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16. **Approaches to Measuring Consumer
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from Food Safety

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Approaches to Measuring Consumer Benefits from Food Safety

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The main objective of the paper is to identify important considerations in estimating consumer benefits of food safety. We develop a model of consumer response to food contamination problems that includes four different types of responses: product avoidance, brand switching, averting behavior, and mitigation. We show how these responses are affected by consumers' knowledge of marginal product contamination, the effect of averting on marginal product contamination, the health effects of total exposure to contaminants, and the mitigation expense associated with these health effects. We develop implications for benefit estimation and empirical methods.

The paper concentrates on consumer benefits because food consumers are clearly one of the largest groups of intended beneficiaries of food safety policies. However, it is important to understand that consumer benefits are not synonymous with social benefits. What consumers may be willing to pay for food safety policies is not the same as what they might be willing to pay in their role as a citizen, producer, or investor. These roles bring additional concerns such as reducing social health care costs; protecting vulnerable, poor, or uneducated segments of the population; reducing liability; and maintaining competitiveness in domestic and export markets.

Section one identifies several problems that are unique to estimating benefits of product safety, regardless of the empirical method used. Section two describes the model. Section three develops implications for estimating the benefits of several types of food safety policies. Section four describes some of the implications for empirical methods for measuring consumer benefits. The final section summarizes major themes.

Special Problems in Estimating the Product Safety Benefits

One of the major challenges in estimating food safety benefits is imperfect information. Food safety problems occur because consumers are unable to observe food contamination or learn about it through experience. In some cases, even if able to observe, they may not possess adequate information to be able to judge the severity, duration, and cost of the health effects associated with exposure to the contaminant. The rationale for government regulation is that experts can acquire the relevant information and make policy decisions on consumers' behalf. The role of benefit estimation is to help the experts assess what policy consumers would prefer if they were as knowledgeable as experts. In other words, we seek the value consumers would place on the safety improvement if they were fully informed of the nature of that improvement.

There are essentially two strategies we can take to achieve this objective. One is to observe the tradeoffs consumers actually think they are making about risk reduction and then infer how they would

act if faced with the tradeoff experts face. The other is to attempt to inform a sample of consumers and observe the choice they make. The problem with the latter strategy is that we can never supply the full set of information. We may be able to see how information changes choices, but we can never provide subjects with the same level of expertise that decision-makers possess.

Thus, a second challenge of benefit estimation is to be able to predict what real, albeit uninformed, consumers would do under various policy scenarios. This task is crucial to accurately inferring what empirical measures of benefits reveal about how consumers would value policy change if they had expert information. For example, suppose contingent valuation methods were used to develop a measure of consumer willingness to pay for a food safety improvement. Respondents' perceptions of the policy scenario and its consequences will influence their valuation. When these perceptions depart from how an informed expert would evaluate the scenario, these differences must be controlled for by careful design of data collection instruments or by accounting for these differences in estimating statistical models. The same is true for any benefit measures based on actual consumer choices, such as hedonic or travel cost estimates.

A third challenge is evaluating the benefits of policies that seek to inform consumers rather than reduce hazard exposure. The problem is determining what type of information is being given, the extent to which it is actually received, and if so, how it changes consumer knowledge. Examples of such policies include labeling, public announcements, and educational programs. Each of these policy options affects consumers' choices differently. Product labels may affect how much of a product is consumed (e.g., reduced fish consumption), which brands are bought (e.g., organic), and how products are used (e.g., cleaning or cooking methods). These choices affect subsequent use of medical services to alleviate illness. Thus, benefit estimation should account for different ways consumers respond to information.

The Model

Consumers may respond to food contamination problems in at least four ways. They include product avoidance (Choi and Jensen 1991, Eom 1994, Falconi and Roe 1991, van Ravenswaay and Hoehn 1991b, Weaver 1995), brand-switching (Choi and Jensen 1991, Hammitt 1993, van Ravenswaay and Hoehn 1991a, Weaver 1995), averting (Eom 1995, Weaver 1995), and mitigating actions (Weaver 1995). Product avoidance eliminates exposure to contaminants. Brand-switching may eliminate or reduce exposure by selection of a similar product which differs in the amount of the contaminant and, possibly, related quality factors (e.g., pest damage). Averting actions reduce food contaminants in products by methods such as thorough cooking, proper storage, and sanitation. Mitigation involves treatment of illness from food contaminants.

