Valuing Food Safety and Nutrition

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PART ONE: Setting the Stage: Research Perspectives and Theoretical Models

4. Information Issues for Principals and Agents in the "Market" for Food Safety and Nutrition

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Information Issues for Principals and Agents in the "Market" for Food Safety and Nutrition

Michael D. Weiss[1]

The economics of food safety and nutrition is a subject still in its infancy, yet one that will surely play an important role in the growing debate over food quality issues. Along what path ought this subject be developed? In this chapter, I will attempt to convey some of the opportunities and challenges of treating the economics of food safety and nutrition within the framework of those new forms of microeconomics, developed over recent decades, that recognize *information* to be an important constituent of economic exchange. In particular, I will explore the potential applicability of principal-agent theory, an important paradigm in the economics of information. I will also discuss implications of this theory and of related information concepts for a definition of the "valuing" of food safety and nutrition.

The Information Problem for Food Quality

Food Safety

Consumers desire food safety and are willing to pay for it. Yet, food safety is not a good that can be purchased explicitly in the marketplace. Rather, it is available only as one of the implicit characteristics of goods that *can* be purchased at explicit prices and in explicit quantities. This inexplicit character of food safety, manifested in the inability of consumers to ascertain the safety level of food with certainty before (and often even after) purchase, is arguably the most important impediment to economic efficiency in the "production" and "marketing" of food safety.[2]

When consumers cannot reliably detect differences in the safety of food products, they have little reason to pay more for a product that a producer merely claims is safer, for they could not distinguish false claims of safety from honest ones. As a consequence, producers of safer food could not successfully charge a higher price to cover their presumably higher cost of production. Ultimately, they could not compete with producers who made false claims of safety. Thus, the information problem faced by consumers undercuts economic incentives for producers to produce a safer product. In effect, less-safe food drives out safer food, and the government finds itself called upon to intervene in the market to guarantee an acceptable level of food safety.[3]

Nutrition

There is a fundamental similarity between the consumer demand for nutrition and the consumer demand for food safety. For, in the absence of labeling or other sources of information, consumers often cannot determine the nutritional content of a food item either before or after purchase. As an example (relating to both nutrition and food safety), consumers cannot directly confirm that food claimed to be organically grown is represented truthfully. Thus, the information problem faced by consumers may undercut producers' incentives to offer the nutritional content consumers desire.

There is, in fact, a sense in which nutritional content is subject to an even more deeply rooted information problem than food safety, at least when food safety is considered from the standpoint of microbial contamination. Probably most cases of foodborne disease manifest themselves within days of ingestion of the offending item. While consumers may be unable to associate a foodborne-disease episode with the specific food sample that caused it, they will at least often be aware of the occurrence of the illness and may suspect its foodborne origin. In contrast, the deleterious effects of poor nutrition would normally take years to manifest themselves. Moreover, consumers may reach a disease state (for example, hypertension) without being aware of it, and, even if they are aware of it, demonstrating a causal role for nutrition (for example, showing a high-sodium diet to be the cause of one's hypertension) may be impossible. Indeed, science itself has not settled whether certain dietary choices are healthy or unhealthy. Thus, nutritional content is, in a sense, an even more strongly justified example of a credence good than food safety.

An additional distinction between food safety and nutrition is grounded in the distinction between the discrete and the continuous. A single sample of pathogen-tainted food can cause illness or even death. Malnutrition, however, arises only as a cumulative, continuous effect; the nutritional content of an individual food purchase has no measurable health consequences.[4] As a result, although malnutrition (as manifested, for example, in obesity in the general population) is probably a greater public health problem in some countries than contaminated food, the incentives for both producers and consumers to avoid poor nutritional content in individual food items are limited in comparison to their respective incentives to ensure that each item of food produced and consumed is safe. It follows too that consumers require information not only about the nutritional content of individual food items, but also about the cumulative effect of their nutritional choices.[5]

In dealing with the "market" for food safety and nutrition, the basic question government and industry must confront is this: What mechanisms can be incorporated into the consumer-producer relationship so as to (1) satisfy consumers that they will in fact receive the level of food quality they wish to purchase and (2) provide producers with incentives to furnish that level of quality? Among the potential forms of government intervention are inspection of production facilities; certification mechanisms, as for organic produce; consumer education concerning food risks, proper food handling, and nutrition; labeling requirements for nutritional content or for safe food handling and preparation; and regulations concerning food treatment methods such as irradiation. Industry may develop its own mechanisms, such as independent testing organizations. Each of these approaches to ameliorating the consumer's information problem imposes its own costs and has its own influence on producers' incentives and rewards.

