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 organization that began operation in October of 2001. The USHBC uses a variety of promotion techniques to increase the demand (sales) for blueberries. In the domestic market these activities include health research, technical assistance and promotion to food service and food manufacturers, consumer public relations, advertising, and promotion

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 original program, domestic blueberry producers and importers were assessed at a rate of $12.00 per ton, and the collected revenue was used to fund promotion, research, and information projects. However, in October 2012, the USHBC unanimously agreed to increase the assessment rate to $18 per ton "to more aggressively promote highbush blueberries and take advantage of the growing scientific knowledge of the healthfulness of our product." In 2014, approximately $2.7 million in USHBC funds was spent on domestic blueberry promotion and $630,000 in USHBC funds spent on 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 2014, 75% of the promotion budget (including USHBC and USDA MAP funding) 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 Professor Harry M. Kaiser of 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 Cornell Commodity Promotion Research Program. Dr. Kaiser has extensive experience in conducting economic evaluation studies of domestic and international checkoff programs. Dr. Kaiser has written 135 refereed journal articles, five books, 17 book chapters, over 150 research bulletins, and received $8 million in research grants in the area of agricultural marketing with an emphasis on promotion programs. He has conducted over 120 economic evaluation studies of domestic and international checkoff programs in the United States, Canada, and Europe on such commodities as fluid milk, cheese, butter, salmon, red meat, pork, raisins, walnuts, blueberries, potatoes, beef, peanuts, wheat, watermelons, high-valued-agricultural commodities, and bulk agricultural commodities. In 2005, Kaiser was the lead author of a book on all commodity checkoff programs in California.

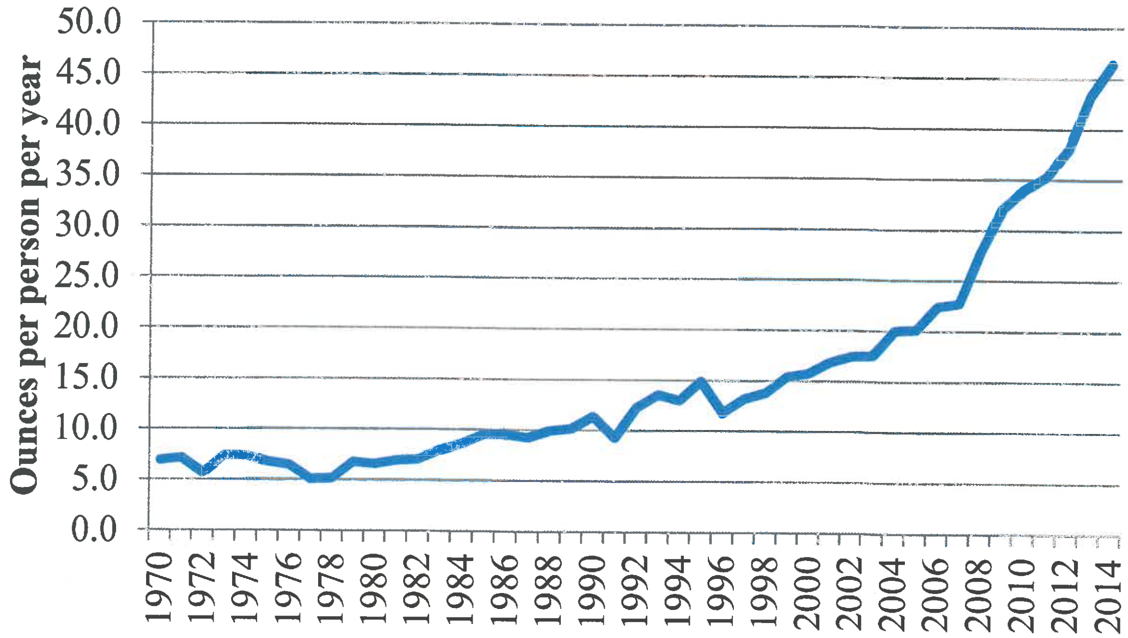
The rest of this report is organized as follows. The next section briefly examines consumption (and factors that affect consumption) trends in the U.S. blueberry industry. This is followed by a simple conceptual overview of the potential impacts of generic marketing programs on industry prices, quantities,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

