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ALLOCATION OF ADVERTISING AND RESEARCH DOLLARS IN THE FLORIDA ORANGE JUICE INDUSTRY

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The Florida citrus industry spends money on both production research and advertising. A significant portion of the money available for these activities comes from self imposed taxes on Florida citrus growers. The largest tax is collected by the Florida Department of Citrus (FDOC) and the largest portion of this money has been used for promotion and advertising. The FDOC also funds post-harvest research, as well as research on mechanical harvesting. Growers also pay a tax specifically for production research. Additionally, State-of-Florida and Federal monies are used to support citrus research through the University of Florida and the USDA.

Advertising by the FDOC focuses on increasing the demand for Florida citrus products, while the State's production research focuses on maintaining and increasing supply (supplying more at a given cost or supplying the same at a lower cost). Florida's major citrus product, orange juice (OJ), is advertised nationally through TV commercials and other media. The FDOC post-harvest research has resulted in various improvements in the processing and fresh packaging sectors, including, for example, the development of frozen concentrated orange juice (FCOJ) in the mid 1940s. Production oriented research conducted by the University of Florida and the USDA has resulted in new fruit varieties, new technologies and improved production practices.

With tens of millions of dollars spent on advertising and research, a question is "what is the best allocation of a given budget to these two alternatives." This has become a particularly important question given the recent threat that two diseases, citrus canker and greening, pose to Florida citrus production. There must be production, of course, to have an industry, which will require a major research effort to fight these diseases, but, on the other hand, there must also be sufficient demand for Florida citrus growers to earn a return that keeps them in business.

Various studies have found that FDOC advertising has had substantial impacts on OJ demand (e.g., FABA; Ward et al; MAP; Brown; and Brown and Lee). A study on post-harvest research in the Florida citrus processing sector also found that this activity had a high rate of return (Stranahan; and Shonkwiler and Stranahan). Studies on the gains from research and promotion for other commodities have also been conducted (e.g., Wohlgenant; Chung and Kaiser; Chyc and Goddard; Cranfield; and Fuglie and Heisley). In this paper, a world OJ model is developed and simulated to examine the OJ advertising-research allocation issue. The focus is on maximization of Florida grower revenue net of the costs of advertising and research.

World Model and Optimal Advertising and Research

The world OJ model developed in this paper is comprised of two demand equations and two supply equations. The first demand equation is for the U.S., given the focus of the study is on how advertising and research impact Florida grower revenue, as well as the fact that the U.S. is the largest OJ market in the world. The second demand equation is for Europe, the second largest market, and other major foreign markets, all of which is referred to as the rest of the world (ROW). On the supply side, Brazil is the largest producer of OJ in the world accounting for over 50% of the world's production, while the U.S. is the second largest producer accounting for about 30% of the world's total. Over the last decade, Florida has accounted for 91% to 98% of the OJ produced in the U.S. Given the dominance of Florida and Brazil, the two supply equations in the model are for Florida and Brazil production (a relatively small amount of other U.S. production is included with Florida production).

The U.S. is treated as a net importer of OJ, while the ROW is a treated as a net exporter, following Spreen, Brewster and Brown (2003) and McClain (1989). The import-export equilibrium is determined by an excess-demand, excess-supply relationship. Formally, the model is specified as

(1) $q_1 = b_{10} + b_{11}(p + c) + b_{12}\log(A)$ (U.S. OJ demand)

(2) $q_2 = b_{20} + b_{21}(p-t)$ (ROW OJ demand)

(3) $s_1 = c_{10} + c_{11}(p - m_{10} - m_{11}\log(R))$ (Florida OJ supply)

(4) $s_2 = c_{20} + c_{21}(p - m_{20} - m_{21}\log(R) - t)$ (ROW OJ supply)

(5) $q_1 - s_1 = s_2 - q_2$ (Equilibrium)

