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

by

Harry M. Kaiser
Cornell University

April 8, 2025

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

Harry M. Kaiser
Cornell University

Executive Summary

This research study had two central objectives:

1. To measure the domestic market impacts of the U.S. Highbush Blueberry Council's (USHBC) promotion programs. Specifically, to determine whether the USHBC's promotion activities increased the demand for blueberries in the United States compared to what would have occurred in the absence of these activities.

2. To measure the benefits of the USHBC promotion activities in terms of incremental profitability for the entire industry and compare these benefits with the cost of the checkoff to compute a return on investment (ROI) to its stakeholders.

To address these two objectives, an econometric model of the domestic blueberry demand was constructed, which enabled us to net out the impacts of other important factors besides USHBC promotion affecting blueberry demand such as blueberry price, price of other berries, consumer income, and blueberry demand in the previous year.

The main highlights of the study include the following results:

- Generic promotion by the USHBC was a significant demand driver on domestic blueberry demand. Specifically, in the short-run (i.e., within one year), a 1% increase in USHBC promotion was found to increase per capita blueberry demand by 0.14%, holding constant all other demand drivers. In the longer-run (i.e., more than one year), a 1% increase in USHBC promotion was found to increase per capita blueberry demand by almost 0.3%, holding constant all other demand drivers.

- The USHBC had a positive and significant impact on total blueberry demand in the United States compared to what it would have been in its absence. Had there not been any domestic USHBC promotion activities over the latest 5-year period, 2019 through 2023, total domestic blueberry consumption would have been 14% (or 191 million pounds per year) lower than it actually was.

- The ROI for the USHBC was 19.29 which implies that, on average over the period 2019-2023, each dollar invested in USHBC promotion programs returned $19.29 in net revenue to blueberry growers.

- The lower bound of the 95% confidence interval on the ROI was 7.16, which means that one could be confident 95% of the time that the true ROI was not lower than 7.16.

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

Harry M. Kaiser
Cornell University

Introduction

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 2023, $7.4 million was spent on domestic blueberry promotion.

Objective and Scope

Since the 1996 Farm Bill, all federal checkoff promotion programs must be evaluated so that their return to investors can be determined. Accordingly, the primary purpose of this research is twofold: (1) to measure the domestic market impacts of the USHBC's promotion programs, and (2) to compute a return on investment (ROI) 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. Specifically, this research examines whether the domestic blueberry promotion activities of the USHBC have had a positive and statistically significant impact on domestic demand for blueberries and on grower profitability. 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 blueberry consumption (and factors that affect consumption) trends in the U.S. blueberry industry. This is followed by a discussion of 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 (i.e., ROI) 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 consistently increased in recent times. Figure 1 displays domestic per capita consumption of blueberries for the last decade-plus from 2010 through 2023, which has steadily increased over this period. In 2010, per capita consumption was 34 ounces per person, which rose to 70.3 ounces in 2023 and represents a 106.7% increase since 2010[1]. 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 2010. Figure 2 shows the average national grower price for fresh and processed blueberries in deflated (i.e., expressed in 2023 dollars) by the Consumer Price Index for all items (2023 = 1.0) from 2010 through 2023. The trend over this period has been downward as reflected by the trend line in Figure 2. In 2010, for example, the average of the price of fresh and frozen blueberries at the grower level was $1.91 per pound (in 2023 dollars); by 2023, this price was $1.59 per pound, which is almost 17% 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.

[1] Longer-term, per capita blueberry consumption has been consistently increasing since 1978 when consumption was only 6.9 ounces per person.

Figure 1. Per capita blueberry consumption in the United States, 2010-2023.

