An Economic Analysis of Domestic Market Impacts of the U.S. Highbush Blueberry Council

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The U.S. Highbush Blueberry Council (USHBC) is a national research and promotion program that began operation in October of 2001. The program uses a variety of promotion techniques in an attempt to increase the demand (sales) for blueberries. In the domestic market, these activities range from technical assistance and promotion to food service, public relations, and a small amount of magazine advertising.

The USHBC is authorized under the Commodity Promotion, Research, and Information Act of 1996 and was approved in the spring of 2000 by a majority (67.8%) of producers and importers in a special referendum. Under the program, domestic blueberry producers and importers are assessed at a rate of $12.00 per ton, and the collected revenue is used to fund promotion, research, and information projects. The total budget for the program has recently been about $3 million annually, with the bulk of money going domestic promotions (in 2009, $1.7 million was spent on domestic and export blueberry promotion).

Since the 1996 Farm Bill, all federal checkoff promotion programs must be evaluated so that their return to investors can be determined. Accordingly, the purpose of this research is twofold: (1) to determine the domestic market impacts of the USHBC's promotion programs, and (2) to compute a benefit-cost ratio (rate-of-return) for the promotion activities conducted by the USHBC. In this study, the impacts of the export marketing activities conducted by the USHBC are not evaluated, since the bulk of the Council's marketing budget is invested in the United States, e.g., in 2009, 89.5% of the promotion budget was allocated to domestic promotion. Specifically, this research examines whether the domestic blueberry promotion activities of the USHBC have had a positive and statistically significant impact on domestic shipments of blueberries and on grower profits. The impacts of all factors affecting domestic blueberry demand for which data are available are measured statistically. In this way, we can net out the impacts of other important factors affecting blueberry demand over time. In addition, the value of the extra sales generated by the USHBC's marketing activities is estimated. These benefits to blueberry growers and processors are compared with the costs associated with the USHBC.

To carry out this independent evaluation, the USHBC contracted with Dr. Harry M. Kaiser (Cornell University) to conduct the economic analysis of the domestic market impacts of its promotion programs. Dr. Kaiser is the Gellert Family Professor of Applied Economics and Management at Cornell University, and director of the National Institute for Commodity Promotion Research and Evaluation (NICPRE). He has extensive experience in conducting economic evaluations of checkoff programs, having worked in this area for 25 years.

The rest of this report is organized as follows. The next section briefly examines consumption (and factors that affect consumption) trends in the U.S. blueberry industry. This is followed by a simple conceptual overview of the potential impacts of generic marketing programs on industry prices, quantities, and profits. The next section describes the economic methodology used in this study to measure the effects of the

USHBC on blueberry demand. Next, the econometric (statistical) estimation results are presented and examined. Then, the econometric results are used in conjunction with a simulation model to simulate market conditions with and without the existence of the USHBC so that the impact (benefit-cost ratio) of its promotion activities can be estimated. The report concludes with a summary and a discussion of the implications of the main findings.

Trends in U.S. Blueberry Consumption

Domestic consumption of blueberries in the United States has generally been increasing since the late 1970s. Figure 1 displays domestic per capita consumption of blueberries from 1970 through 2009. Per capita consumption bottomed out at about 5.1 ounces per person in 1978. However, since then, per capita consumption has been steadily increasing. In 2009, per capita consumption reached its highest level at 31.4 ounces, which represents a 355.1% increase since 1970. What has fueled this tremendous increase in per capita consumption?

One factor that has likely caused growth in consumption of blueberries over this period is that the real (inflation-adjusted) price of blueberries has generally declined. While we did not have access to retail price data for blueberries in this study, it is clear that the real price at the grower level has declined in most years since 1970. Figure 2 shows the average price for fresh and processed blueberries in New Jersey deflated (i.e., expressed in 2009 cents) by the Consumer Price Index for all items (2009 = 1.0) from 1970 through 2009. While there are some significant fluctuations in the real grower price for blueberries over this period, the trend has been downward as reflected by the trend line in Figure 2. In 1970, for example, the average of the price of fresh and frozen blueberries at the grower level was $1.32 per pound (in 2009 dollars); by 2009, this price was $0.98 per pound, which is 25.6% lower in real terms. Consequently, compared with all items in our economy, blueberries have become relatively less expensive, which should have a positive impact on blueberry consumption.

Another factor that may have positively influenced consumption of blueberries is strong growth in U.S. disposable income over this period. Real (inflation-adjusted income) disposable income from 1970 through 2009 is shown in Figure 3. In 1970, per capita income was $19,859 per person, and by 2009 had climbed to $35,659 per person. Growth in real income generally has a positive impact on the demand for most foods. As people's budgets increase, they consume more foods, and fruits and vegetables tend to be more sensitive to change in income than other foods.

Another factor that has likely influenced consumption of blueberries is the price of blueberries relative to the price of other berries. Other berries, such as strawberries are substitutes (i.e., people consume either blueberries or other berries) to blueberries. Figure 4 shows how the average price of New Jersey blueberries (fresh and processed) has varied relative to the average price of strawberries since 1970. In general, the trend has been increasing. For instance, in 1970, the relative price ratio was 1.11 and in 2009 it increased to 1.29, indicating that blueberries have become more expensive over time relative to the price of strawberries. Holding all other demand factors constant, this likely had a negative effect on blueberry consumption since 1970.