(6) $\pi = (p - m_{10} - m_{11}\log(R))\, s_1 - A - R$ (Florida net revenue)

where

i) A and R are U.S. advertising and research dollars, respectively;

ii) q_1 and s_1 are the U.S. quantities of OJ demanded and supplied, respectively;

iii) q_2 and s_2 are ROW quantities of OJ demanded and supplied (Brazil), respectively;

iv) p is the Florida FOB price;

v) t is the transfer cost from the ROW to the U.S.(U.S. tariff and transportation costs);

vi) c is the U.S. retail-FOB price margin, i.e., p + c is the U.S. retail price;

vii) m_{10} and m_{20} are fixed FOB-grower price margins for Florida and ROW, respectively;

viii) m_{11} and m_{21} are additional margin parameters associated with the level of research, i.e., $m_{10} + m_{11}\log(R)$ and $m_{20} + m_{21}\log(R)$ are U.S. and ROW grower price margins, respectively, and $(p - m_{10} - m_{11}\log(R))$ and $(p - m_{20} - m_{21}\log(R) - t)$ are the Florida and ROW grower prices, adjusted for research costs, respectively; and

ix) the b's and c's, as well as the m's, are fixed parameters

The parameters b_{11} and b_{21}, the demand slopes with respect to price, are negative; b_{12}, the advertising coefficient, is positive; c_{11} and c_{21}, the supply slopes with respect to price, are positive;

m_{10} and m_{20} are positive; and m_{11} and m_{21} are negative (more research smaller margins). Price p is set such that excess demand in the U.S. (U.S. imports) is equal to excess supply in the ROW (ROW exports).

Advertising in the model is FDOC generic advertising expenditures. It is assumed that this advertising only impacts U.S. demand, with FDOC advertising messages occurring primarily in the U.S. That is, with b_{12} being positive, an increase in advertising A results in an increase in U.S. demand, equation (1).

Research is U.S. research expenditures. It is assumed that the largest impact of this research is on the U.S. grower price margin as intended (m_{11}). In addition, U.S. research is assumed to have spillover effects on the ROW grower price margin (m_{21}). The marginal impacts of research on U.S. and ROW production are $\partial s_1/\partial R = -c_{11}m_{11}/R > 0$ and $\partial s_2/\partial R = -c_{21}m_{21}/R > 0$, respectively.

Advertising and research are specified in terms of logs, and thus have diminishing returns. This specification allows a solution to the revenue maximization problem.

Equation (6) is the objective function and indicates Florida grower revenue net of advertising and research costs. Specifically, the term ($p - m_{10} - m_{11}\log(R)$) is defined as the on-tree price adjusted for research costs. The parameter m_{10} indicates average processing costs, and pick and haul costs, and the term $m_{11}\log(R)$ indicates average production (cultural) costs due to greening as well as canker. This amount is assumed to depend on the level of greening research. The parameter m_{11} is negative---an increase in research reduces the average costs due to greening.

The endogenous variables are p and the left-hand side variables of equations (1) through (4). The exogenous variables are A, R, c and t. The levels of A and R are chosen so as to maximize net revenue.

An increase in advertising A increases demand and price, while an increase in research R increases supply and decreases price. Changes in price, in turn, further impact demand and supply levels. Based on the solution for p from equations (1) through (4) and (5), the impact of advertising on price is[1]

(7) $\partial p/\partial A = (b_{12}/A) / (c_{11} + c_{21} - b_{11} - b_{21})$,

while the impact of research on price is

(8) $\partial p/\partial R = (c_{11}\, m_{11} + c_{21}\, m_{21}) / R / (c_{11} + c_{21} - b_{11} - b_{21})$.

