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The Economic Value of Public Relations Expenditures: Food Safety and the Strawberry Case

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Food safety has become an important issue affecting public health and grower profits. Outbreaks of foodborne illnesses are typically accompanied by press accounts of the incident and a decrease in demand. This study estimates the short- and long-run impacts of adverse and positive information delivered through print media on strawberry grower profits. Positive information may arise as part of the promotional efforts of grower associations. It is found that adverse information reduces grower profits, but that positive information can partially offset their effects. It is suggested that grower groups could redirect funds used for promotion to food safety initiatives.

Key words: food safety, foodborne illness, information, strawberries

Introduction

Growers and their commodity associations are fully aware that an outbreak of a foodborne illness can cause irreparable harm to the public's perception of the wholesomeness of their product. However, little is known of the exact cost to producers of such incidents, and less is known of the value of efforts used to counteract the negative press that invariably results. For example, California strawberry growers, who experienced two such incidents in 1996 and 1997, estimated the cost of the latter at some $40 million, but this was admittedly only a rough estimate. Beyond the loss of product that is actually found to be contaminated, the full cost includes damage done to a product's reputation with consumers as part of a safe, healthy diet. Such changes in consumers' perceptions may be long lasting, widespread, and very difficult to reverse. To complicate matters, the source of the damage may emanate from one small firm in a fragmented, atomistic industry, while all growers are made to suffer.

As growers evaluate the costs and benefits of adopting new production methods and techniques, accurate measures of these costs must be developed in order to quantify the benefit of more intensive monitoring of possible contaminants. In the past, such efforts at private evaluation would not have been necessary, but as the federal government considers imposing new industrywide regulations, growers and grower organizations are developing guidelines for self-regulation. In the event that self-regulation fails to prevent future outbreaks, more detailed information on the costs of such incidents also

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can be used to quantify the benefits to any defensive action taken by a commodity board, such as the California Strawberry Commission (CSC), in the aftermath of a disease outbreak. To the extent that a product's "clean reputation" is a public good, an analysis of the costs and benefits of trying to dispel consumer concerns provides a measure of the amount that a group of growers, through their association, should be willing to spend on an industrywide system of contamination control irrespective of any new government regulation.

Growers already underwrite extensive advertising and promotional expenditures by commodity organizations such as the CSC. Using these tools to counteract the effects of negative publicity, however, is not likely to be effective due to the different ways consumers process information from advertising and from the seemingly objective news media (Lord and Putrevu). Although advertising offers benefits of a high degree of message control and repetition (Kotler), an increasing body of research questions advertising's effectiveness, as it tends to desensitize its audience with repetition (Tellis; Lipman). Sales promotion also has the potential to erode brand equity as consumers become conditioned to expect deals on their favorite products (Davis, Inman, and McAlister). Publicity, on the other hand, is often believed to enjoy a credibility advantage, especially if the source is considered objective and unbiased (Levy; Salmon et al.). In fact, there are many possible explanations for the differential impact on behavior of positive and negative information.

Mizerski summarizes the research on these explanations into three classifications: (*a*) surprise and frequency of use, (*b*) ambiguity and uncertainty, and (*c*) differences in causal attribution. In a consumer demand context, the first category reflects the notion that negative information reaches a market infrequently, so this "surprise value" tends to be regarded as more credible than a single positive message. However, this notion has little empirical support. The second explanation holds that negative information is somehow less ambiguous than positive information, and so has a greater effect on behavior. This theory, again, has had only limited empirical support. Mizerski, however, provides more rigorous conceptual and experimental support for the third explanation—attribution theory.

Attribution theory (Kelley) represents an explanation of the way decision makers respond to the behavior or signals provided by others, whether they are individuals, organizations, or any stimulus provider. Such signals are regarded as being credible representations of the true intentions of the provider if their cause can be attributed to interests of the provider that go beyond self-interests and reflect a wider concern for, perhaps, other individuals or society as a whole (Bemmels; Sparkman and Locander). Determinations of causality are, in turn, made on the basis of three factors: (*a*) consensus, (*b*) distinctiveness, and (*c*) consistency (Kelley). If everyone in the provider's environment behaves the same way (a consensus), or gives the same signal, then the signals are likely to be viewed as credible. However, if the provider gives a signal that is unique to that individual (distinctive), then the cause of this signal is more likely to be attributed to self-interests, and thereby be less credible. Similarly, if a signal is inconsistent with prior behavior, then the cause is more likely to be viewed as self-interest and the signal will be less credible. For example, if a firm consistently tries to cover up potentially harmful incidents, then claims to the contrary for all such incidents in the future will be given low credibility.

In the current application, therefore, attribution theory maintains that people are far more likely to believe and to act on information from a usually reliable source that could potentially run counter to their own interests. In contrast, mollifying information from a vested interest, such as the CSC, will be given low credibility and will not be acted upon.

Among the early experimental work, Richey, McClelland, and Shimkunas found that positive initial impressions of individuals are easily reversed with some negative information, whereas negative initial impressions are both difficult to reverse and tend to persist even with new positive information. Further, Swinyard and Ray report the results of an experiment wherein individuals who are labeled as "charitable" by Red Cross canvassers are more likely to donate to the cause in the future than those who are not so labeled. The analogy to negative media information about a potential foodborne disease outbreak is clear.

This analysis applies an empirical economic model based in attribution theory that seeks to quantify grower losses due to foodborne disease outbreaks and estimate the benefits of defensive media activities. An application of this approach to disease outbreaks in strawberries in 1996 and 1997 demonstrates not only the value of avoiding future incidents, but also the return to public relations expenditures intended to "control the spin" created by the media. In this sense, the source of the negative demand shock is not the outbreak itself, but rather the exposure of the public to negative information about the commodity or information that reduces the public's "perception of safety" in consuming strawberries. Similarly, defensive public relations activities create potentially offsetting sources of information that improve this perception of safety. Including measures of both of these variables in a dynamic model of demand provides estimates of both long- and short-run effects of each type of information.

In the section that follows, we provide a brief narrative of the events surrounding the strawberry disease outbreaks in 1996 and 1997, including, most importantly, how these events were covered in the media. The next section presents a simple conceptual model of how consumers incorporate both positive and negative information provided by these media reports into their decision making. We then describe an empirical model that is used to estimate the effect of each information type on market demand and to calculate the resulting impact on producer welfare. In this model, negative and positive shocks to demand cause retail prices to change and, through a Muth-type equilibrium displacement model, prices and quantities supplied at the grower level. Each of these variables is then incorporated into a simulation model of grower surplus which is used to calculate the welfare effects, both in the short and long run, of the shocks to demand. Consequently, this study is able to produce an estimate of the economic damage caused by the release of news that may have influenced consumers to question the safety of eating strawberries. Because it takes into account the effect of both positive as well as negative news, the study also provides some insight into the value of defensive public relations activities taken by grower associations and, ultimately, potential measures taken by growers to prevent future disease outbreaks. We conclude by drawing some implications of these results for the potential role of grower associations in overseeing and funding these preventative measures.