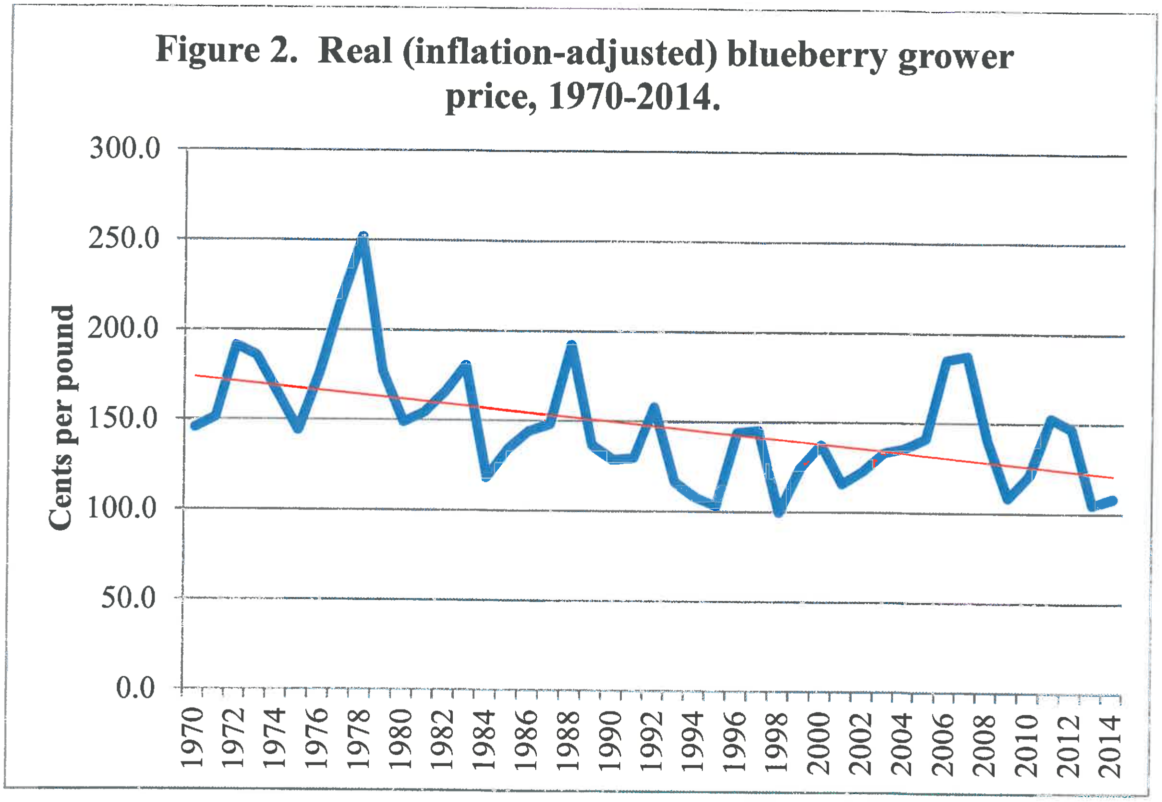
Trends in U.S. Blueberry Consumption

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 2014. 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 2014, per capita consumption reached its highest level at 46.4 ounces, which represents a 572.7% 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 2014 cents) by the Consumer

Figure 1. Per capita blueberry consumption in the United States, 1970-2014.



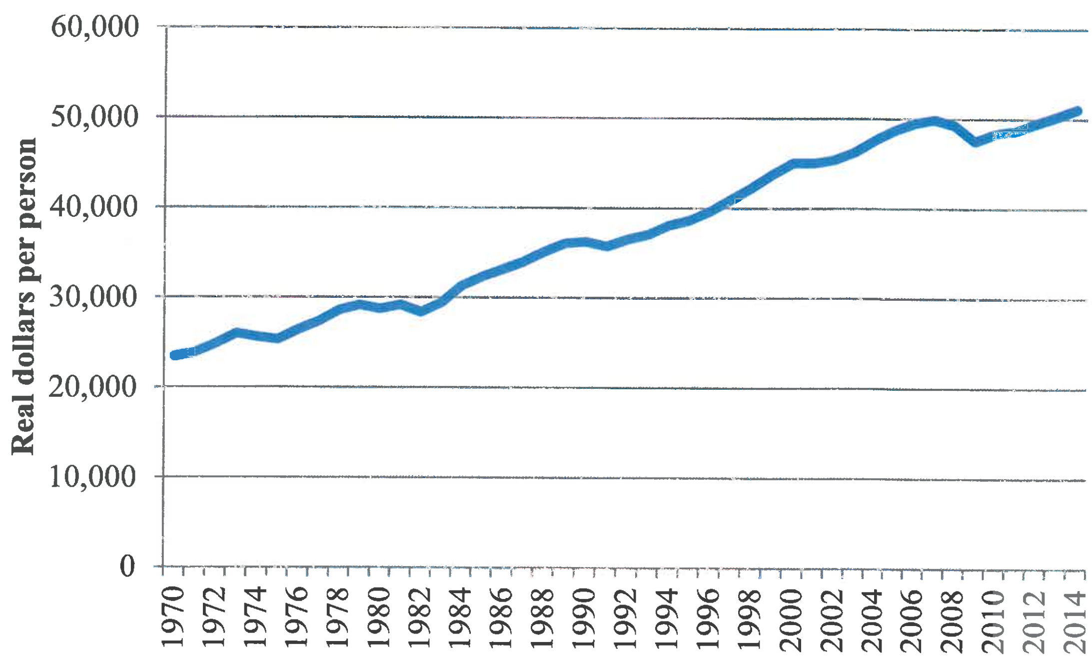


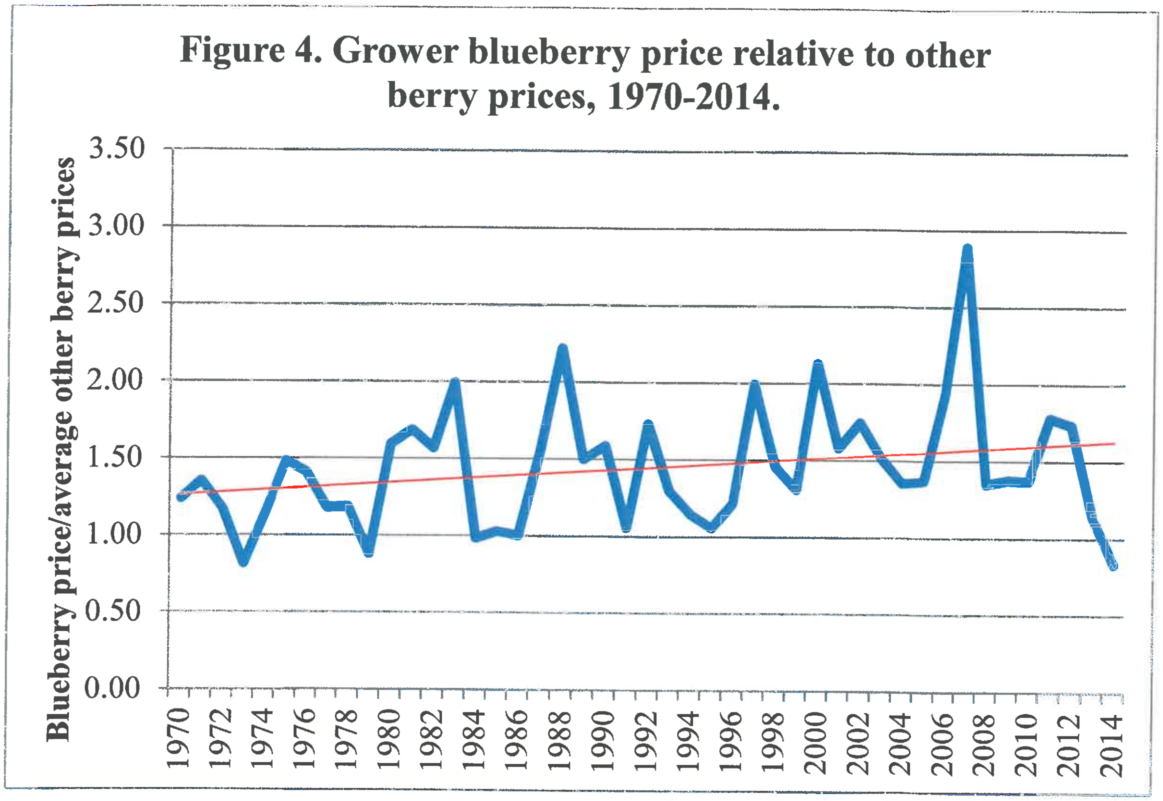
Price Index for all items (2014 = 1.0) from 1970 through 2014. While there are some significant fluctuations in the real grower price for blueberries over this period, the trend has been downward as reflected by the trend line in Figure 2. In 1970, for example, the average of the price of fresh and frozen blueberries at the grower level was $1.45 per pound (in 2014 dollars); by 2014, this price was $1.08 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 2014 is shown in Figure 3. In 1970, per capita income was $23,342 per person, and by 2014 had climbed to more than double that at $51,056 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, raspberries, boysenberries, and blackberries since 1970. In general, the trend has been increasing as indicated by the trend line in this graph. For instance, in 1970, the relative price ratio was 1.24 and in 2011 and 2012 it increased to 1.78 and 1.73 before falling below 1.0 in 2014, indicating that blueberries have become more expensive over time