Differentiating equation (6) with respect to A and R, the first order conditions for

[1] Substituting the right hand sides of equations (1) through (4) into equation (5), and solving for price, find the reduced form equation $p = (b_{10} + b_{11}\, c + b_{12} \log(A) + b_{20} - b_{21}t - c_{10} + c_{11}(m_{10} + m_{11} \log(R)) - c_{20} + c_{21}(t + m_{20} + m_{21} \log(R)))/(c_{11}+c_{21}-b_{11}-b_{21})$.

maximization of net revenue are[2]

(9) $\partial\pi/\partial A = \partial p/\partial A \ (s_1 + c_{11}(p - m_{10} - m_{11}\log(R))) - 1 = 0,$

and

(10) $\partial\pi/\partial R = (\partial p/\partial R - m_{11}/R)(s_1 + c_{11}(p - m_{10} - m_{11}\log(R))) - 1 = 0.$

The ratio of optimal advertising to research expenditures can be found by equating equations (9) and (10) and solving for A/R, using equation (7) and (8), i.e.,[3]

(11) $A/R = b_{12} / ((c_{11} m_{11} + c_{21} m_{21}) - m_{11}(c_{11} + c_{21} - b_{11} - b_{21})).$

The first term on the right-hand side of equation (9), $\partial p/\partial A \ (s_1 + c_{11}(p - m_{10} - m_{11}\log(R)))$, is the marginal revenue with respect to advertising, which is positive given the impact of advertising on price, $\partial p/\partial A$, is positive, along with the other parameter assumptions and the condition that the net price term, $(p - m_{10} - m_{11}\log(R))$, is positive. The second term, -1, is the negative of the marginal cost of advertising. Advertising expenditures are increased until marginal revenue of advertising equals the marginal cost.

In equation (10), the first term on the right hand side is the marginal revenue of research. This term can be decomposed into two parts. The first part is $(\partial p/\partial R)(s_1 + c_{11}(p - m_{10} - m_{11}\log(R)))$, which is always negative, given the impact of research on price, $\partial p/\partial R$, is negative, along with the other parameter assumptions. The second part of the marginal revenue of research, $(-m_{11}/R)(s_1 + c_{11}(p - m_{10} - m_{11}\log(R)))$, is positive given research reduces or negatively impacts the margin ($m_{11} < 0$). At the optimal level of research the second part must exceed the first part (in absolute value) for marginal revenue to be positive, and, as in the case of advertising, research expenditures are increased to the point where the marginal revenue of research equals the marginal cost or one dollar.

The model is solved for given values for the parameters. A critical issue is that prior estimates on the impacts of greening research on the Florida and ROW price margins (m_{11} and m_{21})

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[2] The second order conditions are $\partial^2\pi/\partial A\partial A < 0$; $\partial^2\pi/\partial R\partial R < 0$; and $(\partial^2\pi/\partial A\partial A)(\partial^2\pi/\partial R\partial R) - (\partial^2\pi/\partial A\partial R)^2 > 0$. In the empirical analysis these conditions were met.

[3] The sequence of results for this solution using basic algebraic operations are

i) $\partial p/\partial A \ (s_1 + c_{11}(p - m_{10} - m_{11}\log(R))) - 1 = (\partial p/\partial R - m_{11}/R)(s_1 + c_{11}(p - m_{10} - m_{11}\log(R))) - 1,$
ii) $\partial p/\partial A = (\partial p/\partial R - m_{11}/R),$
iii) $A/R = ((\partial p/\partial A)A) / ((\partial p/\partial R - m_{11}/R)R)$
iv) $A/R = b_{12} / (c_{11} + c_{21} - b_{11} - b_{21}) / ((c_{11} m_{11} + c_{21} m_{21}) / (c_{11} + c_{21} - b_{11} - b_{21}) - m_{11}),$
v) $A/R = b_{12} / ((c_{11} m_{11} + c_{21} m_{21}) - m_{11}(c_{11} + c_{21} - b_{11} - b_{21})).$

Equations (7) and (8) are used to find result iv) from iii).

are not available, with greening being a new disease to Florida and no cure for this disease having been found in other citrus producing regions. The approach taken here is to assume a given level of research expenditures will reduce the average cost of greening and canker to a negligible level. This assumption is then used to set m_{11} and m_{12}, or the curvature of the price-margin responses. Unless by chance, the optimal research-expenditure level, based on this setting of the model, will not be the same as the initial level assumed and will be significantly different in some cases, as the empirical results indicate. Nevertheless, the assumption on research expenditures has a strong influence on the optimal level found and thus results in some circularity. To examine this issue, alternative assumptions on the level of research expenditures are considered.

