Effects of Health Information on Fruit and Vegetable Consumption

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Introduction

In the US, there is a shift from curing to preventing disease and links have been made between food and health suggesting that a fruit and vegetable rich diet can provide medical benefits. Consequently, public-private partnerships such as the "Produce for Better Health Foundation" have been created to raise public awareness and promote greater fruit and vegetable consumption. However, despite these efforts, current US fruit and vegetable daily average per capita consumption of 4.4 servings is still lower than the 5 a day servings recommended for better health.

Recent studies indicate that these promotional efforts may have little impact on fresh produce consumption (Henneberry, 1999). Nevertheless, few existing research has analyzed the overall impact of health information on fresh fruit and vegetable consumption. Therefore, this study examines whether health information has affected consumer demand for U.S. fruit and vegetables. Agribusiness and policy makers need a better understanding of the factors involved as this information will allow for improved marketing and public health programs in the future.

With that in mind, this study examines this issue using fruit and vegetable per capita consumption data for the period 1970-1999. During this period, government policy toward nutritional information changed, allowing for explicit science based health claims in advertising and labeling. This relatively new regulatory environment and a variety of nutrition programs have facilitated the dissemination of scientific research to consumers. At the same time, subjective coverage of risk-benefit information regarding the consumption of fresh fruits and vegetables has also increased in the popular media. In this environment of partial knowledge and incomplete information, consumers continually engage in cost-benefit assessments of the information sources used to determine product characteristics (Mathewson, 1972). Of all the these available sources, consumers most frequently use nutritional information from the popular media while information from professional sources is less used but is considered most useful (IFIC, 1994).

This paper then, will focus on whether this less used but most useful flow of science-based risk-benefit information has influenced consumer fruit and vegetable consumption. Several economic studies have explored the effects of information on diet by including a nutrition information index derived from publications (Brown and Schrader 1990, Schmitz and Capps 1993; Chern, Loehman and Yen 1995; Kinnucan et al. 1997; Henneberry et al. 1999; Kim and Chern 1999). In a seminal study, Brown and Schrader (1990) construct an index based on medical journal articles to investigate how information about cholesterol has affected U.S. shell egg consumption and find that increased information linking cholesterol and heart disease decreased per capita shell egg consumption by 16% to 25%. Using similar methodology, Schmitz and Capps (1993) find that a cholesterol based information index performs poorly in estimating elasticities for cholesterol free foods (i.e. fruit and vegetables). In a study of U.S. meat demand, Kinnucan et al. (1995) find the health information trend is significant and that the estimated health information elasticities in general were larger than price elasticities. Chern, Loehman and Yen (1995) investigate the effect of cholesterol information on the demand for fats and oils in the U.S. and find that it has induced a substitution from animal fats to plant oils. Similarly, Kim and Chern (1999) study the influence of risk information on the demand for fats and oils in Japan and find that greater nutritional awareness has had no major impact on plant oil consumption but has increased the demand for fish oil and reduced the consumption of hog grease, palm oil and tallow.

Recently, Henneberry et al. (1999), investigate the impact of prices, expenditures and food safety concerns (i.e. chemical residue) in the demand for 10 fresh fruits and 10 fresh vegetables. In this study, the measure of risk information, created by subtracting positive media reports from negative ones, is found to have a very minimal and statistically insignificant impact on the consumption of most of the fruits and vegetables under analysis. However, it is not clear whether consumers respond symmetrically to positive and negative news. In a study measuring the economic value of public relations to the strawberry industry, Richards and Patterson (1999), find that negative reports have a greater effect on price than positive reports. Furthermore, since this index was constructed from popular media reports, the question of whether most influential but less used information flowing from professional journals has a similar impact is also not addressed. As such, these are empirical questions best modeled by using flexible functional forms of indirect utility and expenditure functions that approximate the behavior of utility maximizing consumers and arrive at demand systems that can be easily estimated.