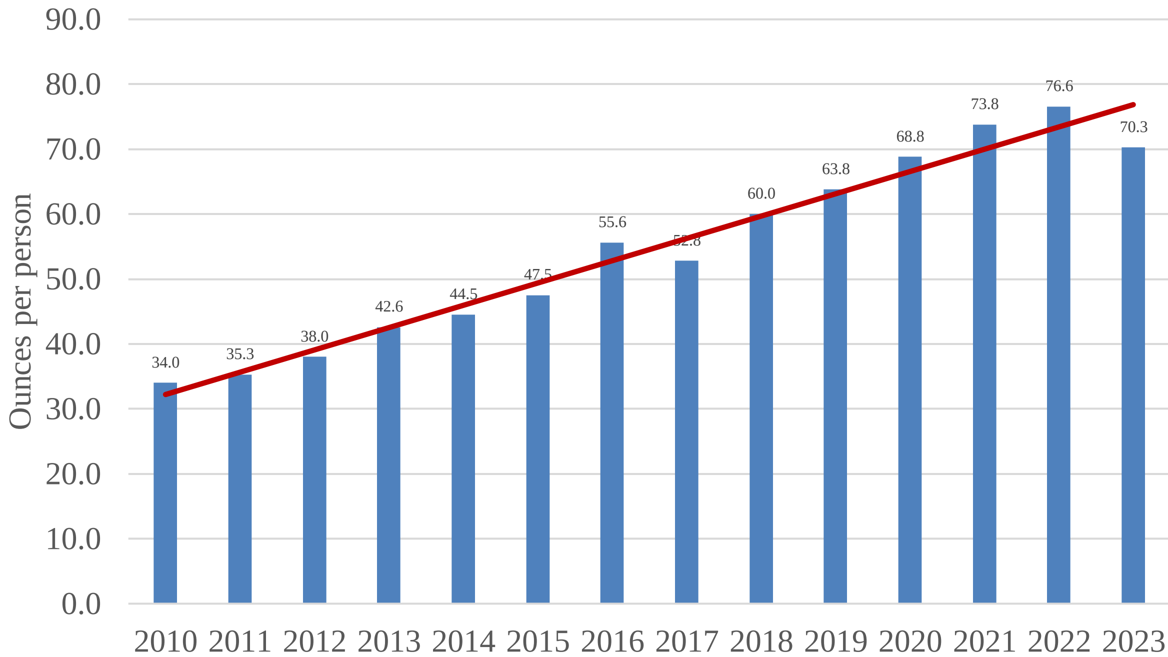
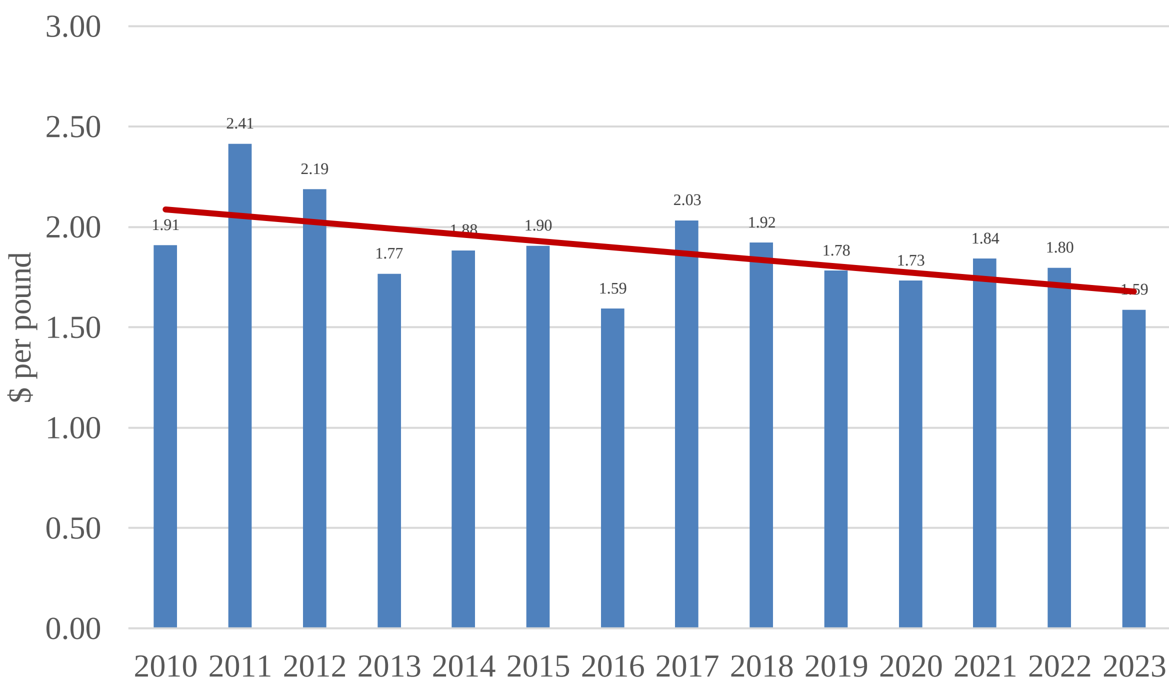
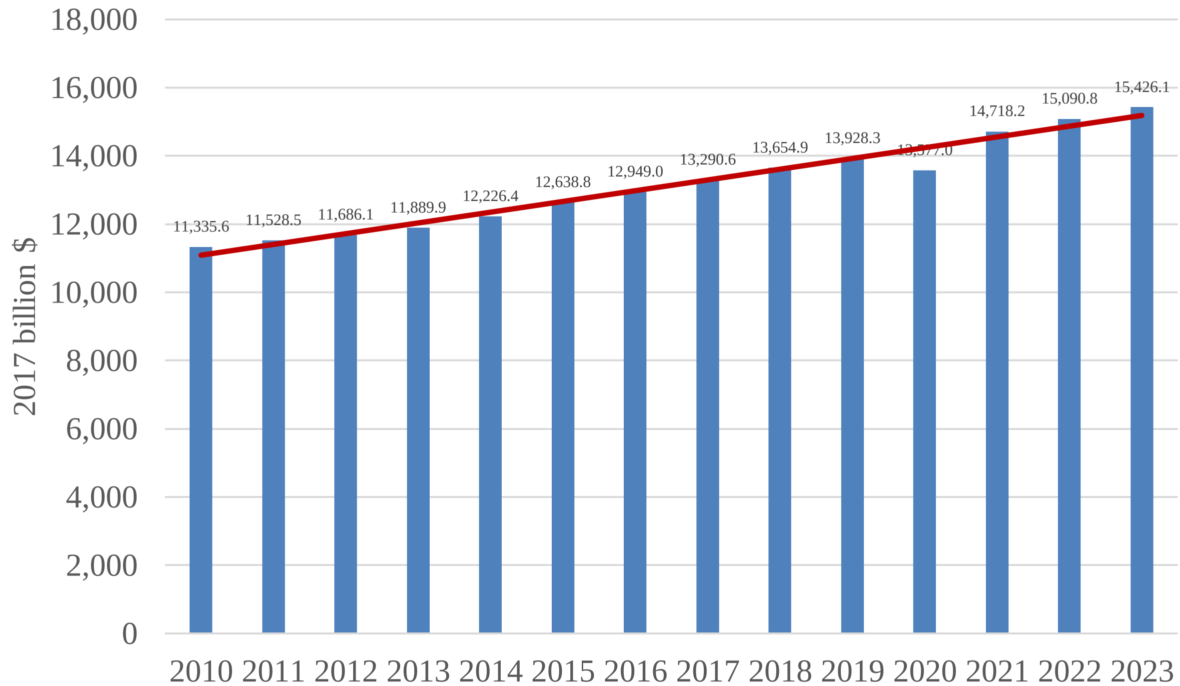