Figure 3. Real (inflation adjusted) per capita income in United States, 1970-2014.





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 $214,000 (measured in 2014 dollars) for generic blueberry promotion. With the implementation of the national blueberry checkoff program, generic promotion of blueberries in domestic markets rose to $568,000 in 2001, and has risen steadily since. In 2014, the annual domestic promotion budget for blueberries was almost $2.8 million.

[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.

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 (inflation-adjusted) blueberry grower total revenue (in 2014 dollars) from 1970 through 2014. 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 almost $128 million in 2014 dollars. In 2014, total revenue grew to $1 billion, an increase of 681.7%. 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.

Figure 5. Real (inflation adjusted) expenditures on generic blueberry promotion, 1970-2014.

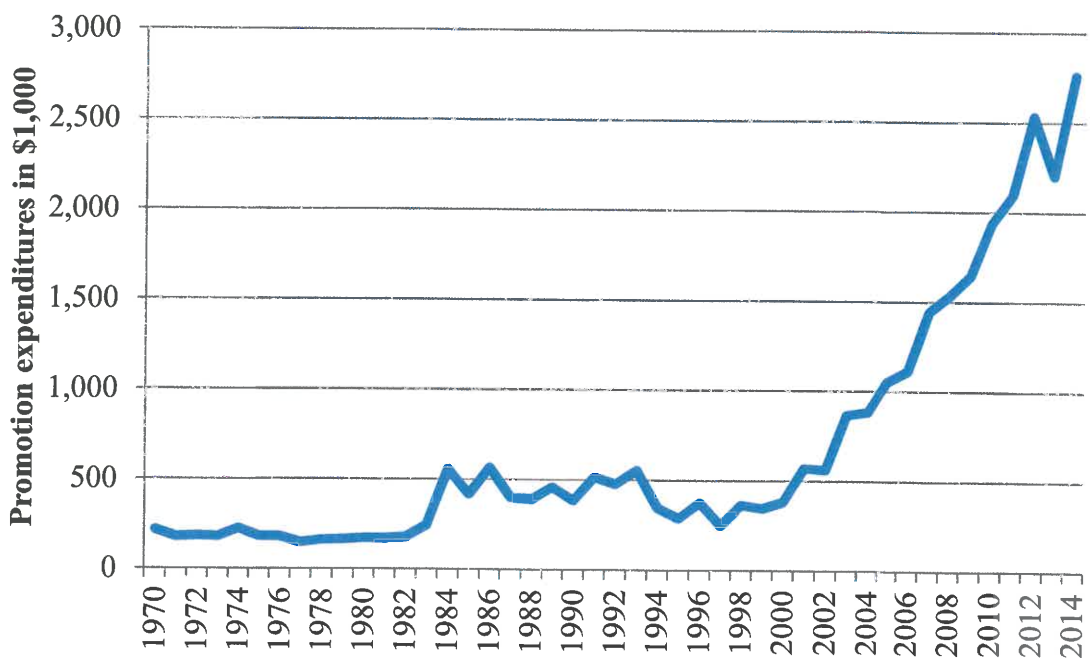
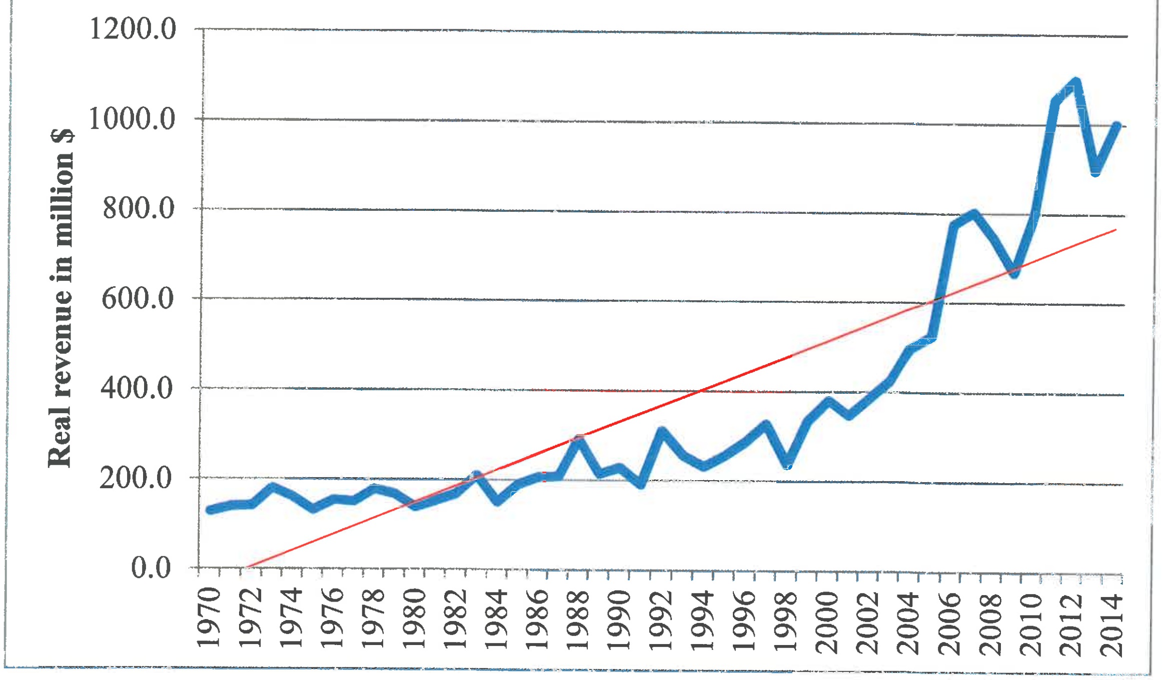