Given the research assumptions made here, the model solutions for advertising expenditures are conditional. That is, the optimal level of advertising needed to support grower returns is conditional on the research assumption. Thus, the results of this study do not indicate the optimal level of research, but to what extent advertising is required to support grower returns in an environment where substantial greening research is needed.

Turning to the other parameters, the values of the demand slopes b_{11} and b_{21} are based on U.S. and ROW demand elasticities reported by Brown, Spreen and Lee. Initially, U.S. and ROW demand levels were set at 1,300 and 1,850 million single strength (SSE) gallons, respectively; price p was set at $1.50 per SSE gallon; and the retail-FOB price margin c was set at $3.75 per SSE gallon. The slope b_{11} is the U.S. retail demand elasticity (-.70) times U.S. gallons divided by the U.S. retail price, while the slope b_{21} is the ROW FOB demand elasticity (-.34) times ROW gallons divided by the FOB price.[4] The parameter b_{12} was set based on advertising elasticities, $(\partial q_1/\partial A)(A/q_1)$, estimated by FABA and MAP. A range of advertising elasticities were considered--.08, .25 and .42. The initial value of advertising was set at $30 million. The elasticity $(\partial q_1/\partial A)(A/q_1)$ times the initial value for q_1 yields $(\partial q_1/\partial A)A$, which is treated as an approximation of the gallons demanded due to advertising; this, in turn, is divided by log(A) to obtain b_{12}. The intercepts b_{10} and b_{20} are determined as the residuals, based on the initial values.

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[4] The magnitudes of the supply and demand shifts due to research and advertising, along with the elasticities of supply and demand with respect to price are basic factors that determine revenue. For a linear relationship between quantity demanded and price, the maximum revenue occurs at the point where the elasticity of demand is unity. If demand is elastic (the elasticity of demand is greater than unity in absolute value), an increase in quantity increases revenue; if demand is inelastic (the elasticity of demand is less than unity in absolute value), an increase in quantity decreases revenue. When demand is fixed and supply increases, the supply-demand equilibrium moves along the demand curve, and revenue increases (decreases) over the elastic (inelastic) portion of the demand curve. Thus, research that shifts the supply curve outward would only increase revenue when demand is elastic. Given many agricultural commodities operate where demand is inelastic, such research would lower revenue.

On the other hand, when the supply curve is fixed with a non-negative slope, and demand increases (the supply-demand equilibrium moves along the supply curve), revenue will always increase. The percentage change in revenue is the percentage change in price plus the percentage change in quantity, both of which will depend on the elasticity of supply.

When there are multiple markets and suppliers, behaving competitively, as assumed in the present study, the revenue situation for a particular supplier becomes more complicated, but the supply and demand elasticities across markets and suppliers continue to be important factors. Maximum revenue for a supplier may occur where the individual market demand curves are inelastic.

The supply slopes with respect to price are based on long-run supply elasticity estimates of .25 for Florida and .50 for the ROW. These values are based on the model underlying the FDOC report "Florida Citrus Production Trends, 2007-08 through 2016-17." The U.S. (ROW) long-run supply elasticity times the supply level s_1 (s_2), divided by the grower price ($p-m_{10}$ or $p-m_{20}-t$) , yields c_{11} (c_{21}). Initial values for s_1 and s_2 were 1,050 and 2,100 million single strength (SSE) gallons, respectively (1,000 gallons for Florida and 50 gallons for the rest of the U.S.).