Model

The linear approximation of an almost ideal demand system model is employed with to estimate the impact of prices, consumer expenditures and positive and negative health information on consumption of major fruits and vegetable commodities. The AIDS model is specified as follows:

$$W_i = \alpha_i + \sum_{\kappa=1}^{n} C_{ik} \log(P_k) + \beta_i \log(Y / P) \tag{1}$$

Where W_i is the budget share of good i, P_k is the price of good k, Y is per capita expenditure, and P is a price index. In this study, a modified AIDS model which incorporates positive and negative information as an intercept shifter is used. The intercept term in equation was specified as:

(2) $$\alpha_i = \rho_{i0} + \rho_{i1} INFH + \rho_{i2} INFP,$$

where INFH corresponds to a cholesterol index similar to Kinnucan et. al and INFP corresponds to pesticide index following Henneberry et. al. Using equation (1), two separate demand systems are used to estimate share equations for fruit and vegetables each. Depending on which system (fruit or vegetable) P_k represents the price of a fruit or a vegetable and Y is per capita expenditure in a fruit or a vegetable. Following related studies, fruits and vegetable commodities are modeled separately and estimated using the seemingly unrelated regression method. Marshallian and Hicksian elasticities were calculated from the estimated parameters following the derivations by Chalfant:

(3) $$\begin{aligned} E_{ii} &= -1 + C_{ii} / W_i - B_{i,} \\ E_{ij} &= C_{ii} / W_i - B_i (W_j / W_i), \\ S_{ii} &= -1 + C_{ii} / W_i + W_i, \\ S_{ij} &= C_{ij} / W_i + W_j, \end{aligned}$$

E are Marshallian elasticities and S are Hicksian elasticities. Expenditure elasticities were computed with the formula:

(4) $$\eta_i = 1 + B_i / W_i$$

As is Henneberry et al, information elasticities are calculated with the equation:

(5) $$R_i = \rho_{i1} (INF / W_i),$$

where R_i stands for information elasticities and ρ_{i1} is the coefficient estimates for health information.

Data Sources

The economic variables comprising price and income for the period 1970-1999 were obtained from the U.S. Department of Agriculture (USDA). The proxy for the health information reaching the consumer, a health information index, was constructed by scanning the U.S.

National Institutes of Health (NIH) Medline database for relevant articles using the Medical Subject Headings (MESH) controlled vocabulary. Titles were read and the articles supporting the benefits of fruit and vegetable consumption or highlighting the risk of fruit and vegetable consumption, pesticide risk in this case, were screened. Articles, which did not appear to be relevant, were eliminated and all foreign language articles were discarded in the belief they are less likely to be read by the US health community. To increase the degrees of freedom, similar fruits and vegetable commodities are combined. For example, broccoli and cauliflower are aggregated as cruciferous vegetables. Among fruits, watermelon, honeydew and cantaloupe are grouped in the melon family while orange, lemon, and grapefruit are grouped together as they belong to citrus family.

Results

The parameter estimates for fruits are reported in table 1. Own price coefficients of all the six fruits are positive and statistically significant. Cross-price coefficients are negative and significant for apples and strawberries and also for bananas, citrus and melons, indicating substitutability among these fruits. The health information variable is expected to hold a positive sign while the pesticide information variable is expected to show a negative sign. Coefficients on the health information variable are significant in three out six equations. However, only apples and strawberries carry the expected sign. In the case of pesticide information, coefficients are significant in two equations with only apples exhibiting the expected negative sign.

Marshallian and Hicksian elasticities for fruits are presented in table 2. All of the own-price elasticities are statistically significant and carry the expected negative sign. Amongst the 36 Marshallian cross-price elasticities, only six are negatively significant. As previously stated, apples and strawberries and bananas, citrus and melons have a significant substitution effect. All expenditure elasticities are significant and have positive signs. The coefficients on health and pesticide information only have a significant and positive sign in the equation for apples. Contrary to expectations, the health and pesticide coefficients for melons carry unexpected signs. Although the impact of health information variable on some of the individual equations is not significant, a joint test shows that the overall impact for all fruit commodities is significantly positive. Likewise, the overall effect of pesticide information for all fruits is significantly negative (Table 2.).

Only three out of six fresh vegetables are significant (Table 3). Cross price elasticites show mixed results. All the coefficients on health information variable are positive as expected but carry a positive sign in only in the equations for carrots and onions. Similarly, the coefficients for the pesticide variable are significantly negative in equation for carrot and onions. In all cases, own price elasticities are negative and significant with the exception of crucifers. Out of 36 Marshallian cross-price elasticities, only 15 are significant with all the expenditure elasticities being positive and significant. With respect to coefficients on health information, only three out of six vegetables are positive with carrots and onions being significant. Surprisingly, the coefficient for cucumbers is significantly negative. The pesticide information variable also shows mixed results. While it is significantly negative in carrots and onions as expected, it displays an unanticipated significantly positive sign for cucumbers. As in the case of fruits, the overall impact of health information on vegetable consumption is positive and significant while the impact of pesticide information is negatively significant.