Background on Disease Outbreaks Linked to Strawberries

Although outbreaks of foodborne diseases linked to produce have been reported by the Centers for Disease Control (CDC) periodically since the early 1980s, the first such incident concerning strawberries in the sample period covered by this study surfaced in May of 1996. In late May, some 300 people in nine states complained of diarrhea, vomiting, weight loss, fatigue, and muscle aches—symptoms subsequently attributed to infection with the cyclospora parasite (*Boston Globe*). Initially, the Texas Department of Health proclaimed that California strawberries "were almost certainly the source" of the cyclospora, but laboratory tests conducted by the CDC could find no evidence of cyclospora contamination in strawberries (*Portland Oregonian*). It was not until some four weeks later, in July 1996, that the CDC and the Ontario Ministry of Health released a statement exonerating strawberries and placing the blame more squarely on imported Guatemalan raspberries. Despite this revelation, the initial damage had already been done; some stores reported reductions in strawberry sales of up to 30% for at least three weeks following the Texas announcement (*Washington Post*).

Almost exactly a year later, the CDC reported another series of cyclospora cases, but this time the link to imported raspberries was established much earlier. However, in March of 1997, 198 Michigan schoolchildren and teachers contracted Hepatitis A from eating a frozen dessert made from contaminated strawberries. Here, the source was clear and particularly easy to trace. Contrary to the laws governing the National School Lunch Program, the dessert's maker, Andrew and Williamson Sales Co., had acquired strawberries in Mexico and sold them to the U.S. Department of Agriculture (USDA). As a result, the firm and its principal owner, Fred Williamson, were subsequently indicted on 47 charges of making false statements, making false claims, and one count of defrauding the United States (Kraul). Initial claims by the CSC put the cost of lost strawberry sales resulting from the negative publicity surrounding this case at $15 million—a figure that was later raised to $40 million, but still subject to much debate.

Growers' chances of recovering economically from this incident and of preventing others in the future depend in large part upon the ability of the CSC to dispel consumers' perceptions of domestic strawberries as a food with a substantial risk of contamination. This ability, however, depends upon consumer trust in the CSC given its vested interest in selling more strawberries. Attribution theory provides a sound logical basis from which to assess the credibility of the CSC and its responses to these incidents.

A Conceptual Model of Responses to Positive and Negative Publicity

Although the psychological and experimental bases for attribution theory are relatively well established (Mizerski), the implications for economic behavior are less clear. The usual approach is to assert that the demand for a commodity is a function of both the positive and negative information received regarding its attributes, but to leave the question of which type of information dominates to empirical study (Swartz and Strand).

Chang and Kinnucan, however, use attribution theory to motivate their expectation that negative information should exert a disproportionate influence on demand, but they do not develop an economic explanation for this asymmetry.

Consider the case where the utility derived from consuming the attributes (**Z**) of a product is a function of the information (N) formed of those attributes over time. In a steady-state equilibrium, no new information arrives, so the perception of each attribute does not change and utility is also at a steady-state level. This occurs at an information state N^*. Suppose new information arrives that causes the perception of one particular attribute (food safety, or the absence of disease or illness-causing contaminants) to change from this reference level to a different level while the perception of all other attributes is held constant. Call the new information state $\hat{N}$. Negative information refers to the case where the new perception of safety is lower in the new information state compared to the reference level ($\hat{N} - N^* < 0$), whereas positive information causes the perception to rise ($\hat{N} - N^* > 0$) above the steady state.[1] Given a well-behaved, increasing, concave utility function defined over the product and its attributes, it is apparent not only that the change in utility from forming this new negative perception of safety is negative and vice versa, but also that the incremental loss in utility dominates the gain in utility from receiving positive news on the safety attribute.[2] This is the prediction of attribution theory. Using a variation of Chang and Kinnucan's extension of Swartz and Strand's utility-based approach to valuing multiple types of information about product attributes, this utility function can be written as

$$(1)\qquad U(X_i) = \begin{bmatrix} U\left(X_i^+(\mathbf{Z}_i(\hat{N} - N^*))\right) = U\left(X_i^+(\mathbf{Z}_i(\tilde{N}))\right) & \text{if } \hat{N} > N^* \\ U\left(X_i^-(\mathbf{Z}_i(\hat{N} - N^*))\right) = U\left(X_i^-(\mathbf{Z}_i(\tilde{N}))\right) & \text{if } \hat{N} < N^* \end{bmatrix},$$

where X_i is the quantity of product i; $\mathbf{Z}_i$ is a vector of attributes of product i; $\hat{N}$ is the current state of consumers' perception of the safety of the product, which can either improve existing perceptions of the product ($\hat{N} > N^*$) or detract from them ($\hat{N} < N^*$); and N^* is the steady-state or reference safety perception. Given this specification and the curvature assumption above, then it must be the case that

$$(2)\qquad \frac{dU}{d\tilde{N}} = \begin{bmatrix} \dfrac{dU^+}{d\tilde{N}} = \left(\dfrac{\partial U}{\partial X_i^+}\right)\left(\dfrac{\partial X_i^+}{\partial \mathbf{Z}_i}\right)\left(\dfrac{\partial \mathbf{Z}_i}{\partial \tilde{N}}\right) & \text{if } \hat{N} > N^* \\ \dfrac{dU^-}{d\tilde{N}} = \left(\dfrac{\partial U}{\partial X_i^-}\right)\left(\dfrac{\partial X_i^-}{\partial \mathbf{Z}_i}\right)\left(\dfrac{\partial \mathbf{Z}_i}{\partial \tilde{N}}\right) & \text{if } \hat{N} < N^* \end{bmatrix},$$

[1] Note that this definition does not imply a negative marginal utility to information, because consumers are likely better off with information about potentially harmful product attributes, but simply that utility falls if new information causes a negative impression to be formed, or rises if the perception of a product attribute improves.

[2] Additional assumptions required here are that consumers receive information costlessly, that it is available to all consumers, and that the interpretation of new information is unambiguous. Other assumptions of instantaneous adjustment of information states and perfect credibility of information sources are made to simplify the presentation of the theoretical model, but are tested, albeit indirectly, in the empirical model to follow.