Finally, another factor that has likely contributed to growth in per capita consumption of blueberries is the promotion efforts of the USHBC. Figure 5 displays real inflation-adjusted expenditures on generic blueberry promotion since 1970.[1] Since 1970, promotion expenditures have increased significantly. For instance, in 1970 the industry voluntarily contributed $193,800 (measured in 2009 dollars) for generic blueberry promotion. With the implementation of the national blueberry checkoff program, generic promotion of blueberries in domestic markets rose to $515,100 in 2001, and has risen steadily since. In 2009, the annual domestic promotion budget for blueberries was slightly over $1.5 million.

The growth in per capita consumption since 1976 is crucial to the overall health and viability of the U.S blueberry industry. This is evident in Figure 6, which displays real blueberry grower total revenue (in 2009 dollars) from 1970 through 2009. The increase in per capita consumption that has occurred since 1970 has been accompanied by a positive trend in grower revenue. In 1970, total grower revenue was $116.51 million. In 2009, total revenue grew to $591.4 million, an increase of 407.6%. Clearly, it behooves the industry to market blueberries effectively, since growth in consumption is so beneficial to grower revenues. But while this graphical analysis is useful in depicting various trends in factors affecting blueberry consumption over time, it does not tell us anything about how important these factors actually are in influencing consumption. For this, we need to turn to more sophisticated statistical models from a field of economics called econometrics, which is the focus of a later section in this report.

[1] Prior to the creation of the USHBC in 2001, the North American Blueberry Council, a voluntary checkoff program for blueberries, conducted generic promotion activities in the United States.

Conceptual Overview of Economic Evaluation

In an economic evaluation of generic (not brand-specific) marketing programs, three basic questions must be answered. First, does the marketing program result in increased demand? To be effective, the program must produce higher demand in the marketplace. Second, does the program result in a higher price? It is possible for the program to increase market demand but not price, if the increased demand is equally offset by an increase in quantity supplied by growers (domestically and/or internationally). Finally, do the industry-wide benefits exceed the total cost of the marketing program? This is the bottom-line, and most important, effectiveness criterion to the industry funding the program.

To evaluate the economic impacts of marketing programs on quantity, price, and profits, economists use a market supply-demand framework. Obviously, other factors besides price affect market demand (i.e., demand determinants--see economic methodology section for detail), and these factors affect the position of the demand curve. Consequently, all these factors must be accounted for in any quantitative analysis of market demand so that the impact of marketing activities can be accurately isolated.

Price determination in a market is based on the interaction of market demand and supply. The market supply curve measures how quantity supplied in the market responds to increases and decreases in price. The first possibility is that supply is fixed regardless of price level. Such a situation is most likely to happen only in the very short run, when producers do not have time to make adjustments in production in response to a price change. The second possibility is that a positive supply response occurs, reflecting the "law of supply." That is, an increase in price induces producers to increase their use of production inputs, which results in an increase in quantity supplied to the market. The last possibility is the "infinite supply response," in which any increase in demand is equally offset by an increase in quantity supplied. This possibility is more likely in markets that have few barriers to entry or exit by producers.

The goal of generic marketing programs is to increase the market demand for the commodity. If a program is successful in increasing market demand, the resulting market effects of this depend, in large part, on the nature of the supply response. Figure 7 illustrates the case of no supply response. Initial market "equilibrium" without a marketing program occurs where market supply and demand are equal, resulting in a market price and quantity of P1 and Q1, respectively. Suppose that the successful marketing program causes the market demand curve to increase from D1 to D2.[2] This marketing-induced increase in demand means that consumers now place greater value on the commodity, as reflected by the fact that they are willing to pay more for each quantity relative to the previous demand curve. However, since supply is fixed, the only way to bring the market back into equilibrium due to the increase in demand is for the market price to increase from P1 to P2. The benefit to producers from the marketing program is the gain in industry-wide "producer surplus" given by the shaded area in the figure. This gain in producer surplus measures the marketing program's gross benefits to producers and should be compared to total marketing costs to determine the net benefits of the program. Typically, economists will use a benefit-cost ratio to measure the net benefits,

[2] Checkoff programs also have an impact on market supply, one similar to the impact of a tax. The mandatory assessment would therefore cause the supply curve to decrease (i.e., shift back to the left). For simplicity, this shift is not drawn here.

which is equal to the gain in producer surplus divided by the cost of the marketing program.

Figure 8 illustrates a similar case for a positive market supply response. Here the successful marketing program again causes the market demand to increase from D1 to D2. Since supply is no longer fixed, there is now a quantity as well as a price response to the increase in demand. Price increases from P1 to P2 and quantity supplied increases from Q1 to Q2 as a result. The benefit to producers is the gain in producer surplus depicted by the shaded area, which should be compared with the total cost of the marketing program.

The final case of infinite supply response is illustrated in Figure 9. In this case, the increase in market demand due to the marketing program is accompanied by an equal increase in quantity supplied. The net result is that there is no change in price, and therefore no gain in producer surplus. In markets that are characterized by an infinite supply response, it would not be a good investment to increase demand since there are no positive benefits of doing so. An example of this would be a small importing country where most of the market demand is satisfied by imports from other countries.

