Food Safety and Inspection

Breakout Session 1, Friday January 14th, 1994, 1:00 pm
Moderated by Gordon Rausser, University of California, Berkeley

Major papers:

Food Safety and Inspection: An Overview

Nancy Bockstael, Richard Just, and Mario F. Teisl, University of Maryland
Paper presented by Richard Just

Current Policy Environment for Food Safety and Inspection

Julie Caswell, University of Massachusetts

Discussants:

Stuart Hardy, Resources Policy Department, U.S. Chamber of Commerce

Dennis Henderson, Marketing Economics Branch, Economic Research Service, U.S. Department of Agriculture

John Horowitz, University of Maryland

Andrew P. Manele, Environmental Protection Agency

Richard Williams, Economics Branch, Food and Drug Administration

Food Inspection and Safety: An Overview

Nancy E. Bockstael, Richard E. Just, and Mario F. Teisl

Food safety is a topic of growing interest and public debate. Current policy debates on food safety regulation are mired in controversy over the desirability of collective decisions about allowable risk levels, conflicts between consumers' rights to know and the high cost of supplying information, and dilemmas about how to enforce truth in labeling. Recent legislation requires resolution of questions such as whether and in what form labeling should be made mandatory, and what health claims can be made by producers (See for example, the Nutrition, Labeling and Education Act of 1990.) The food safety debate is largely about information and the processing and use of that information by consumers. It poses questions such as how much information to supply to consumers to facilitate effective choice and how much to circumscribe those choices with standards and prohibitions. It asks how that information should be supplied and who should supply it.

Naive welfare economics prescriptions such as "more information is better," "unconstrained choice is preferred," and "information is a public good to be supplied publicly," may not characterize an optimal policy solution because the processing of information is complex, time-consuming, and involves ambiguous risks. In addition, distributional implications are far more complex than those typically linked with inequitable incomes (Riepe, Martin, and Uhl 1993). The ability to process and act on information is affected by access to information and cognitive ability, as well as time and income constraints, none of which is distributed uniformly in the population.

Existing food safety regulations either supply information about the distribution of "quality" or truncate that distribution by prohibiting "quality" levels below given standards. Specifically, food safety policy often takes the form of labeling or certification requirements that constrain the methods by which information about some quality dimension of food can be conveyed to buyers. Prohibitions, standards and their associated inspection programs, on the other hand, directly alter the probability distribution of dimensions of food quality but in so doing convey information, at least to the informed, about that altered distribution. An aspect of food safety policy that is attracting increasing attention is the regulation of information provided by the private sector.

To date, the literature on food safety has varied in approach but also in relevance to public policy debates. This paper asks whether the direction of the empirical literature on food safety has the potential to contribute effectively to these pressing public issues. It should be stated at the outset that the authors have little experience in research on food safety, so this overview is likely to appear superficial or overly simplistic. We do not pretend to be comprehensive, nor do we presume a thorough understanding of the relevant regulations or institutions. But we do hope to stimulate discussion.

To put the science somewhat in perspective, we begin the paper with a brief overview of our understanding of the scientific risk assessment process. The next section of the paper sets out our characterization of the food safety and information problem as faced by the consumer. Hopefully, this will help to avoid simplistic and naive conclusions and can help to distinguish the lines of research with promise. We then turn to a review of the literature and research findings to date. Finally, we consider the implications of empirical findings in the context of our characterization of the problem of food safety. Several hypotheses and suggestions for future research emerge.

Scientific Risk Assessment

We hesitate to touch upon the confusing topic of quantitative risk assessment. Yet, because of the highly imprecise and heavily debated nature of the science and the implications of this imprecision for economic research, some discussion is necessary. Given that assessing "potential food-borne risks . . . worthy of concern, are usually too small to be detected by any direct means of observation" (Rodricks 1986, p. 516), food risk assessment is basically an inferential science. In turn, scientists and policy makers must make assumptions or value judgements while doing risk assessments. In fact, the National Research Council of the National Academy of Sciences has identified about 40 points in the assessment process that rely on scientific judgments. Judgments regarding data sets, assumptions and procedures lead current risk assessments to provide what is commonly thought to be an upper bound to the true level of risk, although even this could be debated.

Although we do not provide a thorough discussion of current risk assessment methodology, we present a summary highlighting the uncertainties regarding risk assessment results. Risk assessment can be defined over four stages: (1) identification of risky substances, (2) determination of the response (dose-response modeling), (3) estimation of the level of exposure, and (4) characterization of the risk (Barry 1987). Most of this paper deals with stage four, but it is necessarily predicated upon uncertainties regarding the first three stages.

Identification of the risky substance begins with toxicity testing. Testing can include epidemiological studies, "short-term mutagenicity assays, reproductive toxicity studies, and long-term studies in rodent and non-rodent species" (Rodricks et al. 1986, p. 517). Epidemiological studies provide valuable human-based data for risk assessment but typically have less precise exposure information and usually do not identify or control well for other exogenous factors. In contrast, animal-based studies force scientists to extrapolate results from animals to humans.

After substance identification, the Food and Drug Administration (FDA) attempts to determine the safe or acceptable level of product consumption. Two approaches are taken, depending upon whether or not the substance is cancer-causing. For non-cancer-causing substances, the FDA assumes a threshold level of consumption at which no ill effects occur. In turn, the highest level of consumption that did not produce an ill effect is identified and divided by a "safety" factor (usually 100) to obtain an acceptable daily intake (ADI). The safety factor is meant to account for the uncertainty associated with extrapolating risk factors from animals to humans and for variation in sensitivity among humans.

Risk assessment for carcinogenic substances assumes there is no threshold effect; all exposures affect the probability of carcinogenesis. To reduce the cost of performing the risk assessment while counteracting the statistical weakness of having few observations, only high doses are used in the assessment. However, these high doses are not typical of an individual's consumption; and a mathematical model must be used to extrapolate from the high doses to more relevant low doses. The mathematical models are based on generic theories of carcinogenesis rather than specific chemical and biological interactions, and, in addition, some of the theories are not empirically tested.

Manele: The food safety issue is so focused on carcinogens because we have the tools to look at cancer. There are many other health effects, but we simply don't have the measurement tools. We haven't been completely honest in using cancer risk as a policy tool, but we needed something to justify policy decisions, so we used it.

The use of mathematical models has several problems. First, the use of high doses may produce tumors that are not relevant to humans. For example, organ systems within the body may be able to defend themselves at lower levels of exposure but not at higher levels of exposure. Second, the functional form chosen for the dose-response function can affect and bias the risk assessment (Munro and Krewski 1981; Lichtenberg 1991).