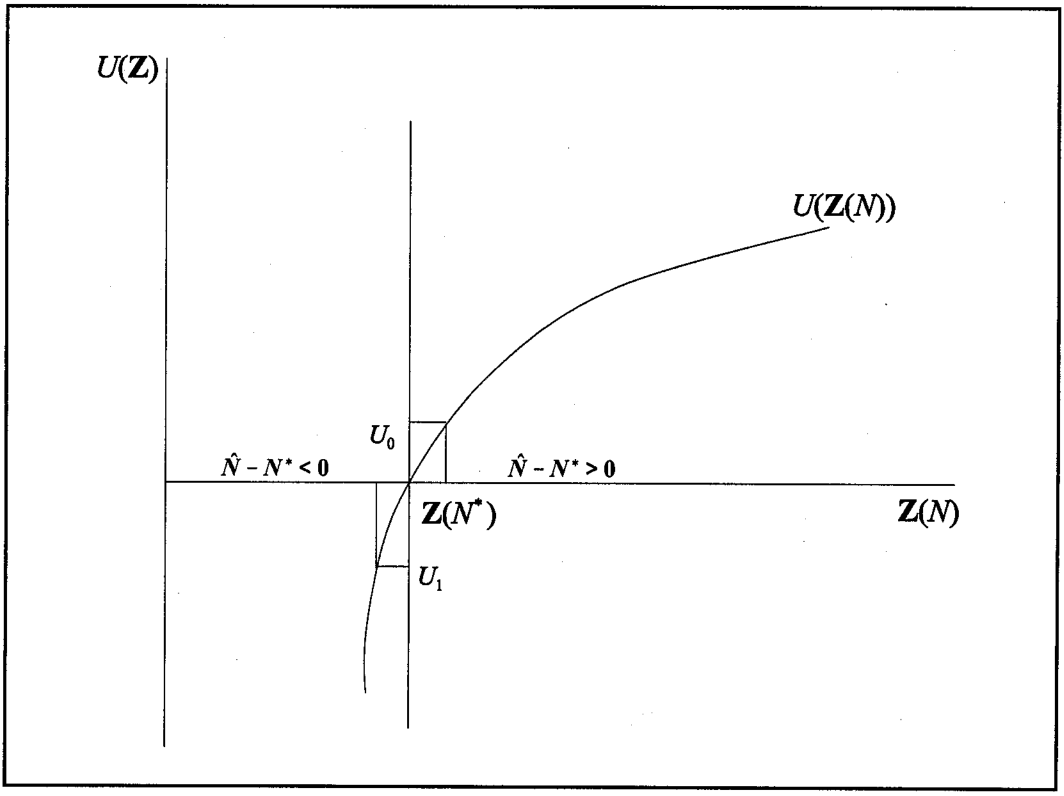

Figure 1. Marginal utility of positive and negative information

and from figure 1 it is also clear that $|dU^{+}/d\tilde{N}| < |dU^{-}/d\tilde{N}|$, or, in other words, a worsening of the perceived safety in consuming the product will dominate an equal-sized positive increment in perceived safety. So, whereas Mizerski develops the psychological basis for attribution theory, its predictions are the natural outcome of well-behaved preferences. Few of the empirical models of negative and positive publicity, however, take this preference structure into consideration.

Empirical Model of the Value of Disease Information

The proliferation of legislation designed to protect growers of fruits and vegetables from unsubstantiated claims of chemical and bacterial contamination suggests that there is a need for economic research on the effects of such negative publicity on grower welfare. Although this legislation is a relatively recent phenomenon, there have been significant cases where a contamination, a disease outbreak, or simply the release of new scientific research results have adversely affected consumer demand for a product.[3] Among the

[3] This is commonly known as "veggie hate crime" legislation. Texas beef growers' unsuccessful lawsuit of Oprah Winfrey over her public comments regarding the safety of beef is a recent example, albeit in the context of meat rather than fruits and vegetables.

first of these cases to be investigated, Swartz and Strand develop the logic underlying (1) in a model of purely negative information regarding a keptone contamination of the James River oyster beds in the 1970s. Their proxy variable for negative information consists of a weighted sum of negative print media articles appearing in the local Baltimore market pertaining to the contamination. The weights are estimates of the probability that a given story will be read. This variable, however, does not allow for the potential differential effects of positive and negative media exposure.

Recognizing that such incidents are usually met with strategic responses either by governments interested in maintaining the public safety of the food supply, or by private firms with a vested interest in preventing lost sales, Smith, van Ravenswaay, and Thompson estimate the effects of both negative and positive media articles on the demand for milk following the 1982 heptachlor contamination of milk on Oahu. Using a J-test procedure to determine the appropriate news-variable specification, they reject models containing both types of information together in favor of including only negative publicity. This result, they argue, supports Weinberger and Dillon's claim that negative information dominates a similar amount of positive information—a claim that follows from the model of utility developed above. They also explain the insignificance of positive information as evidence that dairy processors lack credibility due to their vested interest in maintaining product sales.

Chang and Kinnucan take the separation of positive and negative information one step further in a model of Canadian butter demand. By considering separate variables measuring negative information about the effect of dietary cholesterol on the likelihood of heart disease (Brown and Schrader) and positive information from generic butter advertising, they estimate the ability of promotion to overcome negative media reports. Although it is difficult to compare the relative impacts of two variables measured in different ways, the negative information elasticity is an order-of-magnitude greater than the advertising elasticity in absolute value, suggesting that industry efforts are only partially successful in counteracting reductions in demand from adverse media exposure. However, despite defining both negative and positive information in terms of stocks rather than flows, Chang and Kinnucan do not consider the relative dynamic effects of either.[4] Nonetheless, the methods used in these studies to quantify information flows are of great potential use in valuing investments in publicity and media relations.

For example, Brown and Schrader construct an index of consumer information about the connection between cholesterol and cardiovascular health by counting the number of medical journal articles on this topic over a multi-year period. Articles that argue against a relationship between cholesterol and health are subtracted from those claiming otherwise to produce a cumulative "net" information variable. This index is used in a model of shell-egg demand to show the effects of cholesterol information on the demand for eggs.

The information index used here differs in several respects. First, this study considers the number of articles in popular media outlets, rather than the academic literature. Information disseminated through medical journals is likely to take a long time to reach consumers, and even then may be confusing and inconclusive. Media articles, however,

[4] Chang and Kinnucan report results of tests that reject an exponential distributed lag in an advertising variable, but no others appear to have been tried.

convey information (even if incorrect) immediately to consumers, thereby changing consumer behavior shortly after dissemination.

Second, Chang and Kinnucan recognize that information must be regarded as a stock variable since it accumulates over time and decays with memory loss and obsolescence. Negative information accumulates as a weighted sum of each period's number of net negative articles, where the weights are the proportion of total articles in each period defined as "negative." Given the performance of this variable in Chang and Kinnucan's research, we construct similar indices for both positive and negative media articles. Although this procedure implicitly assumes that articles from different media outlets have equal information content, the errors that are introduced are likely to be random, thereby producing unbiased estimates.[5]

Third, this study does not impose the assumption that positive information exactly offsets negative information. Other studies (Chang and Kinnucan; Brown and Schrader; Smith, van Ravenswaay, and Thompson) develop an "information index" in which positive and negative articles offset one another to produce a net positive or negative index value. Attribution theory, on the other hand, suggests that consumers are likely to place more weight on negative information than positive. Smith, van Ravenswaay, and Thompson suggest adding the number of positive and negative articles together, reasoning that the negative impression toward a product is reinforced by all types of publicity, whether the message itself is positive or negative. However, this approach is not adopted here because the assumption that consumers ignore a valuable source of information is not tenable if the underlying assumption is that consumers remain rational. Using an index of net negative information allows these previous studies to capture the effect of negative publicity in a parsimonious way, but it constrains market responses to positive and negative articles to be the same, so this study constructs a separate index for both negative and positive articles.[6] Consequently, this analysis estimates the effect on grower surplus of news of a disease outbreak given estimates of the response of demand to both negative and positive media.

Specifically, a Muth-type equilibrium displacement model (Kinnucan, Xiao, and Hsia) is used to calculate the net grower price effects of new negative or positive news regarding strawberries. The equilibrium displacement approach specifies a simple, yet complete, model of a strawberry market equilibrium consisting of equations for demand, supply, retail-farm price linkage, and market clearance. The reduced-form solution to this system expresses the change in grower price resulting from changes in each exogenous demand factor—including the release of both positive and negative information. These shocks cause changes in grower price, commodity supply, and, ultimately, producer surplus. In general terms, the monthly market model for K fresh fruits consists

[5] Other studies attempt to define the information content specific to each article through a subjective rating system (Smith, van Ravenswaay, and Thompson), but these calculations are arbitrary and likely create a systematic error due to the fact that they attempt to mimic individuals' cognitive processes in receiving information. These processes are far too complex and diverse to reduce to a subjective rating variable. Although a complete content analysis of each article would be preferable to the approach adopted here, there is insufficient information on each article to conduct such an analysis.