Economic Methodology

This study quantifies the relationship between the promotion efforts of the USHBC and the domestic demand for blueberries.[3] The export market is ignored, since the focus is solely on the USHBC, which devotes most of its services to the domestic market. The

[3] The empirical measure used for blueberry demand in this research is blueberry commercial disappearance. Hence, throughout the text, the terms “demand” and “commercial disappearance” (or “disappearance”) are used interchangeably.

model is based on the economic theory of consumer demand. In theory, one expects marketing activities to be beneficial to blueberry growers and handlers because they increase blueberry demand, resulting in higher prices and revenues. However, there are also other factors that affect domestic blueberry demand. In order to distinguish the impact of the USHBC's marketing activities on demand for blueberries from the impacts of other factors influencing demand, an econometric framework is adopted.

The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting demand for a commodity. These demand-determining factors (called "determinants") include the price of the commodity, prices of competing commodities, population, consumer income, consumer tastes and preferences, and generic marketing expenditures. By casting the economic evaluation in this type of framework, one can filter out the effect of other factors and, hence, quantify directly the net impact of the USHBC's promotion activities on domestic blueberry demand.

In this study, an econometric demand model is constructed for blueberry commercial disappearance (a measure of demand) in the United States, using national annual data from 1970 through 2009.[4] The econometric model uses statistical methods with this time series data to measure how strongly various blueberry demand factors are correlated with commercial disappearance in the United States. For example, with this approach one can measure how important a change in blueberry price is relative to a change in marketing activity in affecting blueberry disappearance.

[4] All the data are listed in the appendix of this report.

The following factors are included in the initial specification of the econometric model to ascertain the extent, if any, of their impact on blueberry commercial disappearance in the United States. Each factor is tracked annually, so that the degree of correlation, if any, it has with changes in blueberry disappearance over this time period can be computed.

1. Blueberry price. Ideally, one would like to use either retail or wholesale level prices over time to determine the relative magnitude of the price effect on commercial disappearance. Unfortunately, these data were unavailable for this study. As a proxy, we use the New Jersey grower (average fresh and processed) price from the USDA's annual Fruit and Tree Nuts Situation and Outlook Report.[5] Changes in the blueberry price should be negatively associated with blueberry disappearance -- i.e., an increase in price should be associated with a decrease in disappearance. The econometric model and time series data will determine how strong of correlation there is between price and disappearance.

2. USHBC public relations and promotion expenditures in the domestic market. Of course, this is the key factor that will be statistically tested in this study to see whether it has a significant and positive impact on blueberry demand. If it has a positive and statistically significant impact on blueberry commercial disappearance, this means that the promotion activities of the USHBC do have a positive impact on domestic blueberry demand. (The source of data for this variable is the USHBC office). It should be noted that these expenditures do not

[5] The average Michigan fresh and processed blueberry price was also tried in the model, but the results were almost identical to using the New Jersey price. The New Jersey price, however, resulted in a little better statistical fit and was therefore used in the demand model instead of the Michigan price.

include any free publicity that has been gained on the healthfulness of blueberries. Such free publicity was not included in the model due to a lack of availability since it is difficult for the public relations firms to quantify a value for such publicity. Assuming that the free publicity has a significant positive impact on blueberry consumption, omission of it could result in the impact of blueberry promotion being somewhat overstated.

3. Consumption in the previous period. This variable represents habit formation on the part of consumers. Consumption levels last year should be positively correlated with consumption levels in the current year. Hence, consumption lagged one year is included as a explanatory variable in the model.

4. Price of competing fruits. Since these commodities are likely competitors to blueberries, there should be a positive relationship between their price and blueberry disappearance. For example, if the price of strawberries increases (holding all other factors constant), blueberry demand should increase. As with blueberry price, this study uses grower-level (all uses) prices for strawberries, red raspberries, boysenberries, and blackberries for competing fruits. (The source of these prices is the USDA's annual Fruit and Tree Nuts Situation and Outlook Report.)

5. Population in the United States. U.S. Population should have a positive influence on domestic blueberry disappearance. To control for the influence of population growth on blueberry commercial disappearance, we convert total disappearance to a per capita basis by dividing by the U.S. population. Consequently, a per capita

blueberry demand model is estimated. (The source of figures for U.S. population is the Current Population Report.)

6. Consumer income. This should be positively related to blueberry disappearance, i.e., as consumers' disposable income increases, blueberry demand should increase. As with commercial blueberry disappearance, disposable income is converted to a per capita basis by dividing by population. (The source of figures for this variable is the Economic Report of the President.)

To compare the relative importance of each factor on disappearance, the results from the statistical (econometric) model are converted into demand "elasticities." A demand elasticity measures the percentage change in domestic per capita blueberry disappearance given a 1 percent change in a specific demand factor, holding all other factors constant. For example, the computed price elasticity measures the percentage change in domestic per capita blueberry disappearance given a 1% change in price. The computed promotion elasticity measures the percentage change in domestic per capita blueberry disappearance given a 1% change in promotion, and so on. Since demand elasticities are calculated for each demand factor listed above, one can compare them to determine which factors have the largest impact on blueberry demand.