The methods used to identify and measure non-carcinogenic risks are standardized and widely accepted. However, techniques used to assess the risks posed by cancer-causing agents are relatively new, and "considerable controversy can arise about the appropriate application of the methods and the reliability of the conclusions derived from them" (Needleman 1993, p. 4).

The current methods used to assess exposure are based on point estimates of an average individual's consumption. However, this approach assumes no variation in total dose, body weight or age among individuals, and the dose is assumed constant throughout one's lifetime. It eliminates consideration of the distribution of the risk within the population and may lead to a bias toward usage restrictions rather than monitoring, data collection and other uncertainty-reducing measures (Lichtenberg 1991). Finally, point estimates may make risk estimates appear more reliable than the data justifiy (Carriquery et al. 1991).

All of these considerations make clear that information on consumer decisions and exposure does not translate clearly into consumer risks, even at the frontiers of scientific knowledge. In fact, given the scientific approach upon which risk assessment is based, the marginal risk reduction that could be the basis for meaningful economic analysis is largely determined by assumed functional forms incorporated in mathematical models. Quite possibly the greatest potential contribution of economics in the food safety debate might be to provide focus on balancing the marginal costs and marginal benefits of risk reduction. However, this point has previously been widely recognized by economists, but to little avail.

The Complex Nature of Consumer Food Selection

In order to assess the empirical literature on food safety, it is useful to consider the decision environment in which consumers make food purchases. Here we include under the rubric, food safety, the entire range of health-related food attributes—partly because of the breadth of the empirical literature and also because all these attributes have been demonstrated to be factors in food choice.

The range of health-related food attributes includes such things as microbial and parasitic contamination, chemical contamination from pesticide residues, animal drugs, additives, etc., and nutritional characteristics such as fat, sodium, cholesterol and fiber content (Jones 1992).

Health-Related Food Attributes

Microbial contamination
Parasitic contamination
Pesticide residues
Animal drugs
Additives
Fat
Sodium
Cholesterol
Fiber
Calories
Other nutrients
Vitamins
Individual tastes

The tendency to consider contaminants as a fundamentally different problem from naturally-occurring substances may not accord with consumers' views, who may align themselves more closely with ultimate

outcomes than causes. Individuals can be expected to react quite differently to risks of microbial contamination that causes acute, but generally temporary, illness than to chemical contamination or dietary considerations that are linked with risks of succumbing to chronic and even life-threatening illnesses (e.g. cardiovascular disease or cancer). Risks associated with chronic illness are generally cumulative, while only one incidence of microbial contamination can cause food poisoning. Food poisoning is a risk quickly resolved (generally within 72 hours of ingestion) and may be viewed as more controllable, since a substantial percentage of food poisoning cases are caused by food handling problems in the home (Roberts and van Ravenswaay 1989).

The voluminous literature on risk perception and behavior under uncertainty concludes that there are no simple characterizations of behavior under risk (Weinstein and Quinn 1983; Viscusi 1989). Psychological research suggests, for example, that the context is exceedingly important (Savage 1991). Individuals react differently to risk if exposure is involuntary, and the length of time to resolution of uncertainty matters. In addition, various outcomes with the same actuarial death rates are viewed with differing levels of fear or dread (Slovic, Fischhoff, and Lichenstein 1982). Thus, even with definitive information on probabilities of unpleasant outcomes, simple expected utility interpretations are generally impossible.

For most risks, consumers have little or no experience with these outcomes and must depend on externally supplied information to form their subjective risk assessments. Even for those risks that have been extensively researched, however, risk information is rarely conveyed in ways that are useful for individual decision making. Risk information frequently takes the form of number of deaths per million. It is not reasonable to assume that even the most informed consumer is able to relate to such figures, nor is it reasonable to expect individuals to retain information on all such probabilities for all risks encountered on a day to day basis. It simply would not be worth the cost. But the world is more complicated still, since food-related risks are not stable over age—the old and the very young are frequently more susceptible—nor are they stable over health status or genetic endowment, and they can sometimes be altered by behavior through different preparation practices. Add to this the cumulative nature of some risks and the joint nature of others, and risk analysis becomes an overwhelming task.

An implicit assumption of some of the research on food safety is that actuarial risks are well understood by experts. However, scientists' understanding of the connection between food attributes and health is imperfect, continually changing, and sometimes contradictory, since one attribute of a given food item may increase susceptibility to cancer or heart disease, while another may increase resistance. In an interesting survey, Maney and Plutzer (1993) found that scientists differed among themselves in their safety assessments of a number of food technologies (including pesticide use).

Horowitz: I'd like to ask a really broad question; Does anybody really think that the federal government can improve life spans through food regulations? Has it ever even been established that changes in smoking behavior have been translated into longer life spans? But the link between food safety and life spans is much weaker. Is there *any* empirical evidence to establish a connection?

Bockstael: But there must be some evidence. Clearly, life spans have been increasing. People have been changing their diets, and lifespans have been increasing, but, of course, many other factors are involved.

Williams: The FDA did actually look into the matter and found that there is a definite connection between health regulations and life spans, but on average, the increase in only a couple of months. And the average doesn't mean much. Rather, it's the distribution we're concerned with. Instead of life spans, we should look at enhancement in the quality of life and reduction in morbidity. Then, we'll have a better chance of getting a meaningful answer.