Each of these possible consumer responses to food contamination depends on consumers' perceptions of several factors. First, consumers have some perception of marginal product contamination levels. For example, consumers may or may not be aware that poultry may contain *Salmonella*. Second, consumers have some perception of the effect of averting on marginal product contamination levels. For example, consumers may or may not be aware that *Salmonella* may be killed by thorough cooking. Third, consumers have some perception of the health effect of total exposure to the contaminant. For example, consumers may or may not be aware of the health consequences of salmonellosis given their age and health status. Fourth, consumers have some perception of the possibility and cost of mitigating these health effects. For example, consumers may or may not be aware of whether salmonellosis is reversible and what medical treatments are required for a cure.

A model incorporating these features has been developed by van Ravenswaay and Hoehn (1996). They use a two period expected utility Lancaster model where the consumer makes product avoidance, brand-switching, and averting choices in period one and experiences health consequences and chooses mitigation in period two. The consumer is assumed to maximize constrained utility over the two periods.

In the first period, the individual earns income, y, consumes market goods, $\mathbf{q} = (q_1,...,q_J)$, and saves s for second period expenditures. The market goods include food brands and averting inputs used to reduce exposure to contaminants in food brands. The jth market good has a vector of perceived attributes $(a_{1j},...,a_{Ij})$. The total amount of the ith attribute that the consumer perceived to be consumed as a result of purchasing q_j units of the jth market good is $a_{ij} q_j$. The total amount of the ith attribute perceived to be consumed from the purchase of all J goods is:

(1)
$$A_i = \sum_{j=1}^{J} a_{ij} q_j.$$

The perceived level of marginal contamination in the jth good is a_{Ij}. The perception of the total contamination in q_j units of the jth good is $a_{Ij}q_j$. When fully informed, the consumer is able to observe exactly how food brands vary in terms of the marginal product characteristic. She may calculate how her total exposure to a food contaminant varies with brand selection. When not fully informed, she makes a different calculation.

Let $\mathbf{A}$ represent the vector $\mathbf{A} = (A_1,...,A_i,...,A_I)$, where perception of total exposure to a contaminant is represented by A_I. Perception of total exposure has no effect on utility in the first period, but on health consequences in the second period. First period utility is:

(2)
$$u_1 = u_1(A_1,...,A_{I-1}).$$

If the consumer perceives that she may avert exposure to contamination, she will have some expectation about the proportion of the marginal product contamination level that can be removed before consumption of a food, q_j. We represent this removal process as $r(\mathbf{q})$, where $0 \le r(\mathbf{q}) \le 1$ and $\mathbf{q}$ are market inputs such as soap and water. Thus, perceived total exposure after averting and food consumption is:

(3)
$$A_I' = A_I [1 - r(\mathbf{q})].$$

In the second period, the individual consumes savings from the first period, experiences a health status (h), and a perceived probability of survival, π, which is a function of perceived health status expressed as $\pi(h)$. Second period utility is:

(4)
$$u_2 = u_2(h,s)\pi(h).$$

The individual has some perception of how health status depends on consumption and averting in the first period as well as mitigation (m) undertaken in the second period. Thus, $h = h(A_I', m)$. Substituting into (4), the second period problem is to maximize second period utility,

(5)
$$u_2 = u_2(h(A_I', m), s - m)\pi(h(A_I', m)),$$

by selecting m where A_I' and s are fixed by actions in the first period. Solving the maximization problem yields m^* and an indirect utility function:

(6)
$$u_2 = v_2 (h(A_I', m^*), s - m^*)\pi(h(A_I', m^*)).$$

The first period maximization problem is:

(7)
$$\max \quad u_1(A_1,...,A_{I-1}) + v_2 (h(A_I', m^*), s - m^*)\pi(h(A_I', m^*))$$

s.t. $y = s + \mathbf{pq}$

$$A_I{}' = A_I[1 - r(\mathbf{q})]$$

by selecting $\mathbf{q}$ and s, where $\mathbf{p} = (p_1,...,p_J)$ are the prices of the market goods. Solving (7) and expressing it in terms of indirect utility yields:

(8) $u = v_1(\mathbf{A},y,\mathbf{p}) + v_2(h(A_I{}', m^*), s - m^*)\pi(h(A_I{}', m^*)).$

Implications for Benefit Estimation

Suppose that a food safety policy reduced the marginal product contamination level on food j. If the consumer was fully informed of the pre- and post-policy levels of contamination, the level of compensation that offsets a small change da_{Ij} is obtained by totally differentiating (8) conditional on the level of averting $(1 - r^*)$ and product avoidance and brand-switching $(q_j{}^*)$:

(9) $dy/da_{Ij} = -[(\partial v_2/\partial h)(\partial h/\partial A_I{}')q_j{}^*(1 - r^*)\pi]/(\partial v_1/\partial y)$

$$- [v_2(\partial\pi/\partial h)(\partial h/\partial A_I{}')q_j{}^*(1 - r^*)]/(\partial v_1/\partial y)$$

The first term on the right-hand side of (9) represents the morbidity effect of a small exogenous change in marginal product contamination. The second term is the mortality impact. Note that these effects depend on chosen levels of avoiding and averting.

However, in the real world, the consumer was probably unaware that any contamination was ever present. In this case, she has been making product avoidance and averting errors, and without the new policy she <u>might</u> continue to do so. We underscore the word <u>might</u> because this seems a rather unrealistic scenario given press coverage of new discoveries of food contamination. But assuming she remains unaware, without the policy she will act as if there is no contamination in period one, but in period two she will experience unanticipated health effects and mitigation expenses. The level of compensation that offsets the disutility from the additional health effects and mitigation measures the value of avoiding the errors.

A more likely scenario, however, is that the consumer would undertake avoiding and averting activities. However, it is also unlikely that the government would not act on the problem in some other manner since legally it must. So let us consider the other possible alternatives.

Suppose that the food safety policy provided information about averting methods that could eliminate contamination in a food. If the information is received by the consumer, this information may change the perception of the removal process from $r(\mathbf{q})$ to $r'(\mathbf{q})$. If the new removal process is not fully comprehended by the consumer, however, she will continue to make errors as described above. In this case, the change in perception of the removal process may be characterized by a learning function (Eom 1995). If the consumer makes no intentional errors, the value of the information would be the amount of compensation that equates two-period utility with $r(\mathbf{q})$ to utility with $r'(\mathbf{q})$. If errors are made, however, the information value declines by the disutility from unanticipated health effects and mitigation expenses.

Alternatively, suppose that the food safety policy required products to label the level of contamination (e.g., presence or absence). This policy changes the choice set facing the consumer so that the number of goods available changes from J to J + K. The consumer now faces new opportunities to reduce total exposure to a contaminant. Assuming that she is aware of them, her perception of the health effects of her first period choices, $h(A_I{}', m)$, will change to h'. Again, this change in perception may be

characterized by a learning process, controlling for awareness. If learning is perfect and no unintentional errors are made, the value of the labeling policy is the amount of compensation that equates utility with and without the J + K products, given the change in perception of the health effects. If errors are made, the information value declines by the disutility from unanticipated health effects and mitigation expenses.

Finally, suppose that a food safety policy provided information only on the health effects of the contaminant. The effect would again be expressed in terms of the health effects function, $h(A_I', m)$. However, in this case, the change in the perception would occur by changing the perception of both health status and mitigation. The value of this information is characterized by examining the avoidance of purchase errors. In other words, without the information, the consumer would choose period one purchases as if health effects are h and mitigation is m, when in fact health effects are h′ and m′. With the information, the perception of h and m are changed and purchase errors are reduced. However, note that the consumer incurs costs in order to avoid the errors. She must avoid the product or avert exposure. This differs from the situation where the policy involves reducing marginal product contamination where no added costs are incurred. Thus, the amount of compensation that offsets the utility gained from avoided errors, minus the disutility of the cost of avoiding errors, measures the value of the information.