Econometric Results

The estimated blueberry demand equation is reported in Table 1. The equation is specified on a per capita basis, using a logarithmic specification. A convenient feature of the logarithmic specification is that each of the estimated coefficients is the demand elasticity for the variable in question.[6] The equation fits the data well; for instance, the adjusted R-square indicates that 95.5% of the variation in per capita blueberry demand is explained by the demand factors in the demand equation. The equation has elasticity signs that are consistent with economic theory, and the estimated coefficients are all statistically significantly different from zero at conventional significance levels. Hence, the estimated demand model is deemed appropriate for this analysis.

The estimated coefficient on the lagged dependent variable is 0.457 and is statistically significant with a p-value of 0.0005. This coefficient enables the computation of long-run elasticities for the other demand factors. Specifically, the estimated short-run elasticities can be transformed into long run elasticities by multiplying them by:

$$1/(1 - 0.457) = 1.842.$$

In other words, the long run elasticities for all demand factors are 1.842 times larger than the short run elasticities.

The estimated demand equation suggests that the average price of blueberries at the grower level is an important factor in explaining annual variations in per capita blueberry demand. The estimated short run own-price elasticity is –0.250, which implies that a 1% increase in the blueberry growers' price would result in a 0.25% decrease in per capita quantity demanded, holding all other demand determinants constant. (All elasticities are based on mean values for the period 1970-2009.) The estimated coefficient (i.e., elasticity) is statistically different from zero with a p-value of 0.01. The

[6] The Durbin-h statistic reported in the table suggests that the resulting estimated equations are free of serial correlation problems. Several econometric diagnostic tests are conducted on the residuals in the regression and no serial correlation or heteroscedasticity problems are detected.

long run price elasticity is 0.461. This result suggests that while price is an important factor, it is still in the "inelastic" range, meaning that a 1% increase in price leads to a lower-than-1% decrease in quantity demanded. With this result, one could conclude that blueberry consumers are not sensitive to small price changes. Price insensitivity is commonly found in empirical studies of food demand in the United States.

The estimation results indicate that strawberries are a substitute for blueberries. The short run "cross-price elasticity" of per capita blueberry demand with respect to the price of strawberries is estimated to be 0.335, and is statistically significant (p-value is 0.03). That is, a 1% increase in the strawberry (growers') price would result in a 0.335% increase in per capita blueberry demand, holding all other demand determinants constant. The long run elasticity is 0.617. This indicates that blueberries and strawberries are substitute products, since the demand for blueberries is enhanced when the price of strawberries increases. The author reported a similar finding in an earlier evaluation of blueberry promotion based on older data where the cross –price elasticity of per capita blueberry demand with respect to the price of strawberries was estimated to be 0.486.

Real per capita disposable income is found to be the most important factor affecting the demand for blueberries. The estimated income elasticity is 1.476, i.e., holding everything else constant, a 1% increase in real per capita income raised per capita blueberry demand by 1.476%. The long run income elasticity is 2.719. This elasticity is highly statistically significant with a p-value less than 0.0003.

The coefficient associated with generic blueberry promotion is positive and statistically different from zero with a p-value of 0.03. This means that the statistical evidence supports the hypothesis that the USHBC's promotional activities increase demand for blueberries in the United States. The estimated promotion elasticity is 0.109, which means that a 1% increase in USHBC promotion expenditures would result in a 0.109% increase in per capita domestic blueberry demand, holding all other demand determinants constant.[7] The long run promotion elasticity is 0.201. This elasticity is substantially higher than the one estimated several years ago by the author. Based on similar data from 1970-2004, the author estimated a blueberry promotion elasticity of 0.043. The rise in promotion elasticity since 2004 suggests an increase in the effectiveness of the USHBC's promotion campaigns over time.

It should be clear from these empirical results that the promotional efforts of the USHBC have had a positive impact on domestic blueberry sales in the United States. While this is important and useful information, two further important questions remain, namely:

1. What has been the impact of the USHBC's domestic promotion on total domestic blueberry commercial disappearance?
2. How does the gain in grower net revenue from the increased demand due to USHBC domestic promotion compare to the costs of the promotion?

To answer these important questions, one must use the econometric results to construct a simulation model, which is presented next.

Simulation Analysis

[7] Recall that any free publicity on the healthfulness of blueberries was not included in the generic blueberry promotion expenditures. If the free publicity has a positive and significant impact on blueberry consumption, then the omission of it may result in the promotion elasticity being somewhat overstated.

The estimation results above indicate that the USHBC's marketing program has had a positive and statistically significant effect on domestic blueberry demand. To answer these two questions just posed, the estimated demand equation is simulated for two scenarios over the period 2001-2009. The first scenario (USHBC scenario) simulates market conditions (i.e., grower price, commercial disappearance, grower profits) assuming that USHBC promotion programs were in effect 2001-2009. This is a baseline or historical scenario with which to compare the second counterfactual scenario. The second scenario is a "No-USHBC" scenario, where it is assumed that there is no USHBC and generic blueberry promotion expenditures are set equal to the level they were in 2000, which is the year prior to the USHBC coming into existence. In this latter scenario, all demand determinants except USHBC promotion expenditures are set equal to their historic levels. The difference between these two scenarios gives the total impact of the USHBC promotion effort on domestic blueberry disappearance.