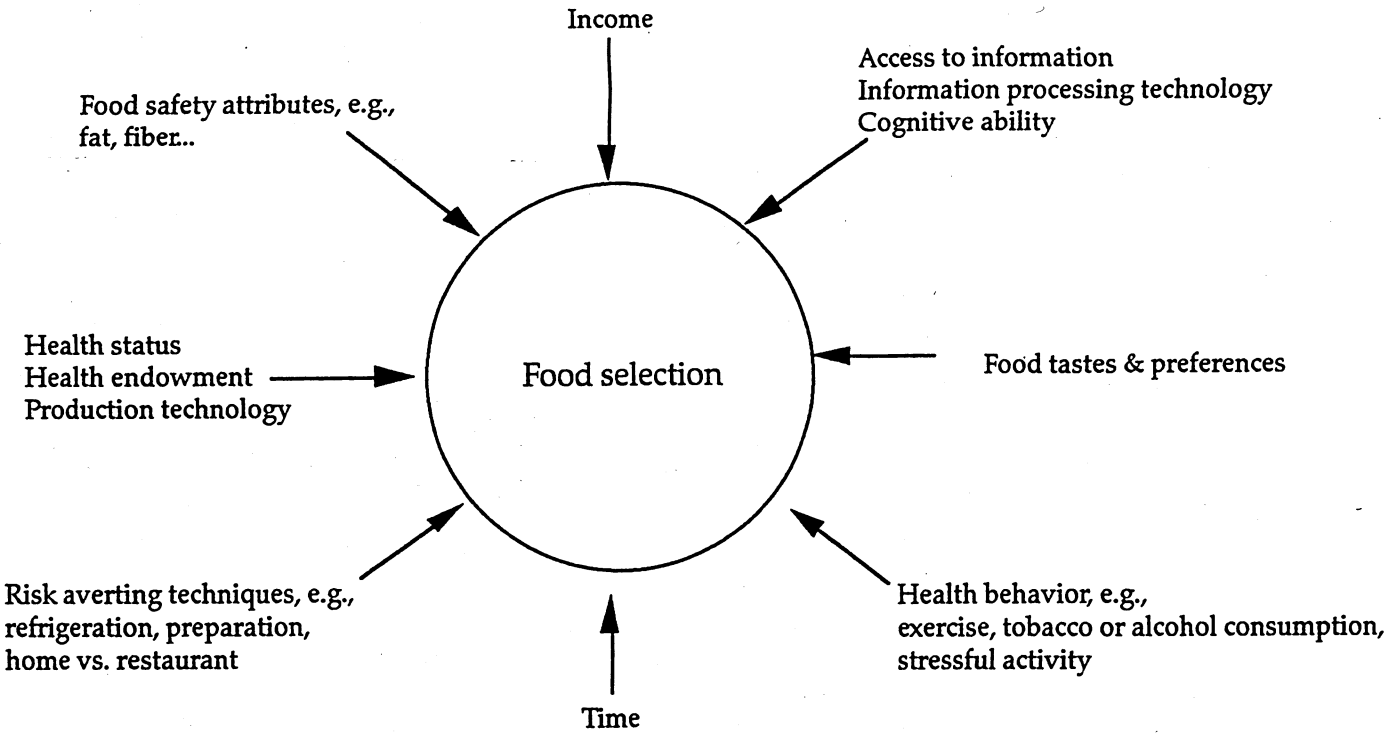
A good deal of uncertainty surrounds the risks associated with some food items. Research suggests that individuals become more anxious when making decisions in the face of uncertain risks and assume a larger dependence on their own judgement, thus invoking feelings of credit or blame (Heath and Tversky 1991). Individuals react differently depending on their assessment of their own competence in decision making, leading some individuals to discount and others to inflate risk estimates that they believe are ambiguous (Weinstein and Quinn 1983; Kahnemann and Tversky 1979). Ambiguity arises from conflicting or confusing information or from distrust of information sources. This latter source of ambiguity is particularly important, because attitude surveys seem to indicate a relatively low level of trust in government- or industry-supplied information, especially compared to that from university scientists, independent labs and consumer groups (Byrne, Gempesaw and Toensmeyer 1991).

These factors cause the array of food safety risks to be substantially different in nature and exceedingly complex to interpret. But to make matters worse, decisions about incurring these risks are set in a still more complicated environment. "Typical supermarkets stock from 13,000 to 60,000 items. These products must be considered for purchase by the consumer in the course of what is, on average, a once- or twice-a-week major shopping trip lasting a little less than an hour. Each food product must be evaluated on the basis of multiple attributes such as taste, convenience, appearance, safety, fat content, and sodium level. In this shopping context, information is asymmetric with consumers being willing to devote only a limited amount of time and effort to information acquisition" (Caswell and Johnson 1991, p. 280).

In making periodic food selections, consumers can be viewed, at a minimum, as factoring in their family's taste preferences, desires for variety, consideration of preparation time, information on health considerations, and time and income constraints. Food safety considerations may prompt consumers to forego consumption of some food item, but they may find it almost impossible to substitute others that do not also have negative health messages. Fruits and vegetables contain large amounts of dietary fiber and other beneficial elements and low amounts of fat, but also potentially contain pesticide residues; fish contains relatively low levels of fat but is particularly susceptible to microbial contamination; sugar is linked with diabetes and other illnesses but artificial sweeteners may be linked with cancer; red wine has been found to reduce cholesterol levels but alcohol is said to promote liver and heart disease. These inherently conflicting health messages are especially difficult to assess as some appear to change with each new scientific experiment.

The food selection process is complicated to perform and even more confusing to analyze, not only because food safety attributes are neither unidimensional nor the only attributes that determine food choice, but also because food is not the only dimension of health production. Some researchers have studied health related policies in terms of health production functions or risk management strategies

The Complex Food Selection Process



(Cropper 1981). Some risk-averting behavior might alternatively be viewed as inputs into a risk management strategy. For example, individuals may choose different preparation techniques, invest in better refrigeration equipment, substitute home-produced food for restaurant-produced food, all to reduce risks. But risk management strategies might transcend these food related activities. Frequent health messages produced by the American Heart Association and by cancer research foundations advocate, for example, regular exercise and abstinence from tobacco and alcohol products.

Given the volume of information on food-related health risks (as well as other related risks) and the ambiguity of this information, differing preferences for other dimensions of food as well as variety, differential health status and endowment, and the array of possible risk management strategies (including conventional averting behavior and behavior unrelated to food consumption), we offer some conclusions. Households will not behave the same; they will choose different implicit levels of exposure to a single risk and will value exogenous risk reductions differently. This is partly because their preferences and income and time constraints differ but, equally important, because their health production technologies and health endowments also differ. The variation will be further exacerbated by differences in access to information, in information processing technology (cognitive abilities) and in time constraints on this information processing. In this complicated decision context, it may not even pay individuals to form very precise priors on any single risk. From a researcher's standpoint, it would be very difficult to separate out the factors determining decisions and the degree to which behavior is affected by information. And it will be impossible to elicit meaningful values for risk reduction or "value of life" estimates.

Sarahelen Thompson, University of Illinois to Richard Just: Comparing the tone of this paper to your work on risk in production agriculture, you apparently attribute a different set of cognitive abilities to consumers than to farmers.

Just: It's not that consumers are cognitively less able, it's just that they have many more choices in their purchasing decisions than farmers do in production.

An Overview of the Existing Empirical Literature

Bockstael, Just, and Teisl: Here we ask whether the direction of the empirical literature on food safety has the potential to effectively contribute to resolving the various pressing public issues that have arisen.

