker, G.S.. 1968. "Crime and Punishment: An Economic Approach." J*ournal of Political Economy* 76(2):169-217.

Crespi, J. M. and R. J. Sexton. 2003. "Competition, U.S. Farmer Cooperatives, and Marketing Orders." *Economie Rurale* 277–278:3–19.

Fon, V. and F. Parisi. 2007. On the Optimal Specificity of Legal Rules. *Journal of Institutional Economics*, 3(2): 147-164.

Goroupa, N. 1997. "A Note on Private Enforcement and Type-I Error." I*nternational Review of Law and Economics* 17(3):423-429.

Innes, R. 2004. "Enforcement Costs, Optimal Sanctions, and the Choice between Ex-post Liability and Ex-ante Regulation." *International Review of Law and Economics* 24(1):29-48.

Kaplow, L. 1992. "Rules versus Standards, An Economic Analysis." *Duke Law Journal*, 42: 557-629.

Kennedy, D. 1976. *Form and Substance in Private Law Adjudication*, 89 *Harvard Law Review* 1685.

McCarthy, N. 2010. "When Are Fuzzy Standards Preferred to Bright Line Rules?" Working Paper.

National Agricultural Law Center. Accessed September 23, 2010. http://www.nationalaglawcenter.org/assets/crs/RS22886.pdf

Polinsky, A.M. and S. Shavell. 2000. "The Fairness of Sanctions: Some Implications for Optimal Enforcement Policy." A*merican Law and Economics Review* 2(2):223-237.

Posner, R.A. 2007. "The Antitrust Laws." Chapter 10, in *Economic Analysis of the Law*. New York: Aspen Publishers.

Posner, R.A. 1988. "Creating a Legal Framework for Economic Development." *World Bank Research Observer*, 13(1):1-11.

Prevor, J. 2010. "How to Improve Food Safety." TheNewAtlantis.com, May 21. Available at http://www.thenewatlantis.com/publications/how-to-improve-food-safety. Accessed May, 2010.

Schlag, P.J. 1985. *Rules and Standards*, 33 *UCLA Law Review* 379.

Sunstein, C.R. 1995. "Problems with Rules." *California Law Review* 53: 953-1023.