Figure 10 displays the simulation results for annual blueberry disappearance in the United States for the two scenarios. It shows clearly the positive impact on domestic blueberry disappearance due to the USHBC's promotion programs. From 2001 to 2009, the USHBC's promotion activities increased total blueberry commercial disappearance by 441 million pounds in total, or 49 million pounds per year. This represents an annual increase in blueberry commercial disappearance of 12.3%. Hence, the promotional spending by the USHBC has clearly had a positive effect on domestic blueberry demand.

While these results indicate a positive impact of USHBC promotion programs on blueberry disappearance, what remains a key concern is the impact promotion has had on industry producer surplus (i.e., profit) compared with promotion costs. The increase in blueberry disappearance due to the USHBC's promotion programs described above assumed that all other demand determinants, including price, would remain constant. However, generally an increase in demand will cause price to increase as well (recall Figures 6 and 7), provided that the demand increase is not perfectly offset by an increase in quantity supplied (as in the "infinite supply response" depicted in Figure 8). Hence, in order to evaluate the full effect of the USHBC's promotion programs on quantity and price, one needs to incorporate the supply response of blueberries into the model. To do this, an estimate of the supply response by blueberry growers is necessary.

Previous econometric studies of fruit commodities have indicated that it is often problematic to obtain a reliable estimate of supply response to price. This is due to the long time lag between plantings and harvest. Consequently, harvest in any particular year is generally a function of yield, which is influenced by weather conditions and is largely unaffected by price. This makes it difficult to statistically determine any positive correlation between fruit production and price. Therefore, an econometric supply model is not developed in this study. Instead, an approach similar to that in previous studies by Alston et al. (1996), Crespi and Sexton, Kaiser, and Schmit and Kaiser is followed. In this approach, the supply response is incorporated using a constant elasticity form, and sensitivity analysis is conducted on a range of assumed own-price supply elasticities.[8]

The simulation procedure begins on the demand side, where predicted quantities of blueberry demand (Q_t^D) are estimated from the estimated demand equation. Then, using a procedure similar to that in Alston et al. (1996), supply is defined in constant

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[8] An "own-price elasticity of supply" measures the percentage change in quantity supplied given a 1% change in the price of the commodity.

elasticity form and equated with the predicted demand quantities. Changes in demand due to USHBC promotion then affect the level of production and the resulting grower price. Specifically, the supply function is defined as:

(1) $Q_t^S = A_t R_t$

where $At = (Q_t^D + CS_t + NX_t)/ R_t^{\varepsilon}$ and

(2) $R_t = P_t - \delta_t$

where R_t is the net grower return per pound in year t, ε is the own-price elasticity of supply, and δ_t is the assessment rate required to finance the USHBC. The change in stocks (CS_t) and net exports (NX_t) are included as exogenous variables to close the model. The defined value, A_t, varies by year and ensures that, given the actual values of prices and other variables, the supply equation passes through the quantity defined by Q_t^D. This makes possible combining of the supply response and estimated demand model to simulate past prices and quantities. To estimate a supply response, an estimate of the own-price elasticity of supply is necessary. Given the lack of previous estimates of own-price elasticity of blueberry supply, ε is varied over a wide range of possible values, from 1.0 to 3.0. Since we are interested in the long-run impacts of promotion, these elasticity values for blueberry supply are all relatively elastic, consistent with longer-run supply adjustments.

Average Benefit-Cost Analysis

Given the simulation procedures described above, the change in net economic benefits due to the USHBC promotion effort is computed for each year from 2001 to 2009 as the difference in producer surplus (ΔPS) between the two scenarios outlined above, which mathematically is equal to the following:

(3) $\Delta PS_t = (R'_t\, Q'_t - R_t\, Q_t)/(1 + \varepsilon)$,

where $R'_tQ'_t$ represents the scenario with the USHBC and R_tQ_t represents the scenario without the USHBC. The average benefit-cost ratio is equal to (3) divided by the costs of the blueberry checkoff program. The average benefit-cost ratio measures the average increase in producer surplus (measured in dollars) given each one dollar investment in USHBC blueberry promotion. For example, a benefit-cost ratio (BCR) of 2.0 would imply that blueberry growers receive $2 in additional net revenue (producer surplus) for every dollar invested in the USHBC. In other words, in this case the benefits would exceed the cost by twofold.

Table 2 presents the average annual impacts and BCRs (from 2001 to 2009) for USHBC promotion efforts for the various assumed own-price elasticities of supply. The USHBC had a positive impact on the blueberry growers' price over this period under all supply response scenarios. The average increase in price ranges from $0.14 per pound, in the case of the most inelastic supply response ($\varepsilon = 1.0$), to $0.05 per pound, in the case of the most elastic supply response ($\varepsilon = 3.0$). The reason the positive price impacts become lower as the assumed supply response gets larger is that under the larger supply response scenarios, producers are dampening the positive price impacts of the increased demand by increasing quantity supplied to the market relative to the lower supply response scenarios. The average impact over all supply responses is $0.084 per pound. In other words, had there not been a mandatory checkoff program, the average growers' price would have been $0.084 per pound, or 7.2%, lower from 2001 to 2009 than it actually was.