Against this characterization of the consumer decision problem, we present an overview of the empirical literature on food safety. We emphasize that our treatment is selective rather than exhaustive. The *empirical* economics literature focuses almost exclusively on the consumer. Using market data, annual panel data, or individual surveys, the literature principally analyzes the following:

(1) attributes about and/or perceptions of food safety concerns,
(2) behavioral response to differences in food safety attributes or changes in food safety information, and
(3) willingness to pay for increased food safety.

Attitude and Perception Surveys

Kramer (1990) and van Ravenswaay (1988, 1993) have provided reviews of the results of a number of attitude surveys regularly conducted by such institutions as the Food Marketing Institute, the Good Housekeeping Institute, and the Center for Produce Quality. These indicate that consumers feel at least some "concern" about food safety issues, and these concerns appear to have been increasing in the latter part of the 1980s (Kramer 1990). Individual surveys analyzed in the journals (e.g., Byrne et al. 1991; Msira et al. 1991, 1993a, 1993b; Ott et al. 1989, 1991; Basiotis and Guthrie 1993; Bailey et al. 1980) report similar indications of "concern"; while a comparative analysis of 1965 and 1984 data by Sachs et al. (1987) documents declining confidence in regulation of pesticide residues in food.

In addition to documenting that substantial numbers of consumers are aware of health concerns associated with food, this literature has highlighted the degree of variability within the population in both level of knowledge and level of concern. Studies, such as that by Byrne et al., find significant differences in concerns depending on gender, education, race, urban/rural residence, and region of the country of the respondent.

As van Ravenswaay (1988, 1990) has pointed out, however, little can be gleaned from the actual answers to these survey questions, because the questions are usually framed imprecisely. Terms are frequently poorly defined and categories of potential concern are not mutually exclusive. Most troublesome, it is generally impossible to determine whether respondents are factoring in their own behavior or whether they are considering the net effect (both benefits and dangers) of food safety concerns.

This is particularly true of surveys that ask consumers to rank food safety concerns or rate riskiness of food safety hazards. Several authors have noted the apparent discrepancies between consumers' and scientists' rankings (Carriquiry et al. 1991; Kramer 1990). But given the imprecision with which these questions are asked and the complex environment in which individuals assess these risks, the significance of any such discrepancy is questionable. If all food safety issues are a concern, which attributes of "concern" are used as the basis for any particular ranking? Even if individuals interpret this as a request to rank their subjective probabilities of harm, upon what assumptions about exposure, behavior, health capital etc., are those probabilities conditioned? Experts at FDA and the Center for Disease Control consistently rate disease-causing microorganisms as presenting the greatest food safety risk to the public (Institute of Food Technologists 1989; Roberts and van Ravenswaay 1989). This does not, however, mean that it is the greatest risk—or should be the greatest "concern"—to any given individual. Rather, this ranking follows from the consideration of immediate health status alone. But if behavior-based precautions are considered, then identification of concerns becomes even more dubious. Responses to questions about food safety "concern" are not independent of the respondents' knowledge about food safety nor of their defensive behavior.

Food Demand as a Function of Food Safety Attributes

A number of studies have empirically documented behavioral responses to changing information on

food-borne risks. Of those that deal with dietary risk, one approach has been to use time series data to estimate the demand for a commodity such as eggs (Brown and Schrader 1990; Putler 1987) or butter (Chang and Kinnucan 1991) or a group of commodities such as meat products (Capps and Schmitz 1991) as a function of some index of information about dietary risk. While all of these studies find significant effects, the structural change in meat demand has been debated extensively in the literature (Alston and Chalfont 1991). Capps and Schmitz (1991) find a significant negative effect of cholesterol information on demand for pork and significant positive effects on demand for poultry and chicken, but insignificant effects for beef. A recent study by Spreen and Gao (1993) uses cross section data, associating variations in health awareness to demand for red meat. Drawing on U.S. Department of Agriculture (USDA) panel data on food consumption, Putler and Frazao (1991) find a significant reduction in consumption of fats between 1977 and 1985. They find that educated women were more likely to change their food choices between these periods and did so by reducing consumption of red meat and eggs.

Another body of empirical literature documents responses to health scares. Some of these studies report what is assumed to be an overreaction to a contamination incident stimulated by news media coverage, e.g., kepone contamination of oysters (Swartz and Strand 1981), herbicide contamination of cranberries (Brown 1969) and EDB and bread products (Johnson 1988). Van Ravenswaay and Hoehn (1991) estimate response to the Alar scare in the apple market, while Smith, van Ravenswaay, and Thompson (1988) consider the negative and positive information associated with the heptachlore contamination in Hawaii's milk supply, attributing the asymmetric response to distrust of public information sources. Analyzing the heptachlor incident, Foster and Just (1989) estimate consumer response to warnings and calculate the damages associated with incorrect information by computing compensating surplus with correct information.

The problem with these approaches (not the particular studies) is that few incidents are sufficiently dramatic to generate a discernible response. Given the complexity of a consumer's underlying decision process and the multiplicity of factors affecting decisions, behavioral effects are often not sufficiently large for any one product to be detectable with any level of significance, even for individuals that care about a given risk. As a result, this empirical literature is valuable in that it validates significant behavior changes in the face of new health information at least for some products. Because demand can be documented to respond to information, we know that individuals, at least in some contexts, exercise defensive behavior in the light of increased perceived risks. Thus, individuals prevented from making such adjustments by lack of information would be worse off (Foster and Just 1989).

What's troubling about some of these studies, however, is that they suggest consumer concerns may be mercurial, changing with publicity of incidents and media coverage. What matters to people may be a moving target. In a context in which individuals have no way of verifying information and have not had a stable and easily interpreted base of comprehensive food safety information over time, it is not surprising to see overreaction to information about well-publicized, concrete incidents.

These considerations raise important and thorny questions about whether information and publicity should be controlled. Are consumers better off not knowing food safety is uncertain if the extent of risk is not known? If publicity causes over-reaction, is a consumer better off not knowing food is unsafe? Standard concepts of economic welfare do not provide clear answers for these questions. Consumers' surplus is greater if consumers believe food is safe, i.e., if demand is greater. But suppose a consumer finds out after consumption that a product is contaminated. How then is that consumption revalued? Many forms of risk may be so low that consumers never obtain correct information by which to value their consumption decisions. How is the cost of correct information to be balanced against the value of making informed decisions?

Estimating Willingness to Pay for Risk Reduction

The desire to measure how individuals value specific reductions in health-related risks is no doubt driven by the way in which risk standards are set by the federal government. The science of quantitative risk assessment produces estimates of probabilities of occurrence of illness or death based on epidemiological or experimental studies for a given risk. It is tempting, therefore, to try to produce an estimate of individuals' valuations of a change in that probability.