The model thus reflects long-run responses for given levels of advertising and research sustained over time.

The margins m_{11} and m_{21} are based on estimates of additional production costs due to citrus greening and canker made by Muraro. Two estimates were considered---greening and canker increase average production costs by $.25 and $.50 per SSE gallon. These additional costs (Δc) were divided by the log of an assumed research level to obtain the parameters m_{11}. That is, given R, the parameter m_{11} is approximated by $-\Delta c/\log(R)$. For example, when $\Delta c = -.25$ and R=$1 million, the minimum research level assumed to occur, the term $m_{11} \log(1) = 0$; when R=$30 million, $m_{11} \log(30) = -.25$, i.e., to approximate the curvature of the price margin response to research, $1 million spent on research per year will not reduce the average cost of greening, but $30 million (sustained over time) will reduce the cost by $.25/gallon. The parameter m_{21} was assumed to be 75% the level of m_{11}, assuming spillover effects are only partial.

Assuming the cost of greening is $.25/gallon (.50/gallon), the margins m_{10} and m_{20} were set at $.85 ($1.10) per SSE gallon and $.60 ($.85) per SSE gallon, respectively, to reflect processing, and pick and haul costs (industry estimates). The U.S. tariff (FCOJ) was set at $.30 per SSE gallons and transportation costs were set at $.10 per SSE gallon.

As alluded to earlier, it is unknown how much research will be needed to overcome greening and the degree that research can save trees and increase productivity; one can only speculate. In this study, three baseline levels of research expenditures (R) are considered---$30 million, $45 million, and $60 million per year. The baseline research expenditure levels are assumed for the scenarios where the average greening/canker cost is $.25/gallon. When the average greening/canker cost is $.50/gallon, assumed research expenditures are doubled. Associated price-margin, research elasticities are m_{11}/m_1, where m_{11} is calculated as discussed above assuming a research expenditure level, and $m_1 = m_{10} + m_{11}\log(R)$ or the U.S. FOB-grower price margin; i.e., $m_{11} = \partial m_1/\partial \log(R) = (\partial m_1/\partial R)R$, and thus the elasticity of this margin with respect to research is $\partial m_1/\partial \log(R)/m_1$ or m_{11}/m_1. Note that the absolute value of this elasticity varies inversely with the assumed level of R underlying it. The margin elasticity evaluated at the initial, without-research margin level ($.85/gallon or $1.10/gallon) is used to define a scenario.

Eighteen scenarios were considered based on the three advertising elasticity levels, three research levels or implied research elasticity levels mentioned above, and the two greening/canker cost assumptions.

In summary, less is know about how the supply price margin might response to a given level of research expenditures, than how demand responses to a given level of advertising expenditures. Thus, importantly, the model provides a better indication of optimal advertising expenditures associated with an assumed research level, rather than predicting the optimal research level.

Results

Optimal advertising and research expenditures for the various scenarios are shown in Table 1. Relatively large amounts of advertising are needed to optimize grower revenue, except for the low-advertising elasticity scenarios. For the mid and high advertising elasticity assumptions along with the assumption that greening and canker costs are $.25 per SSE gallon (scenarios 4 through 9), advertising expenditures are greater than research expenditures, although research expenditures are relatively large. For the low advertising elasticity assumptions (scenarios 1-3), research expenditures exceed advertising expenditures.[5]

The model solutions when the average cost of greening and canker is increased to $.50 per SSE gallon along with associated parameter settings (scenarios 10-18), indicate lower levels of advertising expenditures and higher levels of research expenditures. Although relatively high, advertising expenditures are less than research expenditure for these scenarios.

As mentioned earlier, since less is known about how the supply-price margin might respond to research expenditures, than how demand might respond to advertising expenditures, the optimal levels of research should be treated with caution. What the model indicates is that significant advertising expenditures are needed to optimize grower returns for the research assumptions made.