USHBC promotion efforts had a positive impact on producer surplus over this period as well. The average increase in producer surplus due to the promotion programs of the USHBC range from $5.4 million per year, in the case of the least elastic supply response (ε = 1.0), to $1.9 million per year, in the case of the most elastic supply response (ε = 3). The reason for the negative relationship between supply elasticities and producer surplus is identical to that described above for supply elasticities and price. The average increase in producer surplus over all supply responses is $3.2 million per year. Hence, it is clear that domestic promotion efforts of the USHBC have had a significant and positive impact on growers' profits since 2001.

How does the gain in producer surplus compare with the costs of the USHBC? As mentioned earlier, this is the most important question because the answer tells us whether the program is profitable. To answer the question, an average benefit-cost ratio is computed (see the bottom row of Table 2). A BCR greater than 1.0 implies that the total benefits of the USHBC exceed the costs. The average BCR for the USHBC exceeded 1.0 for every supply response considered in the simulation. For the least elastic supply response (ε = 1.0), the average BCR is 15.41. This implies that, on average over the period 2001-2009, the benefits of the USHBC promotion programs have been over 15 times greater than the costs. At the opposite end of the spectrum in supply response (ε = 3), the average BCR is computed to be 5.36, implying that the benefits of the USHBC are 5.36 times greater than the costs. Given the wide range of supply responses considered in this analysis, and the fact that the BCR is above 1.0 in all cases, there is significance evidence that the USHBC's promotion programs have been profitable for the domestic blueberry industry.[9] The average BCR over all supply responses is 9.12, i.e., the benefits of the promotion activities of the USHBC exceed the costs by about nine-fold. These

[9] Indeed, the simulation results indicate that it would take an own-price elasticity of supply equal to 15 to drive the average BCR down to 1.0, where benefits and costs are exactly equal. This high an elasticity value is extremely unlikely in the case of blueberry supply.

estimates are all larger than those reported by the author in an earlier blueberry evaluation study. In that study, the average BCR over all supply responses was 7.86. Hence, the USHBC has become more effective over time.

Questions often arise about the accuracy of these BCR estimates in economic evaluations of commodity checkoff programs. BCRs are generally large because promotion expenditures are very small relative product value, and therefore only a small demand effect is needed to generate positive and large returns. For example, average generic blueberry promotion expenditures in 2009 were less than 0.24% of the grower value of blueberry marketings. Still, this relatively small investment in generic blueberry promotion increased producer net revenue by over $3.2 million per year since 2001 (average of all supply elasticities). The resulting benefit-cost ratio is therefore quite large.

How does the average benefit-cost ratio estimated above compare to that for other promotion checkoff programs? Table 3 lists the estimated average benefit-cost ratios for selected food commodities. The BCRs range in value from a low of 1.00 for Canadian generic butter advertising to a high of 30.9 for Florida tomato promotion. The overall average BCR for blueberry promotion of 9.12 is almost identical to the overall average of all BCRs in Table 3 of 9.48.

To make allowances for the error inherent in any statistical estimation, a 90% confidence interval is calculated for the above average BCRs. The confidence interval provides a lower bound for the average BCR: one can be “confident” 90% of the time that the true average BCR lies above this limit. Table 4 presents the lower bound on the BCR for the 90% confidence interval. The estimated lower bound of the average BCR for the lowest assumed supply response for the period 2001-2009 is 3.43. This result demonstrate that one could be confident 90% of the time that the true average BCR for this assumed supply response is not lower than 3.43. The lower 90% confidence bound for the average BCR in the highest assumed supply response for the period 2001-2009 is 1.16. (It is important to remember that the average BCR is above 1.0 for all assumed supply responses.) Hence, it is reasonable to conclude that the above confidence lower bound gives credence to the previous finding that the benefits of the USHBC's promotion programs have been considerably greater than their cost.

Conclusion

The objective of this project was to: (1) determine the domestic market impacts of the USHBC's generic promotion programs, and (2) compute an average benefit-cost ratio for the promotion activities conducted by the USHBC. Specifically, this research examined whether the domestic promotion activities by the USHBC since 2001 had a positive and statistically significant impact on domestic shipments of blueberries and grower profits. The impact of all factors affecting domestic blueberry demand (where data were available) was measured statistically. In this way, the impacts of other important factors affecting domestic demand were accounted for over time.

The empirical blueberry demand model developed in this study used annual time series data for the period 1970-2009. In order to distinguish the impact of the USHBC's generic promotion activities on demand for blueberries from the impacts of other factors influencing demand, an econometric framework was adopted. The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting blueberry demand. These demand-determining factors (called “determinants”) included the price of blueberries, prices of blueberry substitutes, population, consumer tastes and preferences, and the USHBC’s generic promotion expenditures.

The results indicated that generic blueberry promotion has had a positive and statistically significant impact on per capita blueberry demand. This means that statistical evidence supports the hypothesis that the USHBC’s promotion activities increase demand for blueberries in the United States. The estimated generic promotion elasticity was 0.109, which means that a 1% increase in generic blueberry promotion expenditures would result in a 0.109% increase in per capita domestic blueberry demand, as indicated by Table 5 which summarizes all the main quantitative results of this study and compares them with the previous evaluation study conducted in 2005. This elasticity was substantially higher than the one calculated several years ago with similar data (0.043). This elasticity is statistically different from zero and positive.