Only a few papers, using behavioral models, have attempted to elicit willingness to pay for risk reductions. Hammitt (1986) uses a hedonic model to value organically grown produce, and van Ravenswaay and Hoehn (1991) measure the shift in a conventional demand model in response to the Alar scare in the apple market. Both use their results together with scientists' estimates of risk associated with Alar consumption to calculate an apparent revealed willingness to pay for change in risk of death. The assumptions needed to support these calculations are extreme and difficult to credit. They

depend on consumers' treating risks independently and possessing the same risk assessments as the scientists' estimates. Even if consumers had access to, and were willing to keep in their minds, all the scientific risk assessments available for all possible risks, they may for good reasons disagree with them.

The remainder of this literature employs contingent valuation experiments to elicit willingness to pay for products that implicitly embody lower hazard levels—specifically organically grown produce (Hammitt 1986; Ott and Haligaya 1989; Ott et al 1991; Misra et al. 1991; van Ravenswaay and Wohl 1993; Underhill and Figuero 1993) or fat-reduced meat products (Halbrendt, Snider, and Santoro 1993). Another group of papers specifically requests bids for reductions in risk measured by number of deaths per million associated with various food products: chicken bacteria (Zellner and Degner 1989); irradiated food (Malone, 1990); oyster contamination (Lin and Milon 1993a, 1993b); grapefruit (Buzby et al. 1993). Finally two studies undertake experimental auctions for chicken sandwiches with reduced risk of pathogen contamination (Fox et al. 1993; Bailey, Giamalva, and Redfern 1993).

At least some of these contingent valuation studies are rather ad hoc and would not pass the increasingly stringent standards that are currently being imposed on this methodological approach (see for example the National Oceanic and Atmospheric Administration Panel Report on Contingent Valuation 1993). But even if these studies were all of uniformly high quality, the value of their results for the policy debate is questionable. Given the complexity of the risk information and of the food safety decision environment, it is unclear how one would appropriately interpret answers to these contingent valuation questions. In fact, one could easily argue that a question about the value of risk reduction associated with a specific dimension of a single food item is meaningless.

A Reaction to this Empirical Literature

The empirical literature to date focuses on risk perception and willingness to pay for risk reduction, and implicitly views the consumer decision about any given food safety risk as inherently one of an independent assessment of probability of occurrence. The existing literature seems to be asking the rather amorphous question: "How much food safety do consumers want?" (van Ravenswaay 1988). Given the complex decision environment in which consumers operate, this question is difficult to interpret. It is equally difficult to interpret its relevance for policy formation.

The empirical literature has tended to concentrate on one food safety problem at a time, e.g., a contaminant, an additive, or a dietary concern, or it has attempted to elicit consumers' relative concerns over the range of food policy issues. The problem with this approach is that food safety has many dimensions. Each food item has a vector of attributes that affect risk including various types of microbial content, pesticide residues of various types, fat content (saturated and unsaturated), etc. Determining these attributes requires significant scientific expertise and suffers from substantial statistical sampling error. Depending on the mix of foodstuffs and quantities consumed as well as other personal attributes relating to genetics, exercise, etc., these vectors of attributes translate into a vector of specific food safety risks, e.g., probability of food poisoning, death from cancer, likelihood of heart disease, and the like. Even scientists have imperfect understanding about how these processes work.

Ignoring the incontrovertible fact that consumers do not have perfect information, answers are still misleading unless all related risk considerations are properly specified in framing a question about changing the safety attributes of a single food product. The value of avoiding a vegetable treated with a particular pesticide may be large for someone who consumes a large amount of other vegetables treated with a similar agent but not so otherwise.

In general, we know little about how consumers process information. Do consumers evaluate the effect each particular food will have on a specific risk, such as probability of heart disease? Or do they evaluate the overall risk of a food such as red meat in forming their consumption habits? Or do they tend to focus on their aggregate intake of a specific attribute after a specific experience? For example, do consumers focus on aggregate fat or cholesterol intake after a stroke or after testing high for cholesterol?

Many of the existing studies implicitly expect consumers to have formulated absolute or relative risk assessments associated with the food safety risk of specific research interest. They express concern when these absolute or relative assessments deviate from "expert opinion" (Mapp 1990; Kramer 1990). Whether individuals form subjective probabilities on each food safety risk and whether these probabilities drive their decision making, or if indeed this is an optimal way to act, has not been established.

Information and Social Tradeoffs

In the remainder of this paper, we consider what appear to us to be the fundamental policy questions in food safety and suggest the sorts of research that would appear to shed light on these questions. We frame these questions as a series of social tradeoffs. One such tradeoff exists between the protection of individuals through prohibitions on substances and the benefits of freedom of choice; another between simplicity and precision of food safety information.

Unrestricted Choice Versus Imposition of Standards

Currently U.S. food policy is characterized by (1) government risk standards that serve as a floor to risk exposure and (2) information that allows private parties to set their own higher standards (Caswell 1990). Standards that prohibit certain substances or restrict the level of others (e.g., product bans, tolerance levels) are viewed as embodying collective decisions on acceptable levels of risk. The apparent need to define "acceptable levels of risk" has led some to argue that standards should be set at levels that accord with what consumers would choose if fully informed (Viscusi 1988). This view no doubt motivates the numerous studies, reviewed above, aimed at revealing the value of risk reduction. Inherent in this argument is that standards should be comparable across products so as to achieve the same level of risk from all sources.

These arguments lose meaning if risks vary over individuals and if fully informed individuals would choose different standards. They also run counter to basic economic principles if the cost of reducing risk differs widely among different types of risks. Since this appears to characterize food safety decisions, standards for food risks would seem, at least on the face of it, to be suboptimal since various individuals, given perfect information, would choose different standards. Differing optimal decisions are to be expected because inherent health statuses (and genetic health risks), preferences for the desirable characteristics associated with the goods affected, production technologies for producing health, and endowments of time and income all differ among consumers. An informed consumer may prefer to control the effects of a risky food by limiting the quantity of intake rather than eliminating it altogether.

But perfect information is not a realistic prospect in food safety considerations. One of the most challenging questions that arises in problems of misinformation and cognitive processing limitations is whether certain choices should be eliminated by government control. If consumers are not able to interpret meaningfully a risk that causes a certain number of deaths per million, should they be given the choice? Should a panel of experts or a strong lobby group be allowed to intervene to eliminate a consumer choice?