[6] A reviewer points out that these article indices are but imperfect measures of positive and negative information, which are unobservable or latent variables. As such, a structural latent variable method, such as Joreskog and Goldberger's Multiple Indicator Multiple Cause (MIMIC) model, may be used to correct for the measurement error inherent in our approach. However, this method requires variables that are acceptable indicators of the latent variables (Gao and Shonkwiler). No such variables were available in the monthly data frequency used in this study. Therefore, the estimated parameters may be biased to the extent that our indices measure negative and positive information with error.

of the following equations representing retail demand (3), farm supply (4), retail-grower price transmission (5), and market equilibrium (6):

(3) $$\mathrm{d}\ln(\mathbf{P}) = \mathbf{F}\mathrm{d}\ln(\mathbf{Q}) + \mathbf{M}\mathrm{d}\ln(\mathbf{Z}) + \theta_1\mathrm{d}\ln(\mathbf{B}) + \theta_2\mathrm{d}\ln(\mathbf{G}),$$

(4) $$\mathrm{d}\ln(\mathbf{X}) = \mathbf{E}_s\mathrm{d}\ln(\mathbf{W}),$$

(5) $$\mathrm{d}\ln(\mathbf{W}) = \mathbf{T}\mathrm{d}\ln(\mathbf{P}),$$

(6) $$\mathrm{d}\ln(\mathbf{Q}) = \mathrm{d}\ln(\mathbf{X}).$$

Using the price and quantity responses from this model, Just, Hueth, and Schmitz provide an expression for the change in producer surplus for good i:

(7) $$\Delta PS_i = S_i^f P_i Q_i \mathrm{d}\ln(W_i)(1 + 0.5\mathrm{d}\ln(X_i)),$$

where **W** is a K-dimensional vector of grower prices, **X** is a K-dimensional vector of farm supplies, **P** is a K-dimensional vector of retail prices, **Q** is a K-dimensional vector of monthly arrivals, S^f is the grower's share of the retail dollar, **Z** is a vector of exogenous factors, **B** is the amount of new negative information about strawberries in month t, and **G** is the amount of new positive information in month t. Both are vectors because they appear in all inverse-demand equations. Among the parameters, **F** is a matrix of price flexibilities of demand, θ_i are "shock flexibilities" for a shock of type i (good news or bad news), **M** is a matrix of demand flexibilities with respect to the exogenous factors, $\mathbf{E}_s$ is a diagonal matrix of supply response elasticities, and **T** is a diagonal matrix of price transmission elasticities.[7] The elements in (3)–(6) are solved simultaneously for the change in retail price by substituting (6), (5), and (4) into (3). Simplifying the result then provides a reduced-form expression for the change in retail price in response to a change in either type of information shock:

(8) $$\mathrm{d}\ln(\mathbf{P}) = (\mathbf{I} - \mathbf{F}\mathbf{E}_s\mathbf{T})^{-1}\mathbf{M}\mathrm{d}\ln(\mathbf{Z}) + (\mathbf{I} - \mathbf{F}\mathbf{E}_s\mathbf{T})^{-1}\theta_1\mathrm{d}\ln(\mathbf{B}) + (\mathbf{I} - \mathbf{F}\mathbf{E}_s\mathbf{T})^{-1}\theta_2\mathrm{d}\ln(\mathbf{G}).$$

The resulting change in retail price is then used to calculate the change in farm price and, in turn, the change in farm supply through (6) and the change in producer surplus through (7). While Kinnucan, Xiao, and Hsia develop this model in order to calculate the returns to promotion and health information, as well as to measure the extent of spillovers between promoting commodities that are related in demand, present concern is with the grower impact of a negative shock to retail demand, and the value of defensive public-relations activities.

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[7] The elasticity of price transmission is given by $T_i = (\sigma_i + e_b)/[\sigma_i + S_i^f e_b + (1 - S_i^f)e_a]$, where σ is the elasticity of substitution between farm and marketing inputs, e_a is the elasticity of supply of farm inputs, e_b is the elasticity of supply of marketing inputs, and S^f is the farm share of the retail dollar (Gardner).

Consistent with (3) above, the sensitivity of strawberry prices to both negative and positive demand shocks is estimated with an inverse, dynamic model of monthly U.S. fresh fruit demand. An inverse demand model is appropriate in this case because, in monthly data, supply is likely to be predetermined. Although supply is fixed each period, consumer buying behavior tends to reflect habits, learning, and experience that persist over time (Blanciforti and Green; Chen and Veeman; Pollak). Specifying a dynamic demand model to account for these effects is particularly important in this case because the principal effect of adverse publicity may be to break consumption habits and to instill new, unfavorable impressions of the good in consumers' minds. Produce items are generally thought to be "experience goods" (Nelson), so establishing a brand reputation for consistently high quality is difficult.[8] Therefore, when this image is broken, it is difficult to reestablish.

Although there is no a priori information to determine the specific form of the dynamic effects of information on prices, it is likely the case that shocks to demand have an immediate impact that declines slowly over time as consumers either forget the information received, or believe that the original cause has been corrected. Therefore, the demand model uses an autoregressive structure in fruit expenditure share similar to that of Blanciforti and Green. This specification allows for both long- and short-run price effects, and long- and short-run responses to demand-side shocks.

In order to ensure that the demand response parameters estimated with this variable are consistent with rational consumer behavior, all price, expenditure, and information effects are estimated in a system of fresh fruit demand equations. Of the functional forms that are consistent with consumers' maximizing income-constrained utility, Deaton and Muellbauer's Almost Ideal Demand System (AIDS) model constitutes one theoretically plausible specification. The advantages of using this specification are well known, as are its limitations (Green and Alston). Eales and Unnevehr argue that one critical limitation of the original specification is its assumption of price exogeneity. For many commodities, especially perishable ones, the quantity supplied is essentially fixed in monthly data, so prices adjust to clear the market (Rickertsen).[9] Beginning from a distance function analogous to Deaton and Muellbauer's PIGLOG expenditure function,

$$\ln D(u, q) = (1 - u)\ln(a(q)) + u\ln(b(q)), \tag{9}$$

Eales and Unnevehr define $a(q)$ and $b(q)$ as follows:[10]

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[8] An anonymous reviewer draws a distinction between experience attributes and credence attributes. While taste and texture are experience attributes that may vary in small ways from shipment to shipment, the safety of a given product is less clearly an experience attribute. If a consumer becomes ill, he or she may not ascribe the illness to one particular food. Given assurances from government or private organizations on the safety of a particular product, consumers simply expect to not become ill from consuming the product, so safety is more of a credence attribute (Darby and Karni). In other words, safety is not experienced, but expected. In this regard, safety is more precisely defined as a credence attribute and is consistent with the role of safety as described by Swartz and Strand.

[9] Conducting commodity-by-commodity Hausman tests for price exogeneity produces χ^2 statistics of 10.781 for bananas, 5.461 for apples, 16.234 for grapes, 2.354 for strawberries, and 5.909 for oranges. The critical χ^2 value at a 5% level with 44 degrees of freedom, where the degrees of freedom are equal to the number of system parameters minus one, is 60.19. Thus, we cannot reject the null hypothesis of exogeneity for any commodity. Consequently, the inverse model is appropriate for this problem.

[10] This distance function is assumed to be linearly homogeneous, concave, nondecreasing in q, and decreasing in u (Eales and Unnevehr).