Price (FOB) ranges from $1.52 to $1.67 per SSE gallon. U.S. supply recovers, ranging from 1,058 million to 1,126 million SSE gallons; while the ROW supply recovers somewhat less based on the assumption that the spillover of research is not full, ranging from 1,935 million to 2,166 million SSE gallons. U.S. consumption ranges from 1,240 million to 1,439 million SSE gallons (the effects

[5] The optimal advertising levels in Table 1 under the assumptions that the advertising elasticity is .08 (MAP estimate) and the cost of greening and canker is $.25 per SSE gallon, are roughly around $14 million, which may differ from expectations that optimal advertising should be higher for the MAP assumption. There are several possible explanations for this difference. First, the curvature assumption related to diminishing returns to advertising likely differs between this study and the MAP study (the MAP advertising response is embedded in a proprietary stock variable and cannot be determined explicitly). Second, initial values of the various parameters may be influencing the results. Third, in the current study, advertising is modeled in a world setting, as opposed to the U.S. retail market setting in which the MAP study was made. Fourth and related to the previous two points, the current study examines long-run effects as opposed to shorter-run effects implied by the MAP study (e.g., there are no long-run supply responses in the MAP study). To clarify, given U.S. demand under the .08 advertising elasticity assumption and the short-run assumption that price is fixed at $1.60 per SSE gallon at the FOB level or $1.00 at the on-tree level, optimal advertising would be determined from the first order condition $\partial\pi/\partial A = p\ \partial q/\partial A - 1 = 0$, or, based on equation (1), $p\ b_{12}/A - 1 = 0$, or $A = p\ b_{12}$ where is $b_{12} = 30.6$ based on the initial setting, or evaluating this result at the FOB level, A = ($1.60) (30.6) = $49.0 million or at the grower level, A = ($1.00) (30.6) = $30.6 million. Thus, in this case, the short-run estimate of the optimal level of advertising is significantly larger than the comparable long-run estimate. Moreover, this example indicates that the level in the marketing chain, at which the optimal level of advertising is based, may dramatically influence the results---at the retail price level, an even higher optimal advertising level would occur for this short-run example.

of higher prices are offset by various degrees by the effects of higher optimal advertising). ROW consumption ranges from 1,779 million to 1,840 million SSE gallons at the higher prices projected.

The ratio of advertising to research expenditures based on equation (11) are shown in Table 2.[6] This table illustrates how the ratio changes for different assumptions on the levels of research expenditures and greening/canker costs.

Summary

In this study, an OJ model was developed to examine the optimal advertising-research mix to maximize Florida grower revenue net of the costs of these activities. The model is based on assumed coefficients reflecting the impacts of prices, advertising and research. The effects of prices on demand and supply, as well as the effect of advertising on demand, were set based on findings of prior studies. The effect of research on supply is less certain, and a range of research effects was considered. A range of advertising effects was also considered given the study's focus. The model solutions for the various advertising and research assumptions considered indicate that optimal advertising expenditures are significant.

Finally, it should be noted that the findings of this study do not indicate how much research is needed. The model solutions for optimal research expenditures, although substantial, are closely related to the assumed research-elasticity levels or, equivalently, the research expenditures assumed to be needed to overcome greening and canker. The study simply indicates that, to maximize grower revenue for the assumptions made, significant advertising expenditures should accompany research.

[6] Some model parameters underlying the results in Table 2 have a different setting than in Table 1.

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Table 1. Optimal Advertising and Research Solutions Based on Alternative Elasticity and Cost Assumptions.