Emphasis of research may be better aimed at the social tradeoff between imposing standards and providing information. Research frameworks that aid public policy making in deciding whether to use standards or information must be capable of comparing the social cost of standards that are imperfectly associated with individual characteristics to the social cost of imperfect information and imperfect consumer use of available information. The tradeoff between inefficiencies due to poor information must be weighed against the inefficiencies of limiting consumer choice, and the same inefficiency may not dominate in all cases. For example, the cost of acquiring and processing information may be more important for pesticide residue problems—suggesting standards—while differences in individual tastes and circumstances may matter more in cholesterol problems—suggesting informed individual choice.

Standard economic welfare concepts are difficult to use and easily misused in addressing these tradeoffs. To address these issues adequately, frameworks must consider both the value of information and the costs of misinformation. A number of rather unusual questions arise: If an ignorant consumer is forced to make the choice he would have made with perfect information, is he just as well off? Or does a consumer suffer from being forced to make a choice which is not believed to be in his best interest? In any event, assessment of the welfare consequences of standards must consider the distribution of characteristics across households.

The Form of Information: Simplicity Versus Precision

Current food policy incorporates labeling as well as standards, and it is expected that future regulatory strategies will continue to have an information component (Caswell 1990). In fact, it is likely that the types of risk that consumers will insist on being informed about will expand. California's Proposition 65, for example, currently exempts food from carcinogenic warning labels, but this exemption is not likely to be sustained much longer (Kramer 1990; van Ravenswaay 1989).

Given consumers' opportunity costs of time, their cognitive abilities and the number and variety of risks that must be assessed in any shopping trip, there are potential gains possible from simplifying information. Consider, for example, the amount and type of information that is currently required on labels, ostensibly to provide consumers with information necessary to follow nutritional guidelines. It is conceivable that a substantial portion of the population would be better off with a few aggregative measures of risk rather than complicated contents and ingredient labels. A number of consumers do not understand or do not use these uniform nutrition labels (Heimback 1982; Achterberg 1990). In addition, surveys have documented consumers' requests for simplified and shortened health information messages (Food Marketing Institute 1989; Sheperd 1990).

How many dimensions of information can usefully be provided on a food label? An important principle from the field of mathematics implies that if consumers are primarily concerned with, say, four health risks, then a simple four dimensional representation of risk may carry as much information as a complete accounting of all ingredients that interact together to determine the risks. This principle is obviously useful if the dimension of the vector of effects of interest is less than the dimension of the vector of nutritional substances and contaminants.

Williams: I agree with Boekstael, Just, and Teisl, that all the nutrition information is extremely difficult and complex for consumers to understand. Consumers tend to decide on the food they want, not generally because of any particular attributes of that food. We need to narrow down the metric for them and keep it relatively simple, for example, a 1 through 5 ranking system on the label for various attributes such as fat content. Then, those who want more detailed information could read the fine print. In the future, they may be able to scan bar codes for this information.

Another dimensionality issue in conveying risk information relates to the units of measurement used in expressing the *level* of effects. Can a consumer learn more by knowing that a food contains 1, 5, or 10 parts per billion of a particular pesticide residual, that it is associated with 1, 5, or 10 deaths per million at average consumption rates, or that the cancer risk is low, medium, or high compared to some standard food basket.

When the number of dimensions of the information is reduced, simple visual

symbols of this information become possible. Quickly perceived representations regarding types and levels of risks can be conveyed with figures or colors. Interestingly, in public hearings held in the late 1970s, many consumers expressed a preference for graphical methods of conveying nutritional information (Department of Health, Education, and Welfare 1978). Others have also recommended graphical formats (Hanson 1985; Geiger et al. 1990).

However, simplified information that is easier to process is by definition less precise. Thus, a tradeoff is likely to exist between cost of information acquisition and information accuracy. Some measures that make processing less costly may reduce the precision in level of risk or in differential risks across sources. A move towards more accessible information messages will benefit some segments of the population and hurt others. Those with more time and possibly more specialized information needs would presumably benefit from more information. Apparently, economists have investigated very little about these potential gains and losses. While labeling has been the focus of major policy initiatives in the last few years, we could find little empirical economic research on food safety that attempted to address questions of the optimal form of labeling.

The Role of the Private Sector in Supplying Information

To this point, we have considered only the value and accessibility of information to consumers and have ignored the conditions under which information is supplied. This is consistent with much of the emphasis in the literature, which views food safety information as a public good. Although the costs of supplying food safety information are incurred by both the private sector (through labeling) and the public sector (through inspection and education programs), information is publicly regulated.

The history of private sector participation in health-related labeling is tied closely to the history of the Food, Drug and Cosmetic Act (FDCA) and its enforcement. The United States does not have a single system to monitor and enforce food labeling, but the primary federal agency responsible for monitoring nutrition and health information with respect to food products is the FDA. (The USDA exercises some jurisdiction over food labeling for meat and poultry products under the Federal Meat Inspection Acts of 1906 and 1907, the Poultry Products Inspection Act of 1957 and the Egg Products Inspection Act of 1970; and the Federal Trade Commission (FTC) regulates food advertising under sections 5 and 12 of the FTC Act). In addition to the federal level, the states' attorneys general are responsible for monitoring and enforcement of food safety information on labels *and* within advertisements.

In contrast to the USDA, which requires pre-approval of new food labels and thus avoids extensive regulations, the FDA relies on publications of formal regulations and labeling requirements as well as periodic threats of enforcement. Hence, industry compliance depends on close monitoring. A consequence of the FDA approach is that issues regarding labeling requirements can remain unresolved, sometimes for years (Committee on the Nutrition Components of Food Labeling 1990).

Until the mid-1980s, the FDA enforced its position of considering a food misbranded if the label "represents, suggests, or implies that the food, because of the presence or absence of certain dietary properties is adequate or effective in the prevention, cure, mitigation or treatment of any disease or symptom" (Reg. 2125 1973). A major policy shift occurred in 1984, when the Kellogg Company used a health claim in

its promotion of "All-Bran" as a way to reduce the risk of cancer and the FDA did not take action. Furthermore, at a conference during 1985, officials at FDA stated that they were prepared to consider ways to use food labeling to convey health messages (Hile 1986) and subsequently proposed a new policy to allow health claims on food labels that would not require prior FDA approval (Cooper et al. 1993).