Figure 2. Real (inflation-adjusted) blueberry grower price in 2023 $, 2010-2023.



Another factor that may have positively influenced consumption of blueberries is strong growth in U.S. personal income over this period. Real (inflation-adjusted in chained 2017 dollars) personal income from 2010 through 2023 is shown in Figure 3. In 2010, real personal income was $11,355 billion, and by 2023 had climbed to $15,426 billion, a 36% increase. Growth in real personal 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.

Figure 3. Real (inflation adjusted) personal income in United States in 2017 $, 2010-2023



Finally, another factor that has likely contributed to growth in per capita consumption of blueberries is the promotion efforts of the USHBC. Figure 4 displays real inflation-adjusted expenditures on generic blueberry promotion since 2010. Since 2010, promotion expenditures have increased significantly. For instance, in 2010 the industry contributed $2.8 million (measured in 2023 dollars) for generic blueberry promotion. Since then, generic promotion of blueberries in domestic markets has steadily risen and by 2023 reached $7.4 million, which is an increase of over 163%.

The growth in per capita consumption since 1978 is crucial to the overall health and viability of the U.S blueberry industry. This is evident in Figure 5, which displays real (inflation-adjusted) blueberry grower total revenue (in 2023 dollars) from 2010 through 2023. The increase in per capita consumption that has occurred has been accompanied by a positive trend in grower revenue. In 2010, total grower revenue was $795 million in 2023 dollars. By 2022,

Figure 4. Real (inflation adjusted) expenditures in 2023 $ on generic blueberry promotion, 2010-2023.