Figure 6. Real (inflation-adjusted) total revenue of blueberry growers in the United States, 1970-2014.



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

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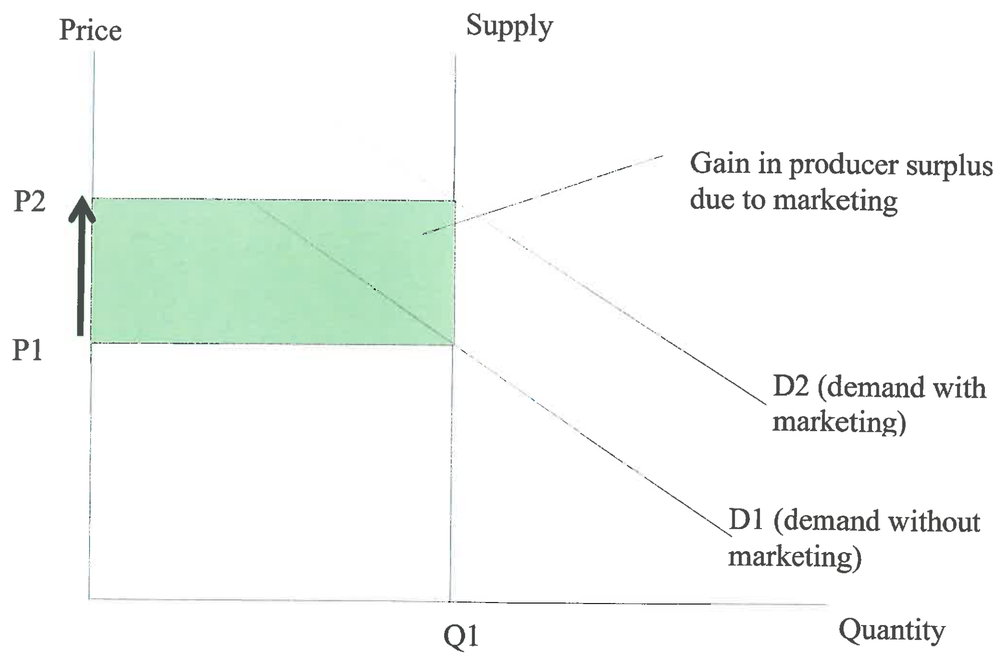
[2] Checkoff programs also have an impact on market supply, one similar to the impact of a tax. The mandatory assessment would therefore cause the supply curve to decrease (i.e., shift back to the left). For simplicity, this shift is not drawn here.

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, which is equal to the gain in producer surplus (or some other measure of profitability) 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.

Figure 7. Impact of marketing when there is no supply response



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

Figure 8. Impact of marketing when there is positive supply response

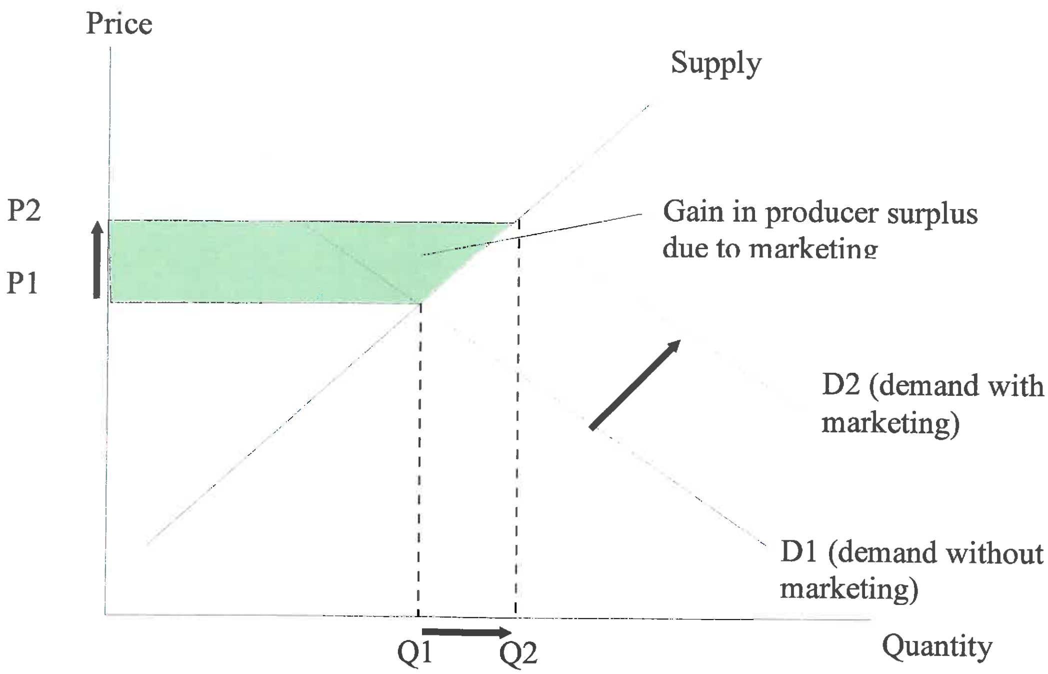
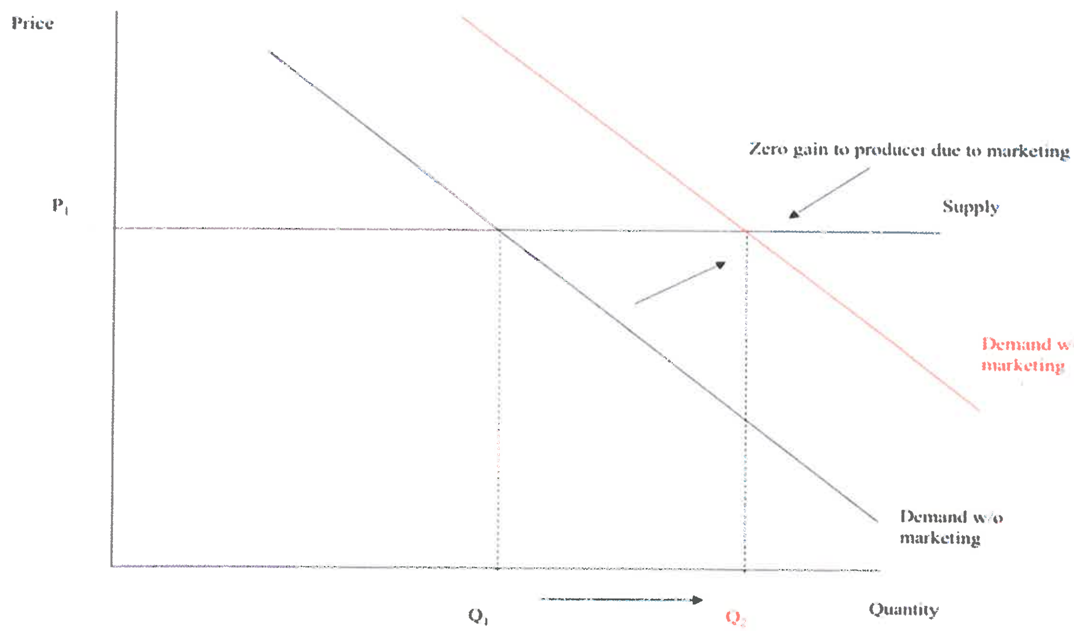