Principal-Agent Theory

Within the economics of information, a key paradigm for the analysis of incentives and rewards in the presence of uncertainty is principal-agent theory. A principal-agent relationship is said to hold between two individuals when one (the principal) provides compensation to the other (the agent) to perform services desired by the principal but whose successful completion cannot be directly verified by the principal. Principal-agent theory has been applied to several areas of economics, including industrial organization and firm behavior, finance, resource economics, and the economics of law. For recent examples of empirical and theoretical applications, see Cohen (1987), Innes (1990), Newman and Wright (1990), Lafontaine (1992), Martin (1993), and Shepard (1993).

In the food quality arena one can visualize many relationships to which, at least at a conceptual level, the principal-agent paradigm may apply. For example, consumers (as principals) desire producers (as agents) to provide safe and nutritious food in exchange for the purchase price, yet consumers cannot directly verify safety or nutritional content. Likewise, taxpayers (as principals) wish the government (as agent) to provide effective food safety monitoring services in exchange for tax payments, although taxpayers cannot directly observe these services. Later, I will discuss some of the technical challenges that must be overcome if principal-agent theory is to be applied to food quality problems not simply as a conceptual paradigm, but as a quantitative modeling procedure.

The relationship between a principal and an agent may be viewed as a special case of a more general notion that Bowles and Gintis (1993) call *contested exchange*. As these authors point out, neoclassical economics portrayed economic exchange as neat, antiseptic, and capable of mathematically elegant characterization. Economic actors optimized, but only within rigid behavioral constraints. The theory accorded little recognition to the possibility of deception, shirking, strategic maneuvering, difficulty in enforcing contracts, and lack of information about what was being traded or the actions of other agents. In effect, economic exchange was implicitly assumed to be costless and frictionless.

In the newer perspective, exchange is recognized as inherently contested. Individuals are still regarded as operating in a self-interested manner, but now the benefits they receive from a transaction are contingent on their ability to enforce its terms. This approach, like the earlier one, can be highly mathematical (indeed, game theory is frequently applied here, and the seminal work of Ross (1973) already drew on the calculus of variations). However, the approach treats a much richer set of human behaviors, motives, and limitations. Throughout it all, the influence of information and incentives is paramount.

The Mathematical Form of the Principal-Agent Paradigm: An Intuitive Description

Principal-agent theory couches its approach within a specific mathematical framework. Here I present an intuitive outline of this framework (Radner 1987). One economic actor, the "principal," wishes a certain service to be performed by another, the "agent," but is able to observe only the final outcome, not the agent's actual level of effort. The outcome depends jointly on the agent's effort and chance. The agent derives greater utility from less effort, while more effort tends to promote outcomes with greater utility to the principal. As an incentive for effort, the principal offers a fee schedule according to which the payment made to the agent depends entirely on the realized outcome. Of course, as chance plays a role in determining the outcome, even a high level of effort on the part of the agent cannot guarantee a result favorable to the principal. Both parties understand this fact, and the fee schedule reflects it.

It is assumed that the principal knows the behavioral characteristics of the agent—the set of feasible effort levels, the utility/disutility function of money and effort (and thus the expected utility of each fee schedule), and the "reservation level"—the level of utility below which the agent would have better alternatives than to accept an offered fee schedule.