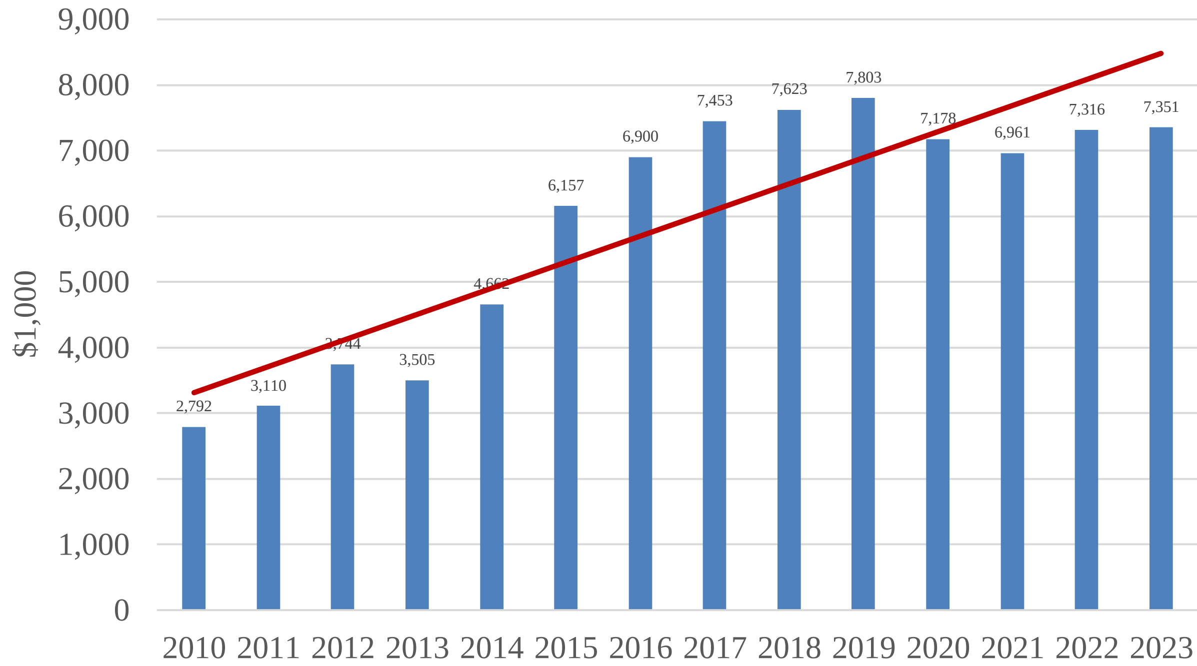
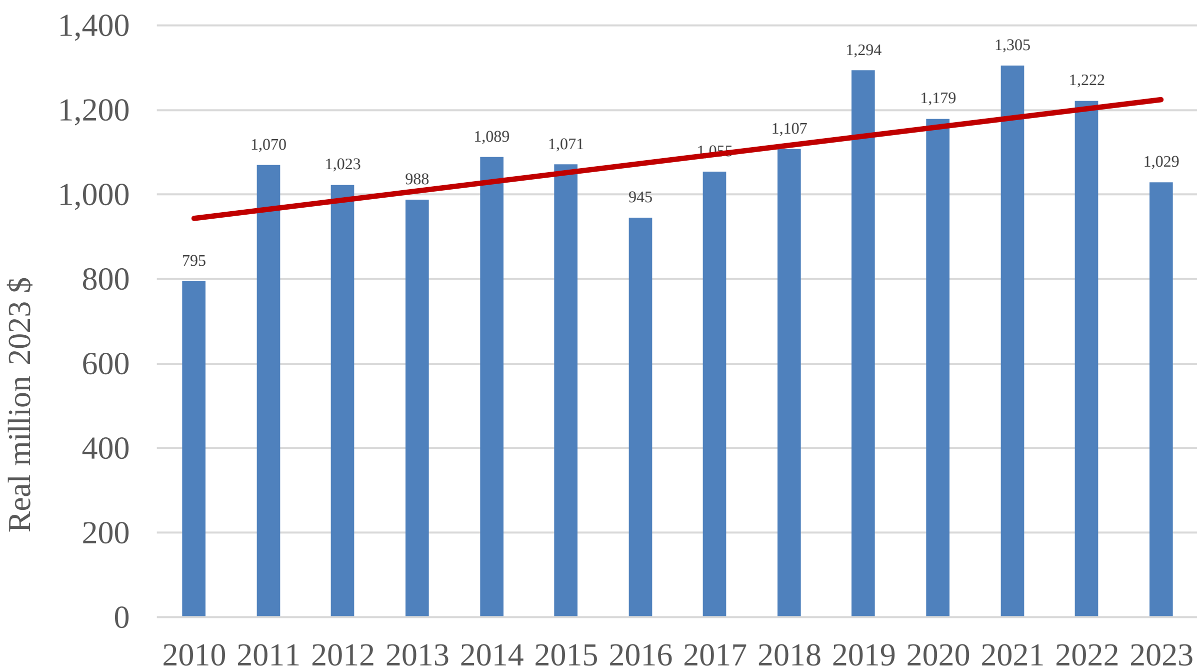


Figure 5. Real (inflation-adjusted) total revenue of blueberry growers in the United States, 2010-2023



total revenue grew to $1.2 billion, an increase of over 50%. In 2023, total revenue decreased slightly to a little over $1 billion, but that was still 30% higher than real total revenue in 2010. 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 analysis, we need to turn to more sophisticated statistical models from a field of economics called "econometrics," which is discussed next in this report.