The estimated demand equation was simulated to determine the market impacts of the USHBC promotion activities for the period 2001-2009. In the baseline scenario, promotion expenditures were set equal to actual levels from 2001 to 2009. In the no-USHBC scenario, promotion expenditures were set equal to their levels from voluntary funding in 2000, which is the year prior to the creation of the USHBC. The difference between the two scenarios gives the total impact of USHBC promotion programs on domestic blueberry commercial disappearance. The simulation results indicate that the USHBC had a major impact on annual blueberry demand in the United States. From 2001 to 2009, the USHBC’s promotion activities increased total blueberry commercial disappearance by 441 million pounds in total, or 49 million pounds per year. This represents an annual increase in blueberry commercial disappearance of 12.3%. Hence, the promotional spending by the USHBC has clearly had a positive effect on domestic blueberry demand.

The results also indicated that generic blueberry promotion by the USHBC had a positive impact on the blueberry growers' price over this period. The average increase in price ranged from 14 cents per pound, in the case of the least elastic supply response, to 5 cents per pound, in the case of the most elastic supply response. The average impact over all supply responses was 8.4 cents per pound. In other words, had there not been generic blueberry promotion by the USHBC, the average growers' price would have been 8.4 cents per pound, or 7.2%, lower from 2001 to 2009 than it actually was.

USHBC promotion efforts had a positive impact on producer surplus (i.e., producer profits) over this period as well. The average increase in producer surplus due to generic blueberry promotion by the USHBC ranged from $5.4 million per year, in the case of the least elastic supply response, to $1.9 million per year, in the case of the most elastic supply response. The average increase in producer surplus over all supply responses was $3.2 million per year. Hence, it is clear that domestic promotion efforts of the USHBC has had a positive impact on growers' profits since 2001.

An average BCR was computed for the generic promotion activities of the USHBC, and the BCR exceeded 1.0 for every supply response considered in the simulation. For the least elastic supply response, the average BCR was 15.41. This implies that, on average over the period 2001-2009, the benefits of the USHBC promotion programs have been over 15 times greater than the costs. At the opposite end of the spectrum in supply response, the average BCR was computed to be 5.36, implying that the benefits of the USHBC were over five times greater than the costs. Given the wide range of supply responses considered in this analysis, and the fact that the BCR was above 1.0 in all cases, there is significant evidence that the USHBC's promotion programs have been profitable for the domestic blueberry industry. The average BCR over all supply responses was 9.12, i.e., the benefits of the promotion activities of the USHBC exceeded the costs by nine-fold.

To make allowances for the error inherent in any statistical estimation, a 90% confidence interval was calculated for the above average BCRs. The confidence interval provides a lower bound for the average BCR that one can be "confident" 90% of the time the true average BCR is not below. The estimated lower bound for the average BCR for the lowest assumed supply response for the period 2001-2009 was 3.43. This result demonstrates that one could be confident 90% of the time that the true average BCR for this assumed supply response is not lower than 3.43. The lower 90% confidence bound for the average BCR in the highest assumed supply response for the period 2001-2009 was 1.16. (It is important to remember that the average BCR was above 1.0 for all assumed supply responses.) Hence, it is reasonable to conclude that the above confidence intervals give credence to the previous finding that the benefits of the USHBC's promotion programs have been considerably greater than their cost.

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Table 1. Estimated elasticities for the domestic per capita blueberry demand equation.

Demand determinant	**Elasticity***	**t-value**
Consumption in previous year	0.457	3.61
New Jersey grower average price	-0.250	-2.43
Strawberry grower price	0.335	1.89
Per capita income	1.476	3.73
USHBC promotion expenditures	0.109	1.95
Durbin-h statistic:	0.26	
Adjusted R-squared:	0.955**	

* Elasticity measures the percentage change in domestic per capita blueberry demand given a 1% change in any demand determinant, holding constant all other determinants.

** The adjusted R-square indicates that the estimated demand equation explains 95.5% of the variation in domestic per capita blueberry demand.

Table 2. Average annual market impacts and average benefit-cost ratios due to USHBC's promotion programs, 2001-2009.

	--------------- Own-price elasticity of supply -------				
Item	1.0	1.5	2.0	2.5	3.0
Change in grower price ($/lb)	0.14	0.10	0.07	0.06	0.05
Change in producer surplus (mil $)	5.431	3.697	2.802	2.256	1.888
Average benefit-cost ratio	15.41	10.49	7.95	6.40	5.36

Table 3. Estimated average benefit-cost ratios for generic advertising and promotion programs for various food commodities.