This situation may be viewed as a noncooperative game in which a strategy for the principal consists of a choice of a fee schedule granting specified payments for specified outcomes. (Thus, the principal chooses a function mapping outcomes to payments.) For the agent, a strategy is more complex. The agent considers *all possible* fee schedules and, for each, selects an effort level that, in combination with the expected fee, is utility maximizing. (Thus, a strategy for the agent is a function that maps the set of feasible fee schedules into the set of feasible effort levels.) Note that the principal, knowing the agent's characteristics, can predict what the agent's own utility-maximizing choice of effort level will be in response to any fee schedule. An *equilibrium* is a pair of strategies—one for the principal, one for the agent—such that the principal's fee schedule (by inducing desired behavior in the agent) maximizes the principal's own utility. An equilibrium represents rational behavior for each player acting on the basis of available information. Neither, *acting alone*, can do better by choosing a different strategy.

Equilibrium Versus Efficiency Under Imperfect Information

Neoclassical microeconomics maintains an implicit assumption that all economic actors have perfect information. Within this approach, an equilibrium is necessarily efficient, that is, Pareto optimal. However, once the assumption of perfect information is dropped, as it is in principal-agent theory, an equilibrium may fail to be efficient, and a market result obtained through the independent, "rational" decisions of individuals may prove less desirable than if a different decision process—perhaps one involving some sharing of information—had been used. In some cases, this inefficiency may serve as a rationale for government intervention. For example, through various food safety monitoring activities, government can provide information that market participants would not individually be motivated to develop or share. Similarly, laws requiring nutritional labeling can enhance consumers' ability to choose better nutrition while imposing similar costs on competing producers. In the absence of such laws, producers of, say, potato chips might not choose individually to inform consumers of their product's nutritional content.

To see why an equilibrium need not be efficient in a principal-agent relationship, suppose the agent is risk averse and the principal risk neutral. Now, assume that a pair of strategies *was* efficient, i.e., that no other strategy pair could raise one party's expected utility without lowering the other's. Then, the agent's compensation would have to be a constant, independent of the outcome. For, if the compensation varied randomly with the outcome, the agent, being risk averse, could do better by accepting its expected value, while the principal, being risk neutral, would be just as well off offering this expected value as a constant compensation. However, if the compensation did not depend on the outcome, the agent would have no incentive for effort! It follows that a nontrivial equilibrium (one in which the agent puts forth some effort) generally need not (and, under the particular assumptions used here, cannot) be efficient (Radner 1987).

Valuing Food Safety and Nutrition Under Imperfect Information

The preceding demonstration of the inequivalence of equilibrium and efficiency within principal-agent theory shows that, within a world of imperfect information, the classical notion of market price cannot be relied on as a "societal" measure of value. For, as our argument revealed, an equilibrium—a rational result of individuals' separate pursuit of their own interests—may lead to a Pareto-inferior outcome. The possibility thus arises that "valuing" food safety and nutrition is a relative notion: Value may be contingent on information, with different, equally valid valuations corresponding to different information environments.

This dependence of value on information may be seen more clearly in an analysis of the consumer demand for food safety and nutrition. Within standard microeconomic theory, consumers' assignment of values to goods is entirely determined by their budget constraints and preference orderings. Even when, as in the Lancaster "goods-characteristics" type of approach (Green 1976), certain implicit features of a good, as distinguished from the good itself, are the focus of consumers' preferences, it is still assumed that preference orderings can "detect" the level of characteristics present.[6] In effect, the choice space in a goods-characteristics model may have changed, but one still has a situation of choice under certainty. However, when the preference ordering cannot clearly "see" the characteristics present, the consumer is forced to use this ordering to rank whatever blurred proxies for the true characteristics *can* be observed. The reduction in information has not altered the fundamental preferences, but it *has* altered the choice set to which these preferences can be applied.[7] These information-dependent choice sets lead to different consumer assignments of value. It would appear from this reasoning, then, that any "value" to be ascribed to food safety and nutrition must be predicated on a specific information environment. In particular, attempts to measure consumer attitudes for the purpose of facilitating government regulatory actions should take into account changes in the information environment, and thus changes in consumer valuations, that such actions may themselves induce.

Monitoring

A common tactic used by a principal in a relationship with an agent is the introduction of *monitoring* of the agent's actions. Principal-agent theory normally ascribes to probabilistic uncertainty the principal's inability to ascertain an agent's effort level from the agent's output. The theory contemplates that a principal can obtain information about the effort level by examining alternative, observable random variables that are correlated with effort. When more accurate (albeit still imperfect) information about the agent's level of effort is available, the principal can design a fee schedule that more responsively rewards the agent and thus serves as an incentive for greater effort. If this increase in effort produces an expected benefit to the principal that outweighs the cost of monitoring, monitoring can leave both the agent and principal better off. Thus, monitoring can improve economic efficiency.