Conclusions and Recommendations

In this study, the health information and pesticide information do not show a consistent effect on individual fruit and vegetable commodities. However, the overall impact of health information while positive and small is statistically significant. This could be because the variable measuring health information (cholesterol) is not directly related to the health benefits of consuming fruit and vegetables. In the case of the overall effect of pesticide information, the overall impact is negative and statistically significant as expected. As Richards and Patterson (1999), this study finds that negative reports have a greater effect on price than positive reports. The results for the pesticide information variable may be more robust than the in the case of health information as this index is more direct measure of the effect of chemical residue on fruits and vegetables. The obvious implication, is that a greater amount of positive news are necessary to overcome the effect of one piece of negative information. As in the case of biotechnology, credible based regulation of the food supply will be fundamental to continue to maintain public confidence in the safety of the fruit and safety food supply.

Meanwhile, there are some indications that there have been improvements in consumer knowledge regarding diet-disease relationships and healthy new products (Mathios, 1996). As the benefits of consuming fruits and vegetables continues to spread, this may in time, translate into greater consumption. Lowering the cost of acquiring information by making it more convenient to obtain or less difficult to understand may be one way to bolster nutritional awareness and perhaps affect changed behavior in the future. Also, a high degree of competition in the market for advertised goods, should continue to be encouraged so producers may carry on advertising the science based health dimension of their products without undue regulatory fear.

Providing incentives to producers to nutritionally enhance and disseminate the healthy characteristics of produce may also add to the positive externalities of communicating health information. More specifically, the informationally and time disadvantaged should be targeted with educational material so it becomes less difficult to translate vague food pyramid recommendation into meaningful, familiar diets and specific purchasing decisions. Given the fine nutritional qualities of produce, policy makers and agribusiness leaders alike, should continue to evaluate and contemplate present and future programs as even small dietary changes in the aggregate have the potential to increase longevity and improve the quality of life for a large numbers of people.

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Table 1. Impact of Health Information on Fruit Consumption, 1970-1999

Variables	Apples	Grapes	Bananas	Citrus	Strawberries	Melons
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
Intercept	0.224 **	0.111 **	0.161 **	0.622 **	0.021	0.149 **
	-(4.165)	-(2.194)	-(3.074)	-(11.542)	-(1.341)	-(11.725)
Apples	0.132 **	-0.034	-0.008	-0.021	-0.017 *	-0.008
	-(4.332)	-(1.500)	-(0.411)	-(0.984)	-(1.936)	-(0.976)
Grapes	-0.034	0.079 **	0.009	0.004	-0.009	-0.010
	-(1.500)	-(2.350)	-(0.404)	-(0.186)	-(0.946)	-(1.361)
Bananas	-0.008	0.009	0.058 *	-0.046 **	-0.015	-0.014 *
	-(0.411)	-(0.404)	-(1.878)	-(2.511)	-(1.405)	-(1.856)
Citrus	-0.021	0.004	-0.046 **	0.060 *	0.011	-0.004
	-(0.984)	-(0.186)	-(2.511)	-(1.920)	-(1.644)	-(0.637)
Strawberries	-0.017 *	-0.009	-0.015	0.011	0.028 **	-0.001
	-(1.936)	-(0.946)	-(1.405)	-(1.644)	(3.048)	-(0.318)
Melons	-0.008	-0.010	-0.014 *	-0.004	-0.001	0.036 **
	-(0.976)	-(1.361)	-(1.856)	-(0.637)	-(0.318)	-(8.053)
Expenditures	0.030 *	-0.037 **	-0.001	-0.126 **	0.000	-0.014 **
	-(1.785)	-(3.457)	-(0.009)	-(8.798)	-(0.002)	-(5.221)
Information:						
Health	4.6E-06 *	-8.0E-07	-1.4E-07	4.0E-06	1.6E-06 *	-1.4E-06 *
	-(1.844)	-(0.250)	-(0.006)	-(1.044)	-(1.827)	-(1.853)
Pesticide	-0.005 **	0.001	0.000	-0.003	0.001	0.001 **
	-(2.861)	-(0.499)	-(0.241)	-(1.304)	-(1.423)	-(2.575)
R^2	0.847	0.927	0.524	0.915	0.978	0.898

Note: Single and double asterisks (*) denote significance at the 10% and 5% levels
numbers in parenthesis are standard errors

Joint test:

Health Information		Pesticide Information	
Test value:	7.9E-06**	Test value:	-0.00454**
T-ratio:	2.91	T-ratio:	-2.47

Table 2. Marshallian and Hicksian Elasticities for Seven Fresh Fruits, 1970-1999.