Commodity	Study	Benefit-Cost Ratio
U.S. dairy advertising	Kaiser (1997)	3.4
U.S. beef advertising	Ward (1998)	4.9-6.7
U.S. cotton promotion	Nichols et al. (1997)	3.2-3.5
U.S. pork advertising	Davis et al. (2001)	4.8-26.2
U.S. red meat export promotion To Pacific Rim (excluding Japan)	Le, Kaiser, and Tomek (1998)	15.62
Hawaii papaya promotion	Ferguson, Nakamoto&Sawada (2001)	0.1 to 31.2
U.S. soybean export promotion & production research	Williams et al. (1998)	8.3
Canadian butter advertising	Goddard and Amuah (1989)	1.0
FL orange juice advertising	Capps et al. (2003)	2.9-6.1
FL tomato promotion	Van Sickle and Evans (2001)	27.2-30.9
Pecan export promotion (Asia)	Onunkwo and Epperson (2000)	6.45
CA walnut export promotion	Weiss, Green, & Havenner (1996)	6.75 (EU) 6.0
Washington apple advertising	Ward and Forker (1991)	7.0
Walnut domestic promotion	Kaiser (2002)	1.65-9.72
Raisin export promotion	Kaiser, Liu, and Consignado (2003)	7.32
Pistachio marketing order (domestic producers)	Alston et al. (2004)	13.5 6.9 (US) 6.7 (world)
Table grape export promotion	Alston et al. (1996)	8.0
Average		9.48
Standard deviation		8.93

Table 4. Lower bound 90% confidence interval for benefit-cost ratio due to USHBC's blueberry promotion programs, 2001-2009.

	------------ Own-price elasticity of supply ---------				
Item	1.0	1.5	2.0	2.5	3.0
Benefit-cost ratio (lower bound)	3.43	2.30	1.73	1.39	1.16

Table 5. Summary of quantitative findings and comparison with the 2005 results.

	2005	2009
Generic promotion elasticity	0.043	0.109
Increased commercial disappearance (%)	2.8%	12.3%
Increased grower price (cents/lb)	1.4	8.4
Increased profit million $/year	$2.76	$3.20
Average BCR	7.86	9.12
BCR at 90% lower confidence bound	2.18	3.43

Appendix Table. Data for blueberry demand econometric model, 1970-2009.

Year	U.S. per capita blueberry consumption	NJ fresh blueberry grower price	NJ processed blueberry grower price	Per capita income	Consumer price index	Blueberry domestic promotion	U.S. population
	ounces	2009 $/lb	2009 $/lb	2009 $	2009=1	2009 $	mil
1970	6.9	0.27	0.21	19,859	0.181	193,769	205.1
1971	7.1	0.29	0.23	20,475	0.189	159,116	207.7
1972	5.6	0.36	0.32	21,278	0.195	163,417	209.9
1973	7.4	0.37	0.33	22,336	0.207	160,621	211.9
1974	7.3	0.41	0.27	21,828	0.230	200,864	213.9
1975	6.8	0.42	0.24	21,949	0.250	161,704	216.0
1976	6.4	0.46	0.39	22,538	0.265	161,831	218.0
1977	5.1	0.56	0.55	23,093	0.282	132,823	220.2
1978	5.1	0.75	0.64	23,785	0.304	146,497	222.6
1979	6.8	0.64	0.45	23,556	0.338	147,825	225.1
1980	6.6	0.69	0.35	22,983	0.384	153,688	227.7
1981	6.9	0.71	0.47	23,060	0.423	153,248	230.0
1982	7.0	0.76	0.59	23,193	0.450	160,815	232.2
1983	7.9	0.82	0.70	23,992	0.464	219,814	234.3
1984	8.6	0.69	0.35	25,447	0.484	502,209	236.4
1985	9.5	0.80	0.42	26,006	0.501	378,018	238.5
1986	9.5	0.84	0.49	26,729	0.511	512,126	240.7
1987	9.3	0.90	0.52	26,912	0.529	362,965	242.8
1988	9.9	1.10	0.82	27,762	0.551	353,625	245.0
1989	10.2	0.93	0.50	28,150	0.578	414,918	247.3
1990	11.4	0.90	0.52	28,142	0.609	347,993	250.1
1991	9.3	0.84	0.65	27,753	0.635	465,689	253.5
1992	12.3	1.04	0.83	28,295	0.654	431,885	256.9
1993	13.5	0.87	0.55	28,030	0.673	501,030	260.3
1994	13.0	0.86	0.49	28,328	0.690	311,970	263.4
1995	14.9	0.88	0.45	28,556	0.710	260,987	266.6
1996	11.8	1.00	0.91	28,847	0.731	339,615	269.7
1997	13.2	1.02	0.95	29,324	0.748	226,540	273.0
1998	13.8	0.87	0.50	30,482	0.760	327,706	276.2
1999	15.4	1.02	0.73	30,869	0.776	312,060	279.3
2000	15.7	1.15	0.85	31,766	0.803	344,011	282.2
2001	16.8	1.09	0.64	31,825	0.825	515,146	285.0
2002	17.4	1.17	0.70	32,402	0.838	507,008	288.2
2003	17.5	1.20	0.87	32,696	0.858	784,552	291.1
2004	20.0	1.21	0.95	33,546	0.880	799,637	293.9
2005	20.1	1.31	1.02	33,553	0.910	952,053	296.7
2006	22.4	1.64	1.51	35,252	0.940	1,008,091	299.4
2007	22.7	1.70	1.58	35,696	0.966	1,306,699	301.5
2008	27.8	1.48	1.07	35,324	1.004	1,390,614	304.8
2009	31.4	1.34	0.62	35,659	1.000	1,506,059	307.5