In the food safety context, monitoring—that is, inspection—seems often to be considered only in its *direct* role of protecting health, through the detection and elimination of unsafe conditions. However, its *indirect* role, as an incentive for greater economic efficiency, should not be ignored.

When the National Research Council stated (1985: 135) that continuous, animal-by-animal inspection of meat and poultry was not needed in processing plants in which certain scientifically designed risk management programs had been instituted, some critics may have envisioned only an unrelieved coarsening of a safety net intended to protect human health. However, if the economic incentives (and disincentives, such as violation penalties) of a discontinuous inspection system are properly devised, the increased producer effort induced by the new system can, in principle, more than compensate for a lowering of the inspection frequency. Moreover, a reduction in the cost of inspection would benefit the public.

The problem of meat and poultry inspection is not to devise the best conceivable inspection system. Rather, it is to devise the best inspection system *permitted by a limited budget*. Realistically, the problem involves both health and economics, and it thus involves tradeoffs and incentives. Interpreted in this light, discontinuous inspection may be an advantageous compromise.

Another example of how monitoring can serve as an economic incentive may be extrapolated from a case cited in a U.S. Government Accounting Office (U.S. G.A.O.) report (1992: 37-38). In May 1989, the U.S. Department of Agriculture's Food Safety and Inspection Service withdrew certain proposed regulations that would have allowed it discretionary authority in setting frequencies of inspection. The proposal had met with strong opposition. As the G.A.O. report states:

> The food-processing industry expressed concern that FSIS would place burdensome requirements on inspected establishments or shut down processing operations for extended periods. For example, FSIS could shut down a processing line because of unsanitary conditions but not return to reinspect the line for several days, even after the line had been immediately cleaned and sanitized.

At first glance, the potential for delays in reinspection that apparently prompted industry objections might appear "obviously" inefficient and unjustifiable. But this interpretation would ignore an important economic point: If the processing line were reopened immediately, the plant would have less *incentive* to stay sanitary. Thus, a delay in reopening could, through its incentive effects and depending on various quantitative parameters, potentially *increase* the (long run) efficiency of the plant's production of safe food.

Free Riding and Nonprobabilistic Uncertainty

In the preceding discussion, the inability of the principal to learn the agent's effort level merely by observing the outcome arose from the fact that outcomes were determined partly by chance, i.e., by some associated probability distribution. That sort of model might apply, for example, in analyzing how effectively a food processor or retailer guards against bacterial contamination (such as by *E. coli* O157:H7, the detection of which, even with conscientious efforts, is subject to chance failures). However, there can be incentive problems in economic relationships leading to an inefficient equilibrium even when chance does not play a role. In fact, whenever several individuals share equally in the result of their efforts, the problem of "free riding" may arise. Each individual will choose an equilibrium level of effort such that the disutility of a slight additional effort would just cancel the personal share of the benefits. However, since an increase of effort by one individual would benefit the others at no cost to them, if *all* increased their effort, *each* could receive greater net utility. Thus, the equilibrium will generally be inefficient. As an example, if the employees of a food service establishment had a disutility for careful food handling, and if each received only a share of the additional profits that his or her efforts might generate through increased wholesomeness of the product sold, the employees' equilibrium behavior would be inefficient. If, however, the company introduced a quality control and monitoring system, the employees, knowing that their co-workers could not shirk without fear of exposure, might be content to work harder. As a result, both their individual welfare and the quality of their joint output could be improved. In essence, a change in the information available to workers about co-workers' effort levels would contribute to a cooperatively-achieved increase in efficiency.[8]

Challenges to the Application of Principal-Agent Theory

Many issues of theory and data must be addressed before principal-agent theory can serve as an effective econometric tool for the study of food quality issues. Among these are:

1. While foodborne-disease incidents may have a serious impact when they occur, they occur with a very low probability for any individual. Thus, empirical changes in rates of occurrence will be difficult to observe. Even if the problems of the information environment are addressed, it is unclear whether individuals are capable of meaningfully comparing and valuing differing but small rates of illness.