	Dependent Variable (per capita consumption of)					
Indep. Variable	**Apples**	**Grapes**	**Bananas**	**Citrus**	**Strawberries**	**Melons**
Marshallian:						
Price of:						
Apples	-0.546 **	-0.109	-0.057	0.072	-0.310 **	-0.076
	-(4.748)	-(1.059)	-(0.396)	(0.643)	-(1.969)	-(0.474)
Grapes	-0.149 *	-0.605 **	0.070	0.168	-0.171	-0.147
	-(1.826)	-(3.905)	(0.427)	(1.423)	-(0.920)	-(0.923)
Bananas	-0.043	0.063	-0.559 **	-0.155	-0.286	-0.245
	-(0.619)	(0.613)	-(2.329)	-(1.604)	-(1.409)	-(1.591)
Citrus	-0.097	0.051	-0.348 **	-0.559 **	0.206	-0.025
	-(1.247)	(0.502)	-(2.503)	-(3.362)	(1.648)	-(0.194)
Strawberries	-0.067 **	-0.033	-0.115	0.093 **	-0.472 **	-0.009
	-(2.121)	-(0.739)	-(1.384)	(2.653)	-(2.707)	-(0.116)
Melons	-0.033	-0.039	-0.103 *	0.011	-0.023	-0.242 **
	-(1.170)	-(1.113)	-(1.826)	(0.355)	-(0.319)	-(2.662)
Expenditures	1.111 **	0.834 **	0.992 **	0.337 **	1.000 **	0.704 **
	(17.845)	(17.331)	(11.364)	(4.480)	(16.372)	(12.435)
Information:						
Health	0.111 *	-0.024	-0.007	0.138	0.198 *	-0.185 *
	(1.844)	-(0.250)	-(0.059)	(1.044)	(1.827)	-(1.853)
Pesticide	-0.285 **	0.081	0.047	-0.271	0.215	0.410 **
	-(2.861)	(0.499)	(0.241)	-(1.304)	(1.423)	(2.575)
Hicksian:						
Price of:						
Apples	-0.244 **	0.118	0.213	0.164	-0.039	0.115
	-(2.183)	(1.151)	(1.493)	(1.494)	-(0.241)	(0.720)
Grapes	0.096	-0.422 **	0.289	0.242 **	0.049	0.008
	(1.151)	-(2.765)	(1.700)	(2.055)	(0.271)	(0.052)
Bananas	0.103	0.173 *	-0.428 *	-0.111	-0.154	-0.152
	(1.493)	(1.700)	-(1.825)	-(1.145)	-(0.757)	-(0.993)
Citrus	0.115	0.209 **	-0.160	-0.495 **	0.397 **	0.109
	(1.494)	(2.055)	-(1.145)	-(3.019)	(3.159)	(0.858)
Strawberries	-0.008	0.012	-0.062	0.111 **	-0.418 **	0.029
	-(0.241)	(0.271)	-(0.757)	(3.159)	-(2.414)	(0.365)
Melons	0.020	0.002	-0.056	0.028	0.026	-0.208 **
	(0.720)	(0.052)	-(0.993)	(0.858)	(0.365)	-(2.257)

Note: Single and double asterisks (*) denote significance at the 10% and 5% levels
numbers in parenthesis are standard errors

Table 3. Impact of Health Information on Vegetable Consumption, 1970-1999

Variables	Cruciferous	Lettuce	Carrots	Cucumbers	Onions	Peppers
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
Cruciferous	0.058**	0.023 *	-0.008	-0.008	-0.016 *	-0.032**
	(4.487)	(1.906)	-(0.941)	-(1.828)	-(2.796)	-(3.869)
Lettuce	0.023 *	0.110**	-0.028**	0.003	-0.036	-0.013
	(1.906)	(4.211)	-(3.025)	(0.519)	-(6.710)	-(1.495)
Carrots	-0.008	-0.028**	0.013	0.023	-0.001**	0.016
	-(0.941)	-(3.025)	(0.641)	(2.445)	-(0.185)	(1.296)
Cucumbers	-0.008 *	0.003	0.023**	0.005	-0.005	0.000
	-(1.828)	(0.519)	(2.445)	(0.559)	-(1.017)	-(0.015)
Onions	-0.016**	-0.036**	-0.001	-0.005	0.083	0.001
	-(2.796)	-(6.710)	-(0.185)	-(1.017)	(12.175)	(0.185)
Peppers	-0.032**	-0.013	0.016	0.000	0.001	0.061**
	-(3.869)	-(1.495)	(1.296)	-(0.015)	(0.185)	(4.301)
Information:						
Health	0.0000	0.0000	0.0000**	0.0000	0.0000**	0.0000
	-(0.290)	-(0.032)	(2.190)	-(1.990)	(2.294)	(1.532)
Pesticide	0.0007	-0.0011	-0.0011**	0.0007	-0.0008**	-0.0005
	(0.815)	-(0.576)	-(1.961)	(2.240)	-(1.955)	-(0.750)
R^2	0.896	0.840	0.879	0.586	0.897	0.898