(10)
$$\ln(a(q)) = \alpha_o = \sum_j \ln(q_j) + 0.5\sum_j \sum_i \gamma_{ij}\ln(q_j)\ln(q_i);$$
$$\ln(b(q)) = \beta_o \prod_j q_j^{-\beta_j} + \ln(a(q)).$$

Substituting these expressions into the distance function (9), differentiating with respect to quantities, and solving for each of the i budget shares leads to an estimable system:

(11)
$$w_i = \alpha_i + \sum_j \gamma_{ij}\ln(q_j) + \beta_i \ln(Q),$$

where w_i is the budget share of product i, and Q is a total quantity index, commonly approximated with Stone's quantity index. Moschini, among others, argues that linearizing the AIDS model (or the IAIDS in this case) with Stone's index leads to inconsistent parameter estimates. However, Moschini also shows that creating a corrected version of this index by scaling all component quantities provides a "proper" index that performs as a very close approximation of the nonlinear IAIDS. Consequently, this study uses Moschini's corrected Stone's quantity index. Restrictions implied by utility maximization require:

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0, \quad \sum_i \beta_i = 0,$$
$$\sum_j \gamma_{ij} = 0, \quad \text{and} \quad \gamma_{ij} = \gamma_{ji}.$$

Although Green and Alston derive elasticities that are consistent with a nonlinear AIDS specification, Chalfant's expression for price and scale flexibilities in the linear-approximate version are given, respectively, by

(12)
$$f_{ij} = -\delta_{ij} + (\gamma_{ij} + \beta_i w_j)/w_i;$$
$$f_i = -1 + \beta_i/w_i,$$

where δ_{ij} is Kronecker's delta. In the inverse model, negative cross-flexibilities indicate gross quantity substitutes, whereas positive cross-flexibilities suggest that the goods are quantity complements.[11] Similarly, products with scale flexibilities below -1.0 are termed necessities, while a scale flexibility above -1.0 indicates the good is a luxury.

Estimating (11) in this example, however, requires that three other considerations be taken into account. First, the demand model must allow for seasonality. This is

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[11] In general, the metric for flexibility is the normalized price of a good, or its price divided by expenditures, which is proportional to its marginal utility. In an inverse demand model, therefore, flexibility refers to the sensitivity of the marginal utility derived from a good to changes in its quantity. If a 1% increase in the consumption of a good results in a greater than 1% increase in its marginal utility, then Eales and Unnevehr define the good to be inflexible (p. 261). Scale flexibility, on the other hand, is best understood in quantity space. If the movement from one consumption bundle to another can be decomposed into a utility-constant substitution, and then a proportionate change in all quantities, the scale flexibility refers to the change in marginal utility from consuming a particular good when the consumption of all goods changes proportionately (Eales and Unnevehr). Therefore, goods with a scale flexibility less than -1 must be necessities, whereas luxuries are greater than -1. Intuitively, if an individual receives more of all goods, then the marginal utility of consuming any one of them must fall. Further, there will be a proportionately greater fall in marginal utility of those goods for which the individual has little need to consume more—or the ones that he or she consumes first, necessities.

accomplished by incorporating a series of monthly dummy variables. Second, the good news (G) and bad news (B) variables are incorporated in linear form. Third, the response of product share to changes in all explanatory variables is assumed to be governed by an autoregressive process, the order of which is to be determined by the data. With each of these considerations, the demand model is written as a system of inverse demand equations:

$$w_{it} = \sum_m \theta_m w_{i,t-m} + \left(\alpha_{i0} + \sum_k \alpha_{ik} \mathbf{L}_k + \alpha_{iB} B_t + \alpha_{iG} G_t \right) + \sum_j \gamma_{ij} \ln(q_{jt}) + \beta_i \ln(Q_t) + \epsilon_{it}, \tag{13}$$

where θ is a vector of autoregressive parameters, $\mathbf{L}$ is a set of monthly dummy variables, B is the index of bad media information regarding strawberries, G is its positive counterpart, Q is the total quantity index, and ϵ is a random error term. Although researchers often invert elasticities to approximate flexibilities, and vice versa for use in simulation models, Huang (1994) provides empirical evidence of the error that this simplification may cause. For this reason, the market equilibrium model uses directly estimated flexibilities in the producer surplus model. Estimates of the fresh fruit system are obtained using monthly price and quantity data for each of the major fresh fruits over a period that includes both of the recent disease outbreaks attributed to strawberries.

Data and Methods

Specifically, the strawberry price and quantity data for this study are from U.S. Department of Agriculture (USDA) and U.S. Department of Labor/Bureau of Labor Statistics (BLS) sources. Because annual per capita consumption aggregates published by the USDA cannot capture the immediate effects of information shocks to the market, monthly arrivals reported in the USDA/Market News Service's *Fresh Fruit and Vegetable Arrivals in Western Cities* and *Fresh Fruit and Vegetable Arrivals in Eastern Cities* for 1995–97 provide the quantity data. Arrivals to six eastern markets (Atlanta, Baltimore, Boston, Detroit, Philadelphia, and Pittsburgh) and six western markets (Chicago, Dallas, Los Angeles, San Francisco, Seattle, and St. Louis) are recorded, providing 432 panel observations.

Although *Arrivals* include more markets than those listed here, the excluded markets had several months where strawberry arrivals were less than one standard unit of measurement (100,000 pounds). With the declining relative importance of terminal markets represented by arrivals data, there is some concern over how well arrivals data correspond to amounts destined for retail consumption. However, monthly CSC shipment data include movements of all strawberries at a national level, and therefore must equal consumption plus loss in transport. The average correlation between arrivals to the 12 markets in the sample and national CSC shipments is 91.6%. Thus, we are confident that arrivals represent a close approximation to the amounts ultimately consumed at retail. Moreover, because the arrivals data represent supply that is not previously committed under contract, fluctuations in these marginal shipments cause changes in the market price.

Monthly arrivals data also permit the estimation of any seasonal effects on demand. Strawberry prices, reported on a dollar/pound retail basis, are supplied by the BLS *Consumer Price Index: Average Price Data*, but for only nine months of the year. Shipments during October, November, and December are insufficient to determine a representative price, so only nine months per year remain in the sample for estimation purposes.

Assuming fresh fruit consumption is weakly separable from other foods and other goods, the set of alternative products includes apples, bananas, oranges, and grapes. Arrivals for each of these are available through *Arrivals*, and retail prices are also found in the BLS *Average Price* database. As in the strawberry case, each price series is expressed on a real, per pound basis and is measured at the retail level.

With data on both farm (or FOB) and retail prices, it also would have been possible, and preferable, to estimate the retail-farm price transmission elasticity. However, in the absence of FOB prices, the transmission elasticity is calculated by assuming plausible values for the elasticity of supply of marketing services (10.0), the elasticity of supply of strawberries (from 0.01 to 5.00), the elasticity of substitution between farm and marketing inputs (0.0), and the farm share of retail value (USDA, *Fresh Fruit Prices and Spreads*). With these parameters, Gardner's formula (see footnote 7) is used to calculate a synthetic elasticity value. Because there is some question as to the elasticity of supply of strawberries in monthly data, the change in producer surplus due to favorable and unfavorable news articles is calculated over a range of values from $\eta = 0.01$ to $\eta = 5.00$. The econometric model in (13) is estimated with least squares by pooling over time periods and markets. A fixed-effects method controls for heterogeneity among markets, but the market-specific parameters are not of immediate interest, and so are not presented. (They are, however, available from the authors upon request.)