2. Most published principal-agent research has studied the case of one agent and one principal. To examine the incentives for workers in such establishments as food-production plants or restaurants, we need more consideration of multi-agent models.
3. When government is cast as an agent, there is the difficulty that consumers (as principals) pay fees to the government only indirectly, through taxes. Thus, the agent's usual fee incentive does not operate here. One would need to define some sort of substitute for a monetary fee structure. In this connection, it can be noted that commercial monitoring services whose fees are paid by producers and passed on to consumers as part of the product price might, in theory, be more responsive to incentives for performance, assuming that claims of monitoring effectiveness are credible.
4. When uncertainty is nonprobabilistic (as the free-rider example illustrated), standard principal-agent theory, which relies heavily on probabilistic concepts, does not apply.

Conclusion

Food safety and nutrition are important factors in the market for food, but they do not satisfy the traditional, simplifying microeconomic assumption that consumers are capable of determining to what degree a purchased product has satisfied, or will satisfy, their preferences. As a result, producers' incentives are undercut, and the market may fail to offer products that, if their characteristics were known, would increase consumer welfare.

A satisfactory economic description of the "market" for food safety and nutrition must somehow incorporate the elusive notion of "information." Principal-agent theory does so, and it offers a starting point for future analysis. Whether the formidable mathematical apparatus that characterizes this theory can be successfully applied to food safety and nutrition, subjects with a paucity of reliable data, remains to be seen. At the least, principal-agent theory suggests and typifies the sort of information-oriented reasoning that is needed to support sound economic analysis of food quality issues.

Notes

1. The author thanks David Torgerson, Jordan Lin, Edna Loehman, Tanya Roberts (who suggested applying principal-agent theory to food safety), and the editor for their comments.

2. A good is called a *search good* (Nelson 1970), an *experience good* (Nelson 1970), or a *credence good* (Darby and Karni 1973) according to whether its quality can

be directly determined by the consumer (1) prior to purchase, (2) (only) after purchase, or (3) never. When quality is interpreted as the embodied level of safety, food, considered as a good, offers examples of each of these three types. However, the credence good case is the most significant from the standpoint of health and economic policy. These comments apply equally well when quality is interpreted as nutritional content.

3. This reasoning, which applies also to producer claims concerning nutritional content or benefits of food, is very much in the spirit of Akerlof (1970).

4. This characterization of a consumer's nutrition behavior as a stream of individually inconsequential but collectively significant purchases is reminiscent of economists' models of pure competition, in which economic agents affect the market collectively but not individually. A formal model of a consumer's nutrition status, no less than a formal model of pure competition, must address the seeming paradox of having many individually null effects combine into a nonnull effect. Techniques such as integration theory or nonstandard analysis (Debreu 1991: 3-4) are thus required.

5. Some confusion about the cumulative nature of nutrition seems to be at work in the current public debate about the fat content of movie-theater popcorn. One view holds that an occasional nutritional "lapse" is acceptable, while the other denies that a diet—implicitly, a continuing diet—of such foods can be healthy. The two sides are not actually arguing about the same proposition.

6. Nutritional labeling laws provide a rather striking opportunity for characteristics analysis, for nutritional labels display an explicit measure of embodied nutritional characteristics.

7. In this context, one can formally model a reduction in information as a change of the *domain* of a preference ordering. For example, changing the domain from a set of degenerate probability distributions to a set of nondegenerate probability distributions can represent a change from choice under certainty to choice under uncertainty (Weiss 1992). In a related vein, Green (1976: 26-27) discusses an advertising model in which preferences do not change but information does.

8. The type of uncertainty described by this example may be modeled in a formal framework by a many-to-one (i.e., noninvertible) function defined on the n-dimensional space R^n, where n is the number of workers. A function value of such a function, representing a joint work output, does not uniquely determine the components of an input vector representing the contributions of individual workers. Yet, the indeterminateness of the input vector is entirely nonprobabilistic.

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