Figure 9. Impact of marketing when there is infinite positive supply response



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 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, 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 2014.[4] The econometric model uses statistical methods with this time series data to

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[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.

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

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.

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 commercial 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

[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.

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 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 an 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 the grower-level price for strawberries as a proxy 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 over 97% 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 the 1% significance level or better. Hence, the estimated demand model is deemed appropriate for this analysis.

The estimated coefficient on the lagged dependent variable is 0.635. 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:

$$1/(1 - 0.635) = 2.74.$$

In other words, the long run elasticities for all demand factors are 2.74 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 –0.205, which implies that a 1% increase in the blueberry growers' price would result in a 0.205% decrease in per capita quantity demanded, holding all other demand determinants constant. (All elasticities are based on mean values for the period 1970-2014.) The long run price elasticity is 0.562. 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

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

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.

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

Demand determinant	**Elasticity***	**t-value**
Consumption in previous year	0.635	7.21
New Jersey grower average price	-0.205	-2.57
Strawberry grower price	0.382	2.70
Per capita income	0.733	3.34
USHBC promotion expenditures	0.129	3.39
Durbin-h statistic:	0.474	
Adjusted R-squared:	0.976**	

* 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 97.6% of the variation in domestic per capita blueberry demand.

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 0.382. That is, a 1% increase in the strawberry (growers') price would result in a 0.382% increase in per capita blueberry demand, holding all other demand determinants constant. The long run elasticity is 1.047. This indicates that blueberries and strawberries are substitute products, since the demand for blueberries is enhanced when the price of strawberries increases.

Real per capita disposable income is found to be the most important factor affecting the demand for blueberries. The estimated income elasticity is 0.733, i.e., holding everything else constant, a 1% increase in real per capita income raised per capita blueberry demand by 0.733%. The long run income elasticity is 2.008.

The coefficient associated with generic blueberry promotion is positive and statistically different from zero. 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 0.129, which means that a 1% increase in USHBC promotion expenditures would result in a 0.129% increase in per capita domestic blueberry demand, holding all other demand determinants constant.[7] The long run promotion elasticity is 0.353. This elasticity is higher than the one estimated several years ago by the author. Based on similar data from 1970-2009, the author estimated a blueberry promotion elasticity of 0.109, and in 2004 the author estimated it to be 0.043. The significant rise in the promotion elasticity since 2004 suggests an increase in the effectiveness of the USHBC's promotion campaigns over time. This increase may also be due to the significant increase in the USHBC's promotion budget since 2004.

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?