The number of favorable and unfavorable articles per month is determined by searching the top 50 newspapers in the U.S. through the *Dow Jones News Service* under the key terms "strawberry," "disease," "hepatitis," and "cyclospora." By searching the top newspapers by circulation, this procedure not only ensures a far broader coverage of U.S. consumers compared to Brown and Schrader's approach, but also minimizes the likelihood that the medium will add a source of uncertainty to the credibility of the message. After reviewing an abstract of the article, or the full article itself, a determination is made as to whether the article creates a favorable or unfavorable perception of the safeness of consuming strawberries.[12] Although it is well known that the impact of a story varies by its location within the paper and on the page, the *Dow Jones News Service* does not provide sufficient information to rate articles on this basis. Consequently, the articles are assumed to be relatively homogeneous in exposure.

As attribution theory predicts, an article's impact will depend not only upon exposure, but on the credibility of the source. However, adjustments for credibility made at the recording stage would be arbitrary and subjective. Rather, in order to conduct statistical tests of the predictions of attribution theory, each article is recorded as creating an unambiguous positive or negative impression of strawberry safety. Although arriving at a definitive assessment of each article may seem to be arbitrary, upon reviewing the

[12] This method approximates as closely as possible the impression a typical consumer will take from the article. Adding further specificity to this measure would introduce bias to the extent that the researcher's interpretation differs from that of consumers. Any article that could not be classified as either positive or negative, such as a recipe or harvest report, could not be included in the indices.

articles it became immediately clear as to the conclusion to be drawn from each. For example, the initial articles written in May of 1996 following the cyclospora outbreak were unambiguously negative, as each cited the Texas Department of Health's claim that California strawberries were "almost certainly" the source of the disease. Later articles, however, cast doubt on this conclusion and pointed instead to imported raspberries as the cause. These were coded as positive because they so clearly contradict the initial claims. By coding each article one way or the other, the econometric model determines, statistically, whether consumers act as if the message is credible or not and if, as a result, producer surplus should rise or fall.

Producer surplus values are calculated under two simulation scenarios using data over the entire sample period: the first assumes only unfavorable media exposure, while the second allows for both good news and bad news regarding strawberries. In each case, the amount of information is defined as the cumulative total number of articles from January 1, 1995 through October 31, 1997. The grower loss or benefit of each type of information is calculated for each month, converted to a present value at January 1, 1995 as an annuity at a 5% rate of interest, and then expressed in November 1997 dollars through a future value calculation. By comparing the producer surplus values that result, the study is able to isolate the value of providing "defensive" information to the market to counter the negative effects of adverse media information. The results of each of these simulations are presented and interpreted following a brief discussion of the demand model estimates.

Results and Discussion

Although the primary concern of this study is with the effect of positive and negative media exposure on strawberry producer surplus, estimates of media's effects on both strawberry and other fruit demand are of some interest. From a broader perspective of the entire U.S. fruit and vegetable sector, spillover effects from strawberry news on the demand for substitute products may serve to mitigate the damage caused to the strawberry industry itself.

To this end, table 1 shows all own- and cross-elasticity estimates as well as goodness-of-fit measures. Although the sample period is relatively short, the model appears to fit the data quite well, as the R^2 values for each equation are over 90% and all own- and cross-price flexibilities are significantly different from zero. Whereas negative cross-price elasticities indicate complementarity, in an inverse demand model, negative cross-price flexibilities suggest q-substitutability. Clearly, table 1 shows that all pairs of commodities are indeed q-substitutes, meaning that as the supply of one increases, the price of the other is expected to fall, albeit less than proportionately. The fresh fruit group is, however, less homogeneous with respect to scale flexibility estimates. While apples, bananas, and grapes are all scale-flexible, and strawberries and oranges are scale-inflexible in the short run, all goods are scale-flexible in the long run.

Further, for all commodities except apples, lagged own-price variables are significant at lags of two periods.[13] Importantly, all roots of the characteristic equations implied by

[13] Detailed parameter estimates for the entire model are available from the authors, as table 1 summarizes these results in terms of the estimated flexibilities.

Table 1. Inverse AIDS Fresh Fruit Demand Flexibilities: Short Run and Long Run

Price	SHORT-RUN FLEXIBILITY WITH RESPECT TO: Q_S	Q_A	Q_B	Q_G	Q_O	Total Q	Bad	Good	R^2
P_S	-0.3527* (-14.0523)	-0.1804* (-18.1807)	-0.1462* (-12.6448)	-0.1599* (-13.7142)	-0.1236* (-13.6225)	-0.9504* (-37.2245)	-0.6482* (-11.5284)	0.3431* (7.7227)	0.9136
P_A	-0.4251* (-19.9402)	-0.0885* (-2.8818)	-0.1384* (-9.4437)	-0.1970* (-7.7015)	-0.1942* (-9.2068)	-1.0576* (-50.0441)	0.3947* (8.5569)	-0.2641* (-7.2134)	0.9295
P_B	-0.2831* (-12.8734)	-0.1092* (-8.5395)	-0.3137* (-17.1112)	-0.1520* (-10.4442)	-0.1482* (-12.3651)	-1.0081* (-40.0461)	0.3499* (6.5114)	-0.1524* (-3.5401)	0.9394
P_G	-0.3877* (-14.4021)	-0.2022* (-7.5445)	-0.1935* (-10.8088)	-0.1019* (-2.6783)	-0.1327* (-5.4036)	-1.0241* (-38.5034)	0.3144* (5.3680)	-0.1799* (-3.8625)	0.9233
P_O	-0.3814* (-14.7932)	-0.2593* (-9.4288)	-0.2019* (-12.0386)	-0.1679* (-5.4328)	-0.2055* (-4.2946)	-0.9963* (-40.3527)	0.4386* (8.1635)	-0.1906* (-4.4961)	0.9156

Price	LONG-RUN FLEXIBILITY WITH RESPECT TO: Q_S	Q_A	Q_B	Q_G	Q_O	Total Q	Bad	Good	R^2
P_S	-0.3944* (-13.0542)	-0.2017* (-17.9645)	-0.1635* (-12.5186)	-0.1788* (-13.6498)	-0.1382* (-14.1695)	-1.0626* (-32.3398)	-0.7247* (-11.8713)	0.3836* (7.8053)	0.9136
P_A	-0.4687* (-18.7035)	-0.0976* (-2.8259)	-0.1526* (-9.4522)	-0.2173* (-7.4468)	-0.2142* (-9.2664)	-1.1662* (-29.1502)	0.4353* (8.7174)	-0.2912* (-7.2605)	0.9295
P_B	-0.3005* (-12.4656)	-0.1159* (-8.4280)	-0.3331* (-14.5151)	-0.1614* (-10.4392)	-0.1573* (-12.9569)	-1.0704* (-29.4812)	0.3716* (6.5557)	-0.1618* (-3.5467)	0.9394
P_G	-0.4434* (-13.9179)	-0.2312* (-7.3302)	-0.2212* (-11.3101)	-0.1165* (-2.6372)	-0.1517* (-5.3876)	-1.1710* (-27.5059)	0.3596* (5.5465)	-0.2057* (-3.8928)	0.9233
P_O	-0.4127* (-14.4122)	-0.2035* (-9.1573)	-0.2184* (-12.3309)	-0.1816* (-5.3802)	-0.2166* (-4.2885)	-1.0778* (-25.3521)	0.4745* (8.2803)	-0.2063* (-4.4918)	0.9156

Notes: An asterisk (*) denotes significance at the 5% level. Values in parentheses are t-ratios.

this lag structure are bound by the complex unit circle, which suggests that prices follow a convergent process toward equilibrium following a shock—converging only after an initial overshot of the steady state. One explanation for this "overshooting" may be the tendency for markets to overcompensate for unexpected news. Given an uncertain situation, risk-averse buyers and sellers tend to err on the side of conservatism and expect the damage to be worse than it actually is. On the other hand, initial reports simply may prove to be wrong. In the case of the 1996 cyclospora scare, blame initially placed on contaminated strawberries was later redirected toward the true culprit—imports of Guatemalan raspberries. This behavior would explain a large price drop, followed by a gradual return to some long-run equilibrium. Irrespective of the cause of the price dynamics found here, the long-run parameters are derived by dividing their short-run counterparts by $(1 - \Sigma_m^2 \theta_m)$, where θ_m denotes the coefficients of the autoregessive process.