Note in most of the cases examined here, consumers may take actions that could substantially affect their food purchases. Because of the potentially large impacts on producers, it is likely that producers and other firms would likely respond, thus creating a different opportunity set for consumers than the ones described here. This may be an important consideration in benefit estimation, especially if consumers anticipate such responses.

Implications for Empirical Estimation

Empirical measures of the consumer benefits of food safety regulations could include cost of illness, contingent valuation methods, hedonics, and averting expenditures. The model above has implications for determining the applicability of each of these methods under different policy scenarios.

Cost of illness studies (e.g., Roberts 1989) generally include estimates of the opportunity cost of lost labor time and mitigation expenses. This approach has the advantage of capturing many aspects of the disutility associated with the consumer errors that occur when consumers are completely ignorant of food contamination problems. However, as the model developed above shows, when measures are already being taken by consumers to reduce exposure or the methods taken are ineffective, cost of illness methods will incorrectly estimate consumer benefits when a policy change involves saving of avoiding and averting costs. In addition, some consumers will not directly bear many of the costs of illness.

Contingent valuation methods ask respondents to directly value a policy scenario. The design of the scenario needs to take into account all the different ways that consumers might respond to a food contamination problem. How they respond will depend on their perceptions of marginal product contamination, methods for reducing contamination, health effects of total exposure, mitigation costs, and prices with and without the policy scenario. Respondents will vary in terms of susceptibility and the extent to which they bear the costs of mitigation. They may also vary in terms of their expectations of what are realistic scenarios about government and producer behavior. Although we can describe scenarios and provide information about some of these variables, we cannot be certain that respondents will take the information at face value. Moreover, respondents may ascribe other consequences to their food purchases such as improved environmental quality, animal welfare, or worker safety, and thus evaluate the characteristics of goods differently than expected. This is especially likely if consumers associate the policy scenario with changes in production practices that have well-known external effects. Respondents may also value a government program because it reduces illness among others today and in the future, and thus they may report purchase changes that in reality they would not make, but that they think might encourage adoption of the policy. Empirical evidence suggests that some of these

values could be important. For example, Eom 1994, Buzby et al. 1995, and van Ravenswaay and Hoehn 1991a find willingness to pay for reduced pesticide residues is only partially explained by perceived risk reduction.

Hedonic methods are unlikely to capture all the behavioral responses to food contamination. It is difficult to determine how objective product characteristics relate to the actual perceptions of consumers. Such methods are most useful when product characteristics are easily understood by consumers, and when brand switching is both possible and a low cost method for consumers to avoid exposure to a contaminant. However, few "safety" brands are available to consumers. Furthermore, the brands available often have many attributes that are difficult to discern. For example, consumers might pay a premium for organic food to avoid pesticide residues, but it is difficult to determine whether the reason is because of food safety concerns or other concerns (e.g., environmental).

Averting expenditure methods capture only one of the possible consumer responses to food contamination. In some of the policy scenarios, this consumer response is not possible. However, this method is potentially useful when averting is a common method for consumers to reduce exposure. As with other methods, however, it is necessary to account for consumers' understanding of the actual effect of their actions.

Conclusion

The literature on food safety has identified at least four different ways that consumers may respond to food safety problems. These responses depend on consumers' knowledge of four different aspects of food contamination problems. Our model of consumer choice incorporates the different ways that consumers can respond to contamination. Implications for the benefits of several food safety policies were developed based on different assumptions about consumers' knowledge. Different methods of estimating benefits were shown to capture only some of the ways consumers might respond to food contamination. Accounting for consumers' information states was found to be a problem for all the possible methods, but the difficulties are different in each case.

Note

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