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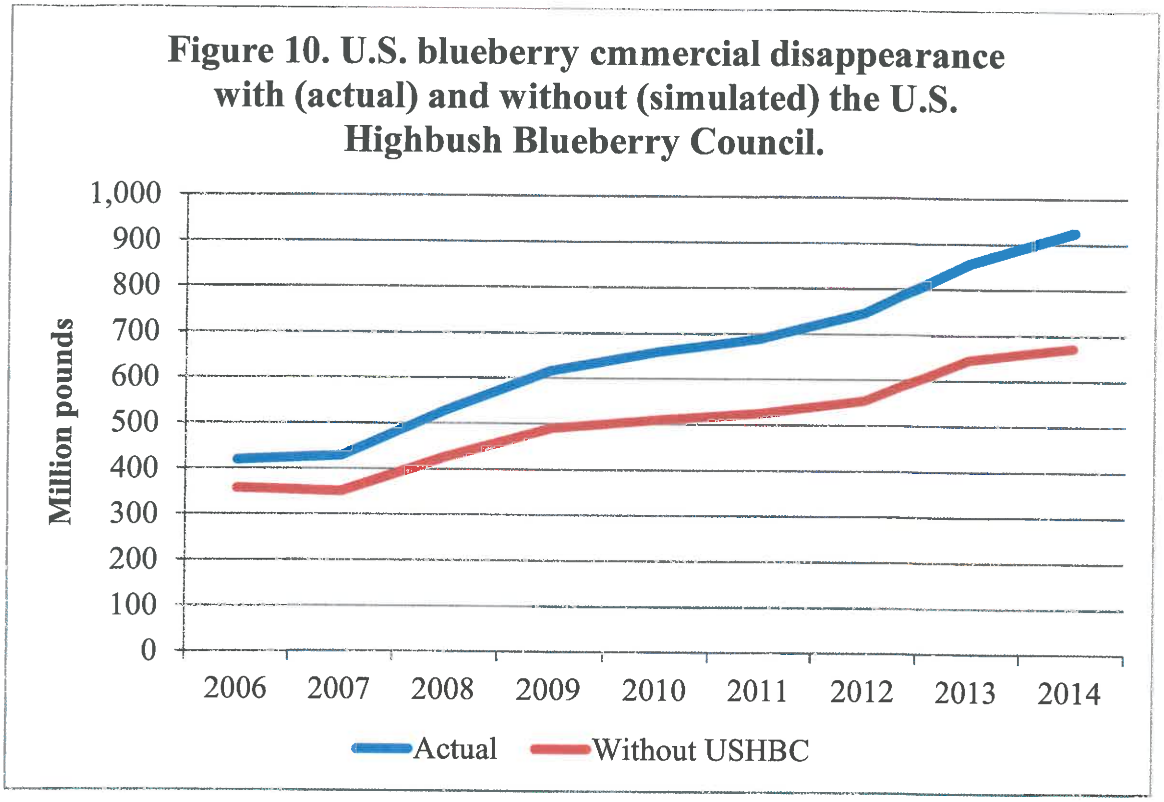
[7] Recall that any free publicity on the healthfulness of blueberries was not included in the generic blueberry promotion expenditures. If the free publicity has a positive and significant impact on blueberry consumption, then the omission of it may result in the promotion elasticity being somewhat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

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

Simulation Analysis

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 the two questions just posed, the estimated demand equation is simulated for two scenarios over the period 2006-2014. The first scenario (USHBC scenario) simulates market conditions (i.e., grower price, commercial disappearance, grower profits) assuming that USHBC promotion programs were in effect 2006-2014. 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 ($276,100), 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 2006 to 2014, the USHBC's promotion activities increased total blueberry commercial disappearance by 1,342 million pounds in total, or 149 million pounds per year. This represents an annual average increase in blueberry commercial disappearance of 22.9%. 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 profitability 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 7 and 8), provided that the demand increase is not perfectly offset by an increase in quantity supplied (as in the "infinite supply response" depicted in Figure 9). 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 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

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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.

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.

Marginal 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 2006 to 2014 as the difference in grower net revenue between the following two scenarios: (1) historic or baseline scenario with USHBC promotion expenditures set to actual levels, and (2) "marginal" scenario where USHBC promotion expenditures are 1% lower than the actual expenditures. The difference between these two scenarios provides a measure of the marginal impact of the USHBC promotion spending, i.e., how the last dollar spent impacts the market.

The change in net revenue is computed as follows:

(3) $\Delta NR_t = (P_tQ_t - P_t'Q_t')M_t$,

where P_tQ_t represents total revenue (price times quantity sold) to blueberry growers for the baseline scenario with 100% USHBC promotion expenditures, $P_t'Q_t'$ represents total revenue to blueberry growers for the scenario with USHBC promotion expenditures reduced by 1%, and M_t

represents a net margin factor for blueberry growers which translates total revenue into net revenue (net of costs). It was assumed that the net margin factor was equal to 10%, which is based on a 2011 study by Julian, Strik, and Yang (2011), who estimated economic costs and returns to blueberry growers in Oregon.[9]

Table 2 presents the average annual marginal impacts and benefit-cost ratios (BCRs) (from 2006 to 2014) 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 0.17 cents per pound, in the case of the most inelastic supply response ($\varepsilon = 1.0$), to 0.06 cents per pound, in the case of the most elastic supply response ($\varepsilon = 3.0$). That is, a 1% increase in USHBC promotion causes grower prices to increase by between 0.06 and 0.17 cents per pound. 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 0.098 cents per pound. In other words, if USHBC promotion were increased by 1%, the average growers' price would increase by 0.098 cents per pound.

USHBC promotion efforts had a positive impact on grower net revenue over this period as well. The average increase in producer net revenue due to a 1% increase in promotion spending by the USHBC range from $207,200 per year, in the case of the least elastic supply

[9] Specifically, Julian, Strik, and Yang (2011) estimated alternative net revenues based on various yields and prices received by blueberry farmers in Willamette Valley, Oregon. Based on a fresh price of $1.30 per pound, which is close to the 2014 fresh price for New Jersey, and an average yield of 16,000 pounds per acre, the estimated annual per acre returns over total economic costs is $2,186 per acre or $0.137 per pound. Based on this type of farm, the net margin factor would be 10.5%, i.e., 0.137/1.30. So in the analysis that follows, the net margin was set equal to 10%.

response (ε = 1.0), to $138,200 per year, in the case of the most elastic supply response (ε = 3). The reason for the negative relationship between supply elasticities and producer net revenue is identical to that described above for supply elasticities and price. The average increase in grower net revenue due to a 1% increase in promotion spending over all supply responses is $163,740 per year. Hence, it is clear that domestic promotion efforts of the USHBC have had a significant and positive impact on growers' profits since 2006.

Table 2. Marginal market impacts and benefit-cost ratios due to USHBC's promotion programs, 2006-2014.

	--------------- Own-price elasticity of supply -------				
Item	1.0	1.5	2.0	2.5	3.0
Change in grower price (cents/lb)	0.17	0.11	0.08	0.07	0.06
Change in net revenue (1,000 $)	207.2	172.7	155.5	145.1	138.2
Marginal benefit-cost ratio	11.48	9.57	8.62	8.04	7.66

How does the gain in grower net revenue 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, a marginal BCR 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 marginal 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 marginal BCR is 11.48. This implies that, on average over the period 2006-2014, the marginal benefits of the USHBC promotion programs have been over 11 times greater than the marginal costs. In other words, if the USHBC had an extra dollar to spend on promotion, it would return $11.48 in net revenue to blueberry growers. At the opposite end of the spectrum in supply response (ε = 3), the marginal

BCR is computed to be 7.66, implying that the marginal benefits of the USHBC are 7.66 times greater than the marginal 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. The average marginal BCR over all supply responses is 9.07, i.e., the marginal benefits of the promotion activities of the USHBC exceed the marginal costs by about eight-fold.