Methodology

This study quantifies the relationship between the promotion efforts of the USHBC and the domestic demand for blueberries. 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 "drivers") include a host of factors including 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, directly quantify the net impact of the USHBC's promotion activities on domestic blueberry demand. The effects of population change over time are controlled for by measuring blueberry demand on a per capita basis.

In this study, an econometric demand model is constructed for per capita fresh plus processed blueberry production (our measure of demand) in the United States, using national annual data from 1970 through 2023.[2] The econometric model uses statistical methods with this time series data to measure how strongly various blueberry demand factors are correlated with blueberry demand in the United States. For example, with this approach one can measure how important a change in the blueberry price is relative to a change in blueberry marketing in affecting per capita blueberry demand. A detailed presentation of the econometric model and the results is presented in the Appendix of this report. Here, we focus on a general overview of the model and a discussion of the results.

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

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

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 per capita demand. Unfortunately, these data were unavailable for this study. As a proxy, we use the national average annual grower price for fresh and processed blueberries from the USDA's annual Fruit and Tree Nuts Situation and Outlook Report. Changes in the blueberry grower price should be negatively associated with blueberry demand -- i.e., an increase in price should be associated with a decrease in quantity demanded. The econometric model and time series data will determine how strong of correlation there is between price and per capita demand.

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 positive and significant impact on blueberry demand. If it has a positive and statistically significant impact on per capita blueberry demand, 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).

3. Per capita demand in the previous period. This variable represents habit formation on the part of consumers. Demand levels last year should be positively correlated with demand levels in the current year. Hence, per capita demand, 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 per capita blueberry demand. In the previous report, strawberries were found to be the main substitute for blueberries, and so the strawberry price is used in this study. If the price of strawberries increases (holding all other factors constant), blueberry demand should increase if the two berries are substitutes. 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 demand. To control for the influence of population growth on blueberry demand, we convert total demand to a per capita basis by dividing total consumption 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. Inflation adjusted personal disposable income. This should be positively related to blueberry demand, i.e., as consumers' personal income increases, blueberry demand should increase. (The source of figures for this variable is the Economic Report of the President.)

To compare the relative importance of each factor on per capita blueberry demand, the results from the statistical (econometric) model are measured as demand "elasticities." A demand elasticity measures the percentage change in domestic blueberry demand 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 per capita blueberry demand given a 1% change in price. The computed promotion elasticity measures the percentage change in per capita blueberry demand 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 percentage impact on blueberry demand.

Results

Estimated blueberry domestic demand model

The estimated blueberry domestic demand elasticities are reported in Table 1 (the full econometric output is listed in the Appendix). The estimated coefficient on the lagged per capita blueberry demand was 0.539. This indicates that there is a positive correlation between blueberry demand in the previous year and current blueberry demand, i.e. a 1% increase in per capita demand in the previous year was associated with a 0.539% increase in demand in the current years when holding all other demand drivers constant. This estimate was also used to derive the long-run elasticities (LRE) by using the following formula:

$$1/(1 - 0.539) = 2.17.$$

In other words, the long run elasticities for all demand factors were a little over two-times larger than the short run elasticities.

Table 1. Blueberry demand elasticities.*

Demand Factor	Elasticity	95% lower bound conf interval	95% upper bound conf interval
Lagged blueberry demand	0.539	0.300	0.782
Blueberry price	-0.139	-0.288	0.011
Strawberry price	0.314	0.006	0.623
Disposable personal income	0.544	0.200	0.889
USHBC domestic promotion	0.140	0.040	0.240

* 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 estimated demand equation suggests that the average fresh and processed price of blueberries at the grower level was an important factor in explaining annual variations in per capita blueberry demand. The short run own-price elasticity was –0.14, which implies that a 1% increase in the blueberry growers' price would result in a 0.14% decrease in per capita quantity demanded, holding all other demand determinants constant. (All elasticities were based on mean values for the period 1970-2023.) The long run price elasticity was 0.30. This result suggests that while price is an important factor, it was 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 were a substitute for blueberries, which was consistent with the previous study. The short run "cross-price elasticity" of per capita blueberry demand with respect to the price of strawberries was estimated to be 0.314. That is, a 1% increase in the strawberry (growers') price would result in a 0.314% increase in per capita blueberry demand, holding all other demand determinants constant. The long run elasticity was 0.61. This indicated that blueberries and strawberries were substitute products, since the demand for blueberries was enhanced when the price of strawberries increased.

Real personal income was found to be the most important factor affecting the demand for blueberries. The income elasticity was 0.544, i.e., holding everything else constant, a 1% increase in real per capita income raised per capita blueberry demand by 0.544%. The long run income elasticity was 1.18.