These flexibility estimates also show that both negative and positive media exposure have significant effects on commodity prices, but, as attribution theory suggests, their impact is not symmetric. Consumers appear to react strongly to negative information about a product, but they are less responsive when presented with favorable news. Because many of the positive articles included here were corrections of previous misinformation, this suggests that once the bad news is made public, the damage has been inflicted and little can be done to reverse it. It may also be the case that favorable information provided by the CSC is viewed as "nonunique" or to reflect its own interest, and so is discounted heavily by consumers. Rather than release such defensive communiques directly, therefore, it is clearly in a commodity board's best interest to filter this information through organizations consumers perceive as objective, such as universities or government research agencies.

It is also interesting to compare the relative magnitudes of the short-run negative and positive information flexibilities. Whereas a rise in the weighted, cumulative index by one more negative article (a 45% increase, on average) in a typical month is likely to reduce strawberry prices by over 29%, a positive article (a 76% increase) will help the CSC recover 26% of the strawberry price. However, if the percentage change in information stock is held constant across the two scenarios (perhaps if the CSC adopts an equivalent tit-for-tat strategy), the CSC will only be able to raise prices by 15%. Thus, if the CSC seeks to mount an intensive campaign to counter the negative media exposure, it will have to almost double the negative exposure provided by the popular media. Because of the autoregressive model structure, this approach gives estimates of both the long- and short-run effects of information and price changes.

Given the sum of the lag coefficients is approximately 0.90, adjustment to the steady-state price level is relatively rapid since it is nearly complete within two periods (months). Consequently, there is little difference between the short- and long-run flexibilities. However, both the short- and long-run estimates are significantly higher than those implied by demand elasticities reported for similar commodities (Huang 1985; Lee, Brown, and Seale; Richards). Some of the difference between the current and prior results is likely due to the fact that this study uses monthly data, whereas most previous studies use annual data. Further, quantity-dependent demand systems will suffer from misspecification bias when prices, in fact, adjust to clear the market following a shock to supply.

Table 2. Loss of Producer Surplus Due to Unfavorable Media Exposure and the Value of Media Defense: 10% Shock to Number of Articles

	Short Run ($ mil.)			Long Run ($ mil.)		
Scenario	Bad News	With Defense	Value of Defense	Bad News	With Defense	Value of Defense
$\eta = 0.01$	-232.656	-109.493	+123.163	-273.424	-128.649	+144.775
$\eta = 0.10$	-227.585	-107.369	+120.216	-266.978	-126.002	+140.976
$\eta = 0.50$	-207.424	-98.612	+108.812	-241.975	-115.232	+126.743
$\eta = 1.00$	-187.800	-90.056	+97.744	-218.559	-105.170	+113.389
$\eta = 2.00$	-161.250	-78.634	+82.616	-189.173	-97.585	+91.588
$\eta = 5.00$	-140.828	-92.257	+48.571	-83.518	-49.705	+33.813

Notes: All cases represent cumulative cost or benefit of all media exposure from January 1995 through October 1997. Producer surplus values are in millions of current dollars.

With a short-run price flexibility of -0.35, and a long-run flexibility of -0.39 (table 1), large changes in supply are required to cause prices to change significantly. This rigidity is consistent with the strong substitute relationships that the cross-flexibility estimates suggest. If consumers regard other fruits as close substitutes for strawberries, they will switch to other products rather than pay much higher strawberry prices. Similarly, the short-run price flexibility in response to negative articles is -0.65, while the long-run flexibility is -0.72. This estimate implies that one more negative article at the height of the 1997 scare (a 6.7% increase) would have caused a long-term price reduction of approximately $0.31 per carton (1.9%), suggesting that strawberry prices are relatively sensitive to even a small amount of bad news. Such estimates of the incremental cost of negative information are helpful in guiding growers' efforts to counter bad publicity through their own media programs.

Most of the impact of positive media exposure occurs in the period in which it is released. Similar to the negative-information case, prices are inflexible in response to positive news, with short- and long-run flexibilities of 0.34 and 0.38, respectively (table 1). As explained above, the fact that these flexibilities are lower than their negative counterparts suggests that equal percentage changes in each type of exposure will cause prices to fall. Examining the cross-flexibilities in table 2, however, shows that news of disease outbreaks related to strawberries does not necessarily reduce the demand for all fruits. In fact, the price of each alternative fruit rises on the news of a strawberry disease scare, but falls in response to positive strawberry information. Growers as a whole, therefore, are not necessarily worse off as a result of negative media exposure.

A more complete analysis of this issue (one that is beyond the scope of this article) would estimate a two-stage model including the demand for the entire fruit category. If total fruit demand falls in response to negative information dominating positive, then perhaps industrywide programs are required rather than commodity- and outbreak-specific measures. With respect to strawberry growers alone, however, long-run cumulative impacts on grower welfare are more clearly shown by calculating the change in producer profit rather than simply looking at changes in price.

The simulation results in table 2 show the short-term and long-term effects of both types of media information. To be able to compare the change in surplus that arises due to changes in the amount of each type of information, an increment is defined as a 10% rise in each with the other held constant. In the short-run scenario, strawberry buyers do not completely adjust their buying behavior in response to the lower prices caused by a disease scare, nor do they remember negative media information for more than the current month. To the extent that these assumptions are unrealistic, this scenario represents an understatement of the true loss to growers. This cost is also sensitive to the extent to which growers and shippers respond to lower prices by supplying fewer strawberries to the market. Specifically, the less elastic is supply, the more price will fall in response to a shock to demand. Therefore, these simulations consider a range of supply elasticities from 0.01 (highly inelastic) to 5.0 (very elastic). Assuming a very low supply elasticity (0.01), short-run price and information adjustment, and focusing on the case where consumers are exposed to only bad news, growers lose a total of $232.6 million over the sample period, or 19.6% of the total value of all shipments. Including the effects of positive media reduces the total loss to $109.5 million, which implies that positive information is worth $123.2 million in this case.

Under a scenario where growers and shippers are better able to adjust strawberry supplies in response to price changes (supply elasticity = 1.0), the loss due to negative information falls to $187.8 million and the net loss becomes $90.1 million, so the value of spin control in this case is $97.7 million. Public relations officials at the CSC should compare this value to the cost of mounting a concerted effort aimed at reassuring consumers of the safety and nutritional value of strawberries through mass media. More realistic estimates of this value, however, take into account consumers' long-run response to both positive and negative reports regarding the health implications of buying strawberries.