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 1.7 for California avocados to a high of 44.9 for California table grapes promotion. The overall marginal BCR for blueberry promotion of 9.07 is significantly higher than the overall median of all BCRs in Table 3 (6.3).

To make allowances for the error inherent in any statistical estimation, a 90% confidence interval is calculated for the above marginal BCRs. The confidence interval provides a lower bound for the marginal BCR: one can be "confident" 90% of the time that the true marginal 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 marginal BCR for the lowest assumed supply response for the period 2006-2014 is 2.51. This result demonstrate that one could be confident 90% of the time that the true marginal BCR for this assumed supply response is not lower than 2.51. The lower 90% confidence bound for the marginal BCR in the highest assumed supply response for the period 2006-2014 is 1.68. (It is important to remember that the marginal 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.

Table 3. Estimated benefit-cost ratios for selected commodities.

Author(s)		Average Benefit/ Cost Ratio	Marginal Benefit/ Cost Ratio
Alston et al. (1997)	California Table Grapes	44.9	38.8
Alston et al. (1998)	California Dried Plums	NA	2.7
Crespi and Sexton (2005)	California Almonds	NA	6.2
Carter et al. (2005)	California Strawberries	NA	44.0
Schmit et al (1997)	California Eggs	NA	6.9
Carman and Craft (1998)	California Avocados	5.0	1.7
Williams et al. (2004)	Florida Orange Juice	2.9-7.0	NA
Kaiser (1997)	All Dairy Products	3.4	NA
Schmit and Kaiser (2004)	Fluid Milk	NA	NA
Ward (1996)	Beef	5.7	5.7-9.7
Davis et al (2000)	Pork	NA	16.0
Kaiser and Schmit (1998)	Eggs	NA	.54-6.33
Kaiser (2005)	Blueberries	4.46-13.22	NA
Murray et al. (2001)	Cotton	3.2-6.0	NA
Kaiser (2005)	Walnuts	1.65 - 9.72	NA
Kaiser et al. (2003)	Raisins	5.1-15.3	.42-3.19
Ward (2008)	Honey	6.02-7.91	NA
Capps and Williams (2008)	Lamb	NA	44.5
Ward (2008)	Watermelons	10.6	NA
Richards and Patterson (2007)	Potatoes	6.5	NA
Williams (1999)	Soybeans	1.7-7.9	NA
Median		6.0	6.3

Table 4. Lower bound 95% confidence interval for marginal benefit-cost ratio due to USHBC's blueberry promotion programs, 2006-2014.

	------------ Own-price elasticity of supply ---------				
Item	1.0	1.5	2.0	2.5	3.0
Marginal benefit-cost ratio (lower bound)	2.51	2.09	1.88	1.76	1.68

Similar economic evaluations of the USHBC were done in 2004 and 2009. Table 5 provides a comparison of the 2004, 2009, and 2015 findings for key results. Since its inception, the USHBC's promotion effectiveness has increased. For example, the estimated promotion elasticity in 2004 was 0.043, which rose significantly to 0.109 in 2009, and then increased again in 2015 to 0.129. Relatedly, the incremental increase in commercial disappearance attributed to the USHBC has consistently risen over time. The 2004 study found that the USHBC increased commercial disappearance by 2.8% in its first years of operation. This figure subsequently increased to 12.3% in 2009 and 22.9% in the current 2015 study. Hence, it is clear that the positive impacts of the USHBC on blueberry demand have increased over time. This is likely due to gains in efficiency by the USHBC management and the increase in the marketing budget over time.

Table 5 also reports on the price, profit, and BCR findings from the three studies, however, it must be noted that while the 2004 and 2009 findings are directly comparable, the 2015 study is not directly comparable. The last four rows of Table 5 for the 2004 and 2009 studies measure the overall impact of the USHBC, i.e., the market impacts of having the USHBC vs. not having the USHBC. For the 2015 study, these rows report the "marginal" impacts of the USHBC, i.e., the market impact of a 1% change in USHBC promotion. Regardless, it is clear that the impacts of the USHBC on grower prices, profits, and BCRs are also increasing over time. For example, the BCR increased from 7.86 in 2004 to 9.12 in 2009. In 2015, the marginal BCR is estimated at 9.07, but had the same procedures as the 2004 and 2009 reports been followed, the 2015 BCR would have been higher than the two previous reports.

Conclusion

The objectives of this project were to: (1) determine the domestic market impacts of the USHBC's generic promotion programs, and (2) compute a marginal 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.

Table 5. Comparison of findings of USHBC economic evaluations in 2004, 2009, and 2015.

Item	2004	2009	2015
Promotion elasticity	0.043	0.109	0.129
Increase in commercial disappearance	2.8%	12.3%	22.9%
Increase in grower price (cents/pound)	1.38	8.4	0.098*
Increase in grower profit (mil $)	2.76	3.22	0.17*
BCR	7.86	9.12	9.07*
BCR lower bound of confidence interval	2.18	2.00	1.99*

*Not directly comparable to 2004 and 2009 study since this is a "marginal impact" not an "average impact." A marginal impact measures how the variable changes based on a 1% change in promotion expenditures. An average impact measures how the variable changes based on a comparison of having vs. not having the promotion program.