The elasticity associated with generic blueberry promotion was positive and statistically different from zero. The short-run promotion elasticity was 0.14, i.e., a 1% increase in blueberry promotion is associated with a 0.14% increase in per capita blueberry demand, holding all other demand drivers constant. This means that the statistical evidence supports the hypothesis that the USHBC's promotional activities increase demand for blueberries in the United States. The long run promotion elasticity was 0.304.

Because there is error inherent in any statistical model, a 95% confidence interval was computed for the USHBC promotion elasticity (see the last two columns of Table 1 for the confidence intervals for the other demand drivers). This interval can be interpreted as the range of possible values where one can be confident that the true population elasticity could be expected to fall 95% of the time. The 95% confidence interval for the short-run USHBC promotion elasticity was (lower bond=0.04, upper bound=0.24). Because the lower bound estimate was still positive, this provides statistical confidence that the USHBC activities have had a positive and statistically significant impact on per capita blueberry demand.

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 was the impact of the USHBC's domestic promotion on total domestic blueberry demand?

2. How did 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

To answer the two questions just posed, the estimated demand equation was simulated for two scenarios over the most recent 5-year period 2019-2023. The first scenario (USHBC scenario) simulated market conditions (i.e., grower price, demand, grower profits) assuming that USHBC promotion programs were in effect 2019-2023. This was a baseline or historical scenario with which to compare the second *counter-factual* scenario. The second scenario was a "No-USHBC" scenario, where it was assumed that there was no USHBC and generic blueberry promotion expenditures were set equal to the level they were in 2000 ($489,000 in 2023 dollars), which was the year prior to the USHBC coming into existence. In this latter scenario, all demand drivers, except USHBC promotion expenditures, were set equal to their historic levels. The difference between these two scenarios gave the total impact of the USHBC promotion effort on domestic blueberry demand.

Figure 6 displays the simulation results for annual blueberry demand (measured as fresh plus processed consumption) in the United States for the two scenarios. It shows clearly the positive impact on domestic blueberry demand due to the USHBC's promotion programs. From 2019 to 2023, the USHBC's promotion activities increased total blueberry demand by 953 million pounds in total, or 191 million pounds per year. This represents an annual average increase in blueberry consumption of 14%. Hence, the promotional spending by the USHBC has clearly had a positive effect on domestic blueberry demand.

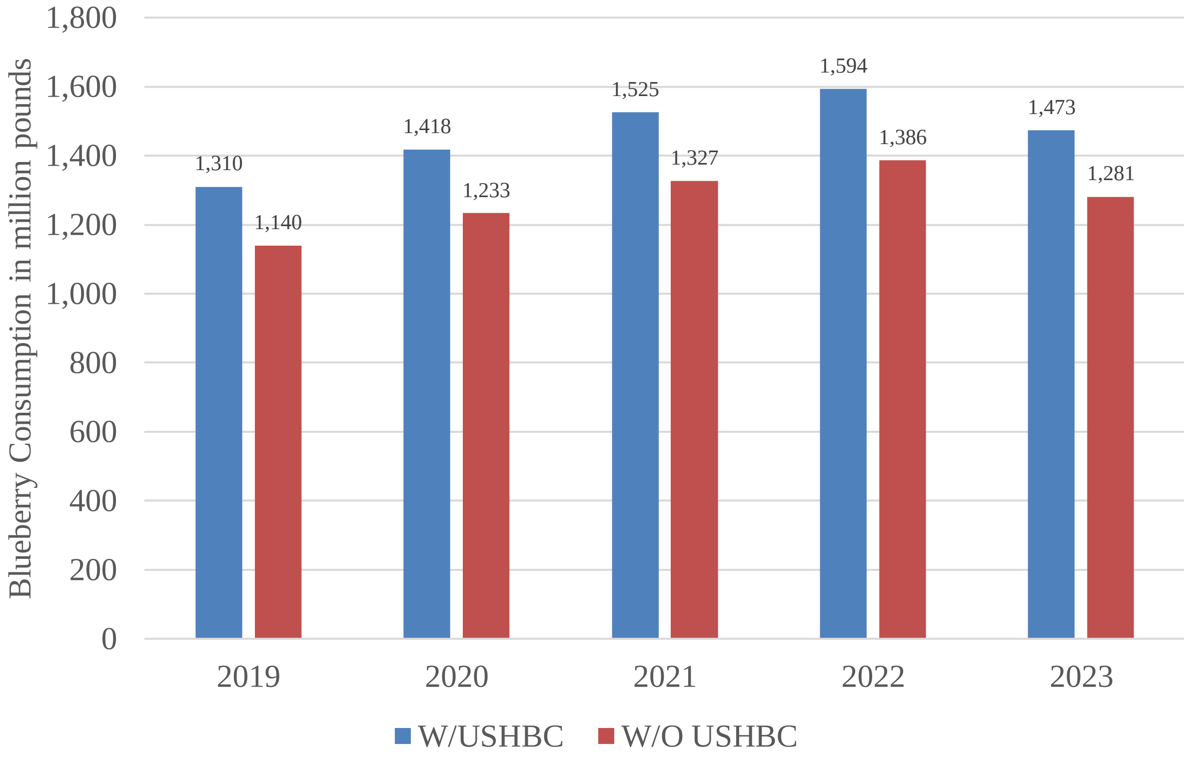
While these results indicate a positive impact of USHBC promotion programs on blueberry demand, what remains a key concern is the impact promotion had on industry profitability compared with promotion costs. Accordingly, we next present the computed return on investment (ROI). The details of how the ROI was computed are provided in the Appendix of the report. The formula for the ROI is equal to:

$$ROI = (\Sigma\ \Delta NR_t - \Delta Cost_t)/\ \Sigma\ \Delta Cost_t$$

where: ΔNR_t is the change in net revenue between the USHBC and no-USHBC scenarios as defined above, and $\Delta Cost_t$ is the change in blueberry promotion costs between the two scenarios. The change in net revenue and costs were summed each year for the most recent 5-year period, 2019-2023.

The overall average ROI for the USHBC was $19.29 for the period, 2019-23. In other words, on average, each dollar invested into USHBC promotion returned $19.29 in incremental net revenue to blueberry producers. Hence, USHBC had a very high ROI for its domestic demand-driving activities for the most recent 5-year period, 2019-2023. This compared well with the USHBC's previous economic evaluation, which reported a ROI of 18.74.

Figure 6. U.S. blueberry demand with and without the U.S. Highbush Blueberry Council domestic promotion



The computed ROI is a "point estimate," rather than an exact measure, meaning there is uncertainty about the precision of the estimate. Therefore, a 95% confidence interval was constructed, and it was especially important to estimate the lower bound confidence interval for the ROI. Collectively, the lower bound 95% confidence interval for the ROI was 7.16, which provides additional empirical evidence that the USHBC had a positive and substantial impact on domestic blueberry demand and industry-wide blueberry producer net revenue for the most recent 5-year period, 2019-2023.

How does the estimated overall ROI for the USHBC compare to that of other promotion checkoff programs? Table 2 lists the estimated ROIs for selected food commodities.[3] The ROIs range in value from a low of 1.7 for California avocados to a high of 32.08 for watermelon promotion. The overall ROI for the of 19.29 for the USHBC was significantly higher than the overall median of all average ROIs in Table 2 (6.50).

[3] In Table 2, some ROIs are marginal, and some are average. A marginal ROI is interpreted as the incremental return generated from an *extra* dollar invested in a demand-driving activity. An average ROI, which is used in this study, represents the return in net revenue, on average, for each dollar invested in the checkoff program.

How sensitive were these results to the assumed 10% net margin factor (see Appendix for details)? To examine this, the model was re-solved by lowering the net revenue percentage from 10% until the ROI was exactly equal to zero, which would indicate the benefits of the USHBC are equal to their costs. The results indicate that the net margin factor would need to be lowered from 10% to 0.5% in order to make the ROI fall to zero. This represents a very large reduction in the net margin factor for the ROI to still be above zero.

Table 2. Estimated return on investments for selected commodities.

Author(s)	Commodity	Average ROI	Marginal ROI
Alston et al. (1998)	California Dried Plums	NA	2.70
Crespi and Sexton (2005)	California Almonds	NA	6.20
Kaiser (2022)	Tart Cherries	2.05	NA
Kaiser (2021)	Cranberries	7.70	NA
Schmit et al (1997)	California Eggs	NA	6.90
Carman and Craft (1998)	California Avocados	5.00	1.70
Williams et al. (2004)	Florida Orange Juice	5.00	NA
USDA (2020)	All Dairy	4.78	NA
USDA (2020)	Fluid Milk	3.37	NA
USDA (2020)	Cheese	3.63	NA
USDA (2020)	Butter	15.67	NA
USDA (2020)	Dairy Exports	6.74	NA
Kaiser (2019)	Beef	NA	11.91
Kaiser (2021)	Pork	NA	27.57
Kaiser (2020)	Blueberries	NA	18.74
Murray et al. (2001)	Cotton	4.50	NA
Kaiser (2021)	Walnuts	11.62	NA
Kaiser (2019)	Peanuts	NA	9.74
Kaiser et al. (2012)	Raisins	9.95	NA
Kaiser (2022)	Pears	NA	4.80
Ward (2008)	Honey	6.80	NA
Capps and Williams (2015)	Lamb	NA	7.10
Kaiser (2017)	Watermelons	32.08	NA
Richards and Patterson (2007)	Potatoes	6.50	NA
Kaiser (2019)	Soybeans	NA	12.34
Median		6.50	7.10