Note: Single and double asterisks (*) denote significance at the 10% and 5% levels
numbers in parenthesis are standard errors
Cruciferous: Broccoli and Cauliflower

Joint test:

Health Information		Pesticide Information	
Test value:	1.23E-05**	Test value:	-2.10E-03**
T-ratio:	1.94	T-ratio:	-1.73

Table 4. Marshallian and Hicksian Elasticities for Seven Fresh Vegetables, 1970-1999.

	Dependent Variable (per capita consumption of)					
	Crucifers	**Lettuce**	**Carrots**	**Cucumbers**	**Onions**	**Peppers**
Indep. Variable						
Marshallian:						
Price of:						
Crucifers	-0.218	0.373 *	-0.031	-0.116 *	-0.135 **	-0.363 **
	-(1.248)	(1.720)	-(1.020)	-(1.858)	-(2.762)	-(3.912)
Lettuce	0.308 *	-0.954 **	-0.100 **	0.034	-0.313 **	-0.144
	(1.886)	(2.019)	-(3.131)	(0.503)	-(6.683)	-(1.502)
Carrots	-0.127	-0.666 **	-0.964 **	0.315 **	-0.006	0.180
	-(1.058)	-(3.842)	-(13.348)	(2.454)	-(0.080)	(1.265)
Cucumbers	-0.118 *	0.006	0.078 **	-0.932 **	-0.042	-0.001
	-(1.882)	(0.071)	(2.364)	-(7.590)	-(0.970)	-(0.017)
Onions	-0.218 **	-0.709 **	-0.009	-0.069	-0.275 **	0.016
	-(2.849)	-(7.133)	-(0.328)	-(1.031)	-(4.641)	(0.181)
Peppers	-0.445 **	-0.279 *	0.053	-0.003	0.015	-0.323 **
	-(3.889)	-(1.781)	(1.212)	-(0.025)	(0.218)	-(2.043)
Expenditures	1.052 **	1.532 **	1.035 **	1.011 **	0.975 **	1.002 **
	(22.877)	(8.833)	(76.301)	(27.160)	(47.710)	(23.648)
Information:						
Health	-0.127	-0.040	0.153 **	-0.303 **	0.302 **	0.450
	-(0.290)	-(0.032)	(2.190)	-(1.990)	(2.294)	(1.532)
Pesticide	0.368	-0.737	-0.132 **	0.343 **	-0.260 **	-0.212
	(0.815)	-(0.576)	-(1.961)	(2.240)	-(1.955)	-(0.750)
Hicksian:						
Price of:						
Cruciferous	-0.140	0.486 **	0.045	-0.041	-0.063	-0.289 **
	-(0.800)	(2.247)	(1.495)	-(0.656)	-(1.286)	-(3.082)
Lettuce	0.366 **	1.040 **	-0.043	0.090	-0.258 **	-0.088
	(2.247)	(2.206)	-(1.315)	(1.359)	-(5.522)	-(0.917)
Carrots	0.178	-0.223	-0.664 **	0.608 **	0.277 **	0.470 **
	(1.495)	-(1.315)	-(9.231)	(4.672)	(3.925)	(3.376)
Cucumbers	-0.041	0.118	0.153 **	-0.858 **	0.030	0.072
	-(0.656)	(1.359)	(4.672)	-(6.969)	(0.694)	(0.849)
Onions	-0.098	-0.533 **	0.110 **	0.046	-0.163 **	0.131
	-(1.286)	-(5.522)	(3.925)	(0.694)	-(2.747)	(1.461)
Peppers	-0.351 **	-0.142	0.145 **	0.088	0.103	-0.234
	-(3.082)	-(0.917)	(3.376)	(0.849)	(1.461)	-(1.485)

Note: Single and double asterisks (*) denote significance at the 10% and 5% levels
numbers in parenthesis are standard errors
Crucifers: Broccoli and Cauliflower