As a result, there was a significant increase in the number of health-related claims in the food products market between 1987 and 1989. Caswell and Johnson (1991) describe the private sector's reaction to this more liberal regulatory environment for health claims and to the increasing consumer demand for information about food safety and nutrition. Undertaken largely by food processors and distributors, product differentiation based on food safety attributes established brand name recognition that served to segment the market and reduce competition from other producers (Caswell and Johnson 1991; Zellner 1989). The importance of these strategies from our perspective, however, is that they provided health related information and provided it in a form less costly to process. In essence, producers provided an information distillation service. "Use of branded products or a particular retail outlet can be a significant time saver. Once a consumer is assured that a particular branded product line provides the desired safety and nutrition attributes, and given that it meets his or her taste and other specifications, the brand can be relied upon without reading the fine print on the nutrition and ingredient labels" (Caswell and Johnson 1991, p. 280).

Once allowed to pursue these strategies, producers have had the incentive to reconfigure products to embody reduced health risks. A number of cases have now emerged where food growers, manufacturers, distributors, and retailers have attempted differentiation strategies that involved: revising the production technology to produce substitute products with low fat, sodium and cholesterol content (e.g., Con Agra's Healthy Choice label; Entenmann's cholesterol-free/fat-free products); providing independent testing and certification for pesticide residues (e.g., NutriClean); screening products for health and nutritional content (e.g., Fresh Fields retailers in the Washington area and Bread and Circus in Massachusetts). Even some restaurants and associated hotel chains have adopted product differentiation strategies by offering menus embodying health risk repackaging options.

This shift in policy is generally considered to have produced beneficial results (Beales and Muris 1993). Besides the benefits of preprocessing information, firms have had incentives to produce a range of products that embody reduced health risks. This has made lower risk food more accessible to those previously unaware or unable to process health risk information. It is interesting that the Federal Trade Commission (FTC), in contrast to the FDA, has always taken the position that "health claims benefit the consumer as long as the information is substantiated, truthful and not deceptive" (Cooper, Frank and O'Flaherty 1993, p. 58). A study by the FTC Bureau of Economics indicates that "health messages are an important stimulus to research and development . . . of more healthful products (Ippolito and Mathios 1989). In a second study, the FTC indicates that consumers can be hurt by denial of access to health claim information (Calfee and Pappalardo 1989).

Evidence shows that at least some of these strategies have been highly successful, suggesting that consumers are indeed willing to pay for someone else to help them process information on food safety. But an equally important point made by Caswell and Johnson is that firms will have incentives to provide this information only if they are guaranteed a regulatory

framework that supports them. This requires, on the one hand, stability of policies that allow such labeling and, on the other, protection from false or misleading claims by others.

The 1990 Nutrition Labeling and Education Act

The regulatory environment of the mid 1980s was not without its problems or its critics, however. The regulatory void led to something of a free-for-all in health claims. In the late 1980s, states stepped up enforcement in health and nutrition claims due to a perceived lack of federal enforcement, and, in 1988, the National Association of Attorneys General approved a resolution calling on FDA to restore prohibitions on claims linking diet and disease on food labels (Beales and Muris 1993). In response to the growing confusion in the market, Congress made several major changes to the FDCA during 1990, under H.R. 3562, the Nutrition Labeling and Education Act of 1990 (NLEA).

NLEA begins by increasing the amount of information to be presented on food labels, although it does allow the current format to be altered to state nutrient levels as ranges. To reduce consumer confusion, labels cannot state the omission of a nutrient unless the nutrient is normally in the food and definitions of "free," "low," "light or lite," "reduced," "less," and "high" are to be provided. NLEA also sets out regulations tying together the labeling of cholesterol and saturated fat and tying together the labeling of fiber and the amount of total fat. In addition, nutrition information is to be provided at the point of sale for the 20 most frequently consumed raw agricultural commodities (vegetables and fruit) and the 20 most frequently consumed varieties of fish.

Of particular interest to our discussion, NLEA significantly restricts the use of labels in making health claims. It prohibits all health claims in labelling until FDA, through a Public Health Service (PHS) panel, develops a scientific survey of the evidence, a consumer health message summarizing the evidence in lay terms, and a model label statement. In addition, the FDA will publish a consumer guide to food labeling to educate customers. Health claims will be restricted to those diet-disease connections for which there is scientific consensus. At present these include: calcium and osteoporosis, sodium and hypertension, lipids and cardiovascular disease, dietary fiber and cancer, and dietary fiber and cardiovascular disease. (In addition, the FDA is to study the links between folic acid and neural tube defects, antioxidents and cancer, zinc and immune functions in the elderly, and omega-3 fatty acids and heart disease.) But even for the well established diet-disease connections, health claims must await the PHS panel's survey, summary and label development, which may take years. In the interim, no previous health claims are necessarily exempt from prosecution as misbranding.

Some see this amendment as returning FDA "substantially to its historical position in opposition to health claims on food labels" (Cooper et al. 1993). The new policy would prohibit health claims in new areas, even if supported by National Academy of Science studies or Surgeon General proclamations, unless or until a PHS panel reaches consensus and produces the necessary documentation. The development of the health messages is "elaborate and reminiscent of the procedures for the over-the-counter drug review" (Cooper et al. 1993, p. 69).

Another aspect of the FDA's new position is a distrust for the competitive edge provided by health claim labeling. The Agency seems to want to restrict the possibility of a product making a (legitimate) health claim, when the health effects of the product are no better than those associated with competing products that do not likewise label. This position

blatantly ignores the service that such labeling provides in providing pre-processed information. Firms who wish to incur the extra costs of providing this service should be allowed to reap the returns from it.

Caswell: There has been a veritable explosion of health-claim information, leading to NLEA. The new law will put some limits on these claims but will by no means choke them off. Health claims will still be made, but NLEA will truncate some of the deceptive claims.
Williams: FDA has been studying nutrition label formats. The ones that work best with consumers do not correspond to the ones they like best. In the end, the choice was a political one.

Costs of labeling—
Williams: We can't quantify all the benefits or costs from labeling. Labels sometimes involve lots of indirect costs that are not obvious at first. For example, FDA imposed a seemingly innocuous regulation involving labeling products as containing "no sulfites." Campbells was forced to carry out a very costly testing of thousands and thousands of products, including all the inputs for these products. Companies can spend millions and millions to reformulate, but the products are not always better.
Dan Padberg, Texas A&M: That's the nature of interaction between firms—it costs to compete. They would be continually interacting anyway. But now we're changing the nature of that competition. Now there will be some public value instilled in the process.

NLEA will not apply to all products—
Williams: It's simply not true that under NLEA all food will be labeled. Small businesses will be exempted, because we found out that it would place too much of a cost burden on them. And, although products from these small businesses represent only a very small portion of our diets, they account for well over half the number of products on the market. In the end, I feel that the variety they provide offsets any worry about safety.