The empirical blueberry demand model developed in this study used annual time series data for the period 1970-2014. 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 0.129, which means that a 1% increase in generic blueberry promotion expenditures would result in a 0.129% increase in per capita domestic blueberry demand. This elasticity was substantially higher than the one calculated in 2005 (0.043) and is also higher than the one computed in 2009 (0.109)

The estimated demand equation was simulated to determine the market impacts of the USHBC promotion activities for the period 2006-2014. In the baseline scenario, promotion expenditures were set equal to actual levels from 2006 to 2014. In the no-USHBC scenario, promotion expenditures were set equal to their levels from voluntary funding in 2000 ($276,100 in 2014 dollars), 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 2006 to 2014, the USHBC's promotion activities increased total blueberry commercial disappearance by 1,342 million pounds in total, or 149 million pounds per year. This represents an annual increase in blueberry commercial disappearance of 22.9%. 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 marginal increase in price ranged from 0.17 cents per pound, in the case of the least elastic supply response, to 0.06 cents per pound, in the case of the most elastic supply response. The average marginal impact over all supply responses was 0.098 cents per pound. In other words, a 1% increase in generic blueberry promotion by the USHBC increases the grower price by 0.098 cents per pound.

USHBC promotion efforts had a positive impact on blueberry grower net revenue over this period as well. The average increase in net revenue due to a 1% increase in generic blueberry promotion by the USHBC ranged from $207,200 per year, in the case of the least elastic supply response, to $138,200 per year, in the case of the most elastic supply response, in the case of the most elastic supply response. The average increase in producer net revenue over all supply responses was $163,740 per year. Hence, it is clear that domestic promotion efforts of the USHBC had a positive impact on growers' profits.

A marginal 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. A marginal BCR measure how an extra dollar would increase net revenue to blueberry growers. For the least elastic supply response, the BCR was 11.48. This implies that, on average over the period 2006-2014, an extra dollar spent on USHBC promotion programs returned over 11 times its costs in incremental net revenue to blueberry growers. At the opposite end of the spectrum in supply response, the average BCR was computed to be 7.67, implying that the benefits of the USHBC were over six 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 marginal BCR over all supply responses was 9.07, i.e., the benefits of the promotion activities of the USHBC exceeded the costs by eight-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 of the marginal BCR for the lowest assumed supply response for the period 2006-2014 is 2.51. This result demonstrate that one could be confident 90% of the time that the true marginal BCR for this assumed supply response is not lower than 2.51. The lower 90% confidence bound for the marginal BCR in the highest assumed supply response for the period 2006-2014 is 1.68. (It is important to remember that the marginal 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.

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Appendix Table. Data for blueberry demand econometric model, 1970-2014.

Year	Per capita blueberry consumption ounces	NJ fresh blueberry grower price 2014 $/lb	NJ processed blueberry grower price 2014 $/lb	Real Gross Domestic Product 2014 mil $	Consumer price index 2014=1	Blueberry domestic promotion 2014 1,000 $	US population mil
1970	6.9	0.27	0.21	4779.66	0.164	35.0	204.0
1971	7.1	0.29	0.23	4937.16	0.171	30.0	206.8
1972	5.6	0.36	0.32	5196.99	0.176	31.8	209.3
1973	7.4	0.37	0.33	5490.33	0.187	33.2	211.4
1974	7.3	0.41	0.27	5461.89	0.208	46.1	213.3
1975	6.8	0.42	0.24	5451.16	0.227	40.5	215.5
1976	6.4	0.46	0.39	5744.70	0.240	42.9	217.6
1977	5.1	0.56	0.55	6009.49	0.256	37.5	219.8
1978	5.1	0.75	0.64	6343.72	0.275	44.5	222.1
1979	6.8	0.64	0.45	6545.15	0.307	50.0	224.6
1980	6.6	0.69	0.35	6529.16	0.348	59.0	227.2
1981	6.9	0.71	0.47	6698.50	0.384	64.9	229.5
1982	7.0	0.76	0.59	6570.56	0.407	72.3	231.7
1983	7.9	0.82	0.70	6874.93	0.420	102.0	233.8
1984	8.6	0.69	0.35	7373.95	0.439	243.1	235.8
1985	9.5	0.80	0.42	7686.52	0.454	189.5	237.9
1986	9.5	0.84	0.49	7956.48	0.463	261.5	240.1
1987	9.3	0.90	0.52	8231.90	0.480	192.1	242.3
1988	9.9	1.10	0.82	8577.97	0.499	194.9	244.5
1989	10.2	0.93	0.50	8893.68	0.524	239.7	246.8
1990	11.4	0.90	0.52	9064.34	0.552	211.9	250.2
1991	9.3	0.84	0.65	9057.66	0.575	295.5	253.5
1992	12.3	1.04	0.83	9379.75	0.592	282.3	256.9
1993	13.5	0.87	0.55	9637.25	0.610	337.3	260.3
1994	13.0	0.86	0.49	10026.34	0.626	215.4	263.5
1995	14.9	0.88	0.45	10299.03	0.644	185.4	266.6
1996	11.8	1.00	0.91	10689.95	0.663	248.3	269.7
1997	13.2	1.02	0.95	11169.64	0.678	169.5	273.0
1998	13.8	0.87	0.50	11666.63	0.689	249.0	276.2
1999	15.4	1.02	0.73	12213.22	0.704	242.3	279.3
2000	15.7	1.15	0.85	12713.05	0.727	276.1	282.4
2001	16.8	1.09	0.64	12837.05	0.748	425.2	285.2
2002	17.4	1.17	0.70	13066.42	0.760	425.1	288.0
2003	17.5	1.20	0.87	13433.14	0.777	672.8	290.6
2004	20.0	1.21	0.95	13941.67	0.798	704.0	293.3
2005	20.1	1.31	1.02	14408.00	0.825	866.7	296.0
2006	22.4	1.64	1.51	14792.23	0.851	947.2	298.8
2007	22.7	1.70	1.58	15055.31	0.876	1,262.9	301.7
2008	27.8	1.48	1.07	15011.48	0.909	1,395.6	304.5

2009	32.1	1.34	0.62	14594.75	0.906	1,488.0	307.2
2010	34.0	1.34	0.89	14964.31	0.921	1,782.0	309.8
2011	35.3	1.60	1.30	15204.00	0.949	1,986.0	312.0
2012	38.0	1.64	1.21	15556.86	0.970	2,454.0	314.2
2013	43.3	1.22	0.84	15902.12	0.984	2,165.0	316.5
2014	46.4	1.28	0.88	16271.05	1.000	2,760.0	318.7