In fact, table 2 shows that the long-run effects are somewhat greater than the short-run effects. Again assuming that supply is virtually fixed (a less tenable proposition in the long run), the loss due to negative information rises to $273.4 million, and the value of media efforts to ameliorate the damage rises to $144.8 million. Although these damage estimates are far higher than the rough estimates provided by CSC officials during the 1997 scare ($40 million), they come closer as the assumed elasticity of supply rises. Specifically, if the elasticity is 5.0 instead of 0.01, then the loss due to bad news falls to $83.5 million, while a positive media response reduces this loss to $49.7 million. Therefore, the value of a campaign to either correct misinformation or to change consumer perceptions is $33.8 million.[14] Given even this most conservative estimate, it appears that the amount spent by the CSC during the 1997 outbreak, which officials estimate at roughly $250,000, was money very well invested. To be useful as a practical guide to investing in media programs, it is necessary to demonstrate how sensitive these results are to changing the definition of a publicity response, or how "news" is quantified.

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[14] Notice that this definition of a long-run effect differs from that of Brown and Schrader. They consider the addition to a cumulative stock of "net negative articles," whereas this study treats each new article as an independent shock. This difference may be significant because their approach implicitly assumes that consumers become desensitized to bad news as it accumulates—an assumption that cannot be made in this case.

Table 3. Loss of Producer Surplus Due to Unfavorable Media Exposure and the Value of Media Defense: One Article Shock Simulation

	Short Run ($ mil.)			Long Run ($ mil.)		
Scenario	Bad News	With Defense	Value of Defense	Bad News	With Defense	Value of Defense
$\eta = 0.01$	-899.335	-32.347	+866.988	-1,056.203	-37.980	+1,018.223
$\eta = 0.10$	-861.837	-30.527	+831.310	-1,006.814	-35.530	+971.284
$\eta = 0.50$	-714.526	-22.532	+691.994	-814.502	-24.761	+789.741
$\eta = 1.00$	-570.818	-14.143	+556.675	-628.509	-13.389	+615.120
$\eta = 2.00$	-361.515	-0.486	+361.029	-347.125	+7.339	+354.464
$\eta = 5.00$	+163.124	+263.324	+100.200	-126.225	-58.041	+68.184

Notes: All cases represent cumulative cost or benefit of all media exposure from January 1995 through October 1997. Producer surplus values are in millions of current dollars. Scenario assumes an average of one more positive and negative news item per month.

Table 3 shows the change in producer surplus that results from defining an increment to the stock of information due to a single negative or positive article in an average month. Given the relatively low number of articles reaching the media each month, these estimates are far higher than the scenario considered above. While both positive and negative media have very large independent effects on surplus, the net effect is relatively small because a single-article change represents a far higher percentage change for good news as opposed to bad news. Specifically, in the short run, the net impact with inelastic supply is $32.3 million, rising to $14.1 million under an assumption of unitary supply elasticity. In the long run, inelastic supply produces an estimate very close to the "best-guess" numbers of CSC officials ($38 million), while the assumption of unitary elasticity yields a net cost of $13.4 million to growers. Although these results also suggest that publicity is a good investment, the question remains as to whether growers' money could have been put to an even better use.

Although it sounds cliché, in this case an ounce of prevention may indeed be worth more than a pound of cure. Preventing a loss this large not just in revenue, but in *profit*, provides ample justification for investing in an industrywide safety-control program. The problem is that a disease-free reputation is a classic example of a public good. Because all growers benefit from this product image, but none can be compelled to pay their individual benefit, the private market will fail to provide any protection at all. If it is rational for one grower to be a "free rider," then it is rational for all to become free riders.

However, commodity organizations were initially established to provide another type of public good—generic commodity promotion. It seems natural, therefore, that commodity groups could treat contamination prevention as an equal and companion objective to promoting their products. Mandatory grower check-off fees would fund inspectors and industry-designed standards that would obviate the need for more government regulation of growers. In the strawberry industry, some of the largest, vertically integrated grower/marketers have recognized the fundamental truth in this logic by investing in their own Hazard Analysis and Critical Control Point (HACCP) programs (*The Packer*). To the extent that their strawberries are seen as close substitutes for all others, however, they are still subject to the risk that one culprit will again damage the buying public's image of strawberries as a safe and healthy food.

In fact, as a result of the 1997 outbreak, the CSC has taken steps in this direction with the establishment of a food safety director position. While the director has no enforcement abilities, she has been successful in helping growers and shippers establish systems of efficient traceback, providing them information on existing sanitation and hygiene standards, and is working toward industry-standard HACCP programs. The creation of this position is but one part of the industrywide approach to maintaining food safety, based on principles of grower/shipper self-interest and self-reliance that has brought praise to the CSC from all corners of the fruit and vegetable industry.

Conclusions and Implications

Whether beef growers arguing the amount of damage inflicted by Oprah Winfrey's comments or strawberry growers placing a value on one individual's indiscretion, estimates of profits lost due to a shock to an agricultural market are usually little better than guesses. Accurate information on these costs is important to growers and their associations in establishing the value of a defensive response through promotion or news releases—or spin control. This study develops a model designed to quantify the effects of media reports of a disease outbreak on the profits of commodity growers. An application of this model to the U.S. strawberry market from 1995–97 demonstrates that these lost profits can be significant.

The approach taken in valuing negative media reports, and efforts to counter these reports, involves estimating a model of strawberry demand that allows for the independent effects of negative and positive news. The psychology of "attribution" suggests that each type of news will have a different effect on consumers, depending upon the credibility of each source of information and that source's perceived vested interests in making news widely known. Quantitative measures of the amount of either type of news are developed by counting the number of positive and negative media articles appearing in the popular media on a monthly basis. These shocks are allowed to persist over time by specifying the demand model in inverse, autoregressive form.

Estimates of this model show that positive and negative media articles have the expected effects on price, but negative reports have a greater effect on price than positive reports—exactly the result predicted by attribution theory. Simulations of a producer-welfare model that incorporates these elasticities find the loss due to bad news regarding strawberries to range from $273.4 million to $83.5 million in the long run, depending upon the supply elasticity assumptions made. Estimates of the value of defensive media efforts range from $144.8 million to $33.8 million, which are both many times the amount actually spent by the CSC during the most recent outbreak.

One implication of this result is often overlooked. If a product's image among consumers as a safe and healthy alternative is considered a public good, then grower associations have an incentive to broaden their missions to include not only generic commodity promotion, but also to consider industrywide efforts at preventing future disease outbreaks. Individual firms' efforts to develop HACCP programs or to adopt new production practices can be undermined by one individual who takes one risk too many. Recognizing this fact, the CSC has taken steps to remind growers and shippers of their responsibility to the integrity of the "California Strawberry" brand, and to assist them in adhering to food safety regulations that cover all industry members.

Future research in this area should recognize the fact that negative and positive impressions of the safety attributes of a particular food are latent variables and should be explicitly identified as such. Structural latent variable models can be constructed from annual data that use media indices similar to those developed here as cause variables and treat the numbers of foodborne disease outbreaks reported to the Centers for Disease Control and the residuals from a demand system (Gao and Shonkwiler) as indicator variables. With this MIMIC approach, measurement errors inherent in the approach used here and elsewhere would be held to a minimum. This approach, however, will require much better disease-reporting data than are now currently available.

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