Nonuse benefits of food labels—
Tom Sporleder, The Ohio State University: Something we haven't discussed much is the nonuse benefits of information being supplied to consumers, for example in the new labels. The food production and distribution system is very complex. Most consumers don't understand it but want assurance from some expert that it's okay. That is, even if they don't directly use the information on a label, they can still benefit from it. The label gives a signal to consumers who then know that somebody is focused on nutrition or the safety of their food.
Padberg: Consumers' not using or not undertanding label information, therefore, does not imply an overinvestment in labeling. One very important thing is the manufacturers' reaction. They are sensitized and made aware of the food's content, the ingredients. Labels evoke a behavioral change in manufacturers. For example, they are induced to reformulate products so the label will sound better to consumers.
Mandele: For example, all the emphasis on salt has led manufacturers to reduce the salt content. Thus, this labeling has benefited consumers.

The Raison d'Etre for Intervention

It appears that the removal of the government-imposed ban on advertising health claims was one of the most positive steps in food safety provision in recent times. However, the unregulated environment may have failed to protect firms' investments in new products and may have encouraged fraud. The revised policies of the 1990s, however, may once again have shifted too far in the direction of control. Given the willingness of the private sector to enter the fray, what precisely is the optimal role of the government?

Imposing mandatory labeling requirements has likely been excessively costly because more information is conveyed than some consumers need, and the excessive information has complicated information processing. Furthermore, mandatory labeling requirements and constraints have likely limited competition. Private firms have not been free to determine the most effective way of transmitting safety information to consumers. Perhaps a better mix of products can be achieved by facilitating a wider range of methodologies for describing food safety. If standards are the most effective way of dealing with a particular safety concern, why will a product line offered by private firms satisfying desirable standards not arise? Better yet, if two important types of consumers exist that are better served by products satisfying different standards, why would the private sector not find provision of both types of goods profitable? (By comparison, the likelihood of legislating two types of safety standards by government regulation which are open to free choice is remote.) Similarly, if a simple means of transmitting food safety information is desirable in facilitating individual choice, why will private industry not discover it as a means of attracting consumer demand? Some consumers prefer highly aggregative measures of safety, while others prefer great detail, and still others would be willing to pay for brands that go to expensive lengths to eliminate risks. This benefit from competition can only be gained by allowing the market to seek out its own ways of reporting or representing safety.

The nature of the market failure, here, obviously has to do with the inability of consumers to determine the validity of claims. This has two dimensions. Without information, the public has no knowledge of the connection between risk on the one hand and contaminants and nutritional composition on the other. Product differentiation is only profitable if the public has some awareness of health attributes of food. This type of information is truly a public good and is likely to be more thoroughly accepted if provided publicly. Additionally, consumers will almost never be able to verify whether the level of contaminants or nutritional ingredients is correct, because they are not directly observable nor can they be definitively connected with ultimate health outcomes. A firm may attract consumers by investing in, and advertising, a safe and reliable product, and then relax their standards unbeknownst to consumers.

Beales and Muris (1993) see the problem of regulating labeling as a straightforward tradeoff between the costs imposed on consumers from overstatement of claims and the losses in information and reduced product innovation from undue restrictions on producers. Clearly, in the complete absence of monitoring and enforcement, "lemons" will prevail, information validity will deteriorate, and labeling will lose its ability to convey any useful information. But barring these extremes, what exactly is the nature of the social tradeoff between more tightly controlled health messages and more freedom for product innovation?

These considerations raise some interesting moral hazard and principal-agent questions. Obviously, regulatory agencies do not have the resources to

monitor all health claims at all times. The question then becomes how to induce proper behavior by firms that otherwise have a profit incentive to let standards or safety levels temporarily decline within the bounds of consumer non-perception. Some interesting research questions then become (1) how frequently should individual products be monitored, (2) what penalties should be imposed for failure to meet safety claims of labeling, and (3) how to design verification of information so as to induce self policing of the industry.

Market intervention—

Williams: There are very high standards as to when the federal government should intervene in markets. Intervention is called for *only* in cases of market failure. Many apparent difficulties don't justify regulatory intervention. There are many other actors involved in the food safety issue, not just the government. There's a court system that works, the media, third party observers, such as *Consumer Reports.* And finally, private contractors, such as Safeway, are extremely particular about their procurement, handling, and merchandising. It's not just the government who is concerned about food safety.

Henderson: But there's a private demand for food safety and nutrition standards from both consumers and producers. Consumers demand reduced health threats associated with eating, while producers demand standards to reduce or eliminate unfair competition, from somebody selling a "bad" as a "good."

Williams: I still say that the standards should be very high before the government intervenes in the market. You ought to be able to prove that the market has failed in some way. There ought to be much more analysis of regulations. There are complaints against FDA that it can't get anything (e.g., drugs) out very fast. Well, I think that's okay. We need to deliberate until we're sure we're right.

Dan Padberg, Texas A&M: You seem to be taking the status quo as some sort of optimum that shouldn't be disturbed. Well, before the 1975 "intervention" with its labeling law, consumers simply didn't know at all what was in the products they consumed. Nutrition was not in the equation at all. I think they're much better off now, knowing more.

Conclusions

Our primary conclusion is that the bulk of the empirical literature on food safety does not seem closely aligned with the important policy debates. Most of the literature addresses how people feel about or value individual food safety risks. The policy issues surround the provision of information.

We submit that scientific progress in the transfer of food safety information to consumers should be based on an analytical framework of the cost of acquisition and processing of information. Simple means of representing information in ways that permit near-instantaneous cognitive transmission may be necessary to reach the vast majority of consumers. The choice of these methods calls for challenging research on the tradeoff between the cost and accuracy of information pre-processing, the complexity of information presentation in labeling, and the proportion and characteristics of the population that are able to make more informed choices as a result. Of equal importance for research are the implications of different regulatory schemes for firms' incentives in supplying health-related information and for repackaging that information and the health attributes of their products.

To predict the future of food safety is both naive and presumptuous. Yet it appears likely that desirable offerings of food safety in the market will be characterized by a mix of information facilitating free choice and standards tailored to various collectives. Also, optimal information provision apparently will be characterized by some mix of completeness and simplicity. Finally, given the lack of uniformity of characteristics among consumers, it appears that a private-sector-based approach will be necessary to find these optimal mixes so as to meet individual needs and facilitate a wide variety of approaches to "information packaging" that make processing less costly for consumers in a wide variety of circumstances. This suggests that empirical research on these tradeoffs may be socially more valuable than research aimed at comparing risk perceptions of uninformed consumers or valuing risk reductions for individual commodities.

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