Scenario	Assumed Value			Optimal Value							
	Cost of Greening[1]	Advert. Elasticity	Research Elasticity	Advert.	Research	FOB Price	Fl Grower Price[2]	U.S. OJ Sales	ROW OJ Sales	U.S. OJ Prod.	ROW OJ Prod.
	$/ga.	%Δq/ %ΔA	%Δm/ %ΔR	mil. $	mil. $	$/ga.	$/box	mil. ga.	mil. ga.	mil. ga.	mil. ga.
1	0.25	0.08	-0.09	14.3	38.4	1.52	6.03	1273	1840	1067	2047
2	0.25	0.08	-0.08	14.2	34.0	1.55	5.94	1269	1830	1061	2038
3	0.25	0.08	-0.07	14.1	31.5	1.56	5.89	1267	1825	1058	2033
4	0.25	0.25	-0.09	45.2	38.8	1.54	6.16	1332	1832	1075	2089
5	0.25	0.25	-0.08	44.8	34.4	1.57	6.07	1327	1822	1070	2080
6	0.25	0.25	-0.07	44.6	31.9	1.58	6.02	1324	1817	1066	2075
7	0.25	0.42	-0.09	77.4	39.6	1.58	6.39	1439	1817	1090	2166
8	0.25	0.42	-0.08	76.8	35.1	1.60	6.31	1433	1807	1084	2156
9	0.25	0.42	-0.07	76.5	32.5	1.61	6.26	1430	1802	1081	2151
10	0.50	0.08	-0.11	9.9	64.9	1.58	6.36	1252	1815	1111	1956
11	0.50	0.08	-0.10	9.8	58.3	1.62	6.24	1244	1798	1100	1943
12	0.50	0.08	-0.09	9.7	54.3	1.65	6.18	1240	1788	1093	1935
13	0.50	0.25	-0.11	31.1	65.2	1.59	6.40	1288	1812	1116	1984
14	0.50	0.25	-0.10	30.7	58.6	1.63	6.29	1280	1795	1104	1971
15	0.50	0.25	-0.09	30.4	54.6	1.65	6.22	1275	1785	1097	1963
16	0.50	0.42	-0.11	52.8	66.0	1.60	6.51	1373	1806	1126	2052
17	0.50	0.42	-0.10	52.1	59.3	1.65	6.39	1364	1789	1115	2038
18	0.50	0.42	-0.09	51.7	55.3	1.67	6.32	1358	1779	1108	2030

[1] The increase in the average Florida production cost related to greening and canker (Muraro).
[2] On-tree price: the FOB price minus the Florida grower margin times 6.4 SSE gallons per box, i.e., $(p - m_{10} - m_{11} \log(R))*6.4$.

Table 2. Ratio of Optimal Advertising-to-Research Expenditures, Based on Alternative Assumed Parameter Values.[1]

Assumed Research Expend. (R)	Cost of Greening/Canker	Ratio of Advertising/Research Expenditures: A/R		
		Advertising Elasticity		
mil. $	$/ga.	0.08	0.25	0.42
10	0.25	0.25	0.79	1.32
20	0.25	0.33	1.02	1.72
30	0.25	0.37	1.16	1.95
40	0.25	0.40	1.26	2.12
50	0.25	0.43	1.34	2.25
60	0.25	0.45	1.40	2.35
70	0.25	0.46	1.45	2.44
80	0.25	0.48	1.50	2.52
90	0.25	0.49	1.54	2.59
100	0.25	0.50	1.57	2.65
10	0.50	0.13	0.39	0.66
20	0.50	0.16	0.51	0.86
30	0.50	0.19	0.58	0.98
40	0.50	0.20	0.63	1.06
50	0.50	0.21	0.67	1.12
60	0.50	0.22	0.70	1.18
70	0.50	0.23	0.73	1.22
80	0.50	0.24	0.75	1.26
90	0.50	0.25	0.77	1.29
100	0.50	0.25	0.79	1.32

[1] Price margin parameters are dependent on assumed research expenditures, and cost of greening and canker; the advertising parameter is based on the advertising elasticity; other parameters are fixed, at slightly different settings than in Table 1.