Finally, how sensitive were the results to the estimate of the own price elasticity of supply, which was set at 0.22 based on a study by Yang (2008). To examine this, the model was re-solved by increasing the 0.22 estimate. The results (last column of Table 2) indicate that even if the elasticity was increased from 0.22 to 100, the ROI was still 4.96 indicating profitability of the USHBC. Both sets of sensitivity analysis indicated that the ROI remains well above zero even for ultra-large and adverse movements in either the net margin factor or the assumed supply response.

Conclusion

The objectives of this project were to: (1) determine the domestic market impacts of the USHBC's generic promotion programs, and (2) compute an average return on investment for the promotion activities conducted by the USHBC. Specifically, this research examined whether the domestic promotion activities by the USHBC had a positive and statistically significant impact on domestic demand for blueberries and grower profits. The impacts of all factors affecting domestic blueberry demand (where data were available) were 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 national time series data for the period 1970-2023. 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, including the grower price for blueberries and strawberries, personal income, U.S. population, and blueberry demand in the previous year, 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.

The results indicated that generic blueberry promotion 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 increased demand for blueberries in the United States. The estimated short-run generic blueberry promotion elasticity was estimated to be 0.14, which meant that a 1% increase in generic blueberry promotion expenditures was associated with a 0.14% increase in per capita domestic blueberry demand when holding all other demand drivers constant. The long-run (two or more years) blueberry promotion elasticity was 0.304, i.e., a 1% increase in promotion increased per capita blueberry demand by 0.304%, holding all other demand drivers constant.

The estimated demand equation was simulated to determine the market impacts of the USHBC promotion activities for the most recent five-year period, 2019-2023. In the baseline scenario, promotion expenditures were set equal to actual levels from 2019 to 2023. In the no-USHBC scenario, promotion expenditures were set equal to their levels from voluntary funding in 2000 ($489,000 in 2023 dollars), which was the year prior to the creation of the USHBC. The difference between the two scenarios measured the total impact of USHBC promotion programs on domestic blueberry consumption. The simulation results indicated that the USHBC had a major impact on annual blueberry demand in the United States. From 2019 to 2023, the

USHBC’s promotion activities increased total blueberry demand by 953 million pounds in total, or 191 million pounds per year. This represented an annual average increase in blueberry consumption of 14%. Hence, the promotional spending by the USHBC has clearly had a positive effect on domestic blueberry demand.

The results indicate that the USHBC was highly beneficial to blueberry producers. Specifically, the average ROI for the program was computed to be 19.29. That is, each dollar invested in the USHBC returned $19.29 in incremental net revenue to blueberry growers. Hence, it is clear that domestic promotion efforts of the USHBC had a positive and significant impact on growers’ profits since 2019.

To make allowances for the error inherent in any statistical estimation, a 95% confidence interval was calculated for the above average ROI. Collectively, the lower bound 95% confidence interval for the ROI was 7.16, which provides additional empirical evidence that the USHBC has had a positive and substantial impact on domestic blueberry demand and industry-wide blueberry producer net revenue for the most recent 5-year period, 2019-2023

References

Agricultural Marketing Service, USDA. *U.S. Department of Agriculture Report to Congress on the Dairy Promotion and Research program and the Fluid Milk Processor Promotion program 2018 program Activities*. November 2020.

Alston, J.M., H.F. Carman, J.A. Chalfant, J.M. Crespi, R.J. Sexton, and R.J. Venner. *The California Prune Board's Promotion program: An Evaluation*. Giannini Foundation Research Report no. 344, 1998.

Carman, Hoy F. & Craft, R. Kim, 1998. "An Economic Evaluation of California Avocado Industry Marketing Programs, 1961-1995," Research Reports 11925, University of California, Davis, Giannini Foundation.

Crespi, John M. and Richard J. Sexton. (2005). 'Evaluating the Effectiveness of California Almond Promotion: How Much Did the Litigation Cost Producers?' in H.M. Kaiser, J.M. Alston, J.M. Crespi, and R.J. Sexton (eds.), *Commodity Promotion: Lessons from California*. New York: Peter Lang Publishing,167-190.

Ghosh, Somali & Williams, Gary W., 2015. "Returns to Stakeholders from the American Lamb Checkoff program: A Supply Chain Analysis," 2015 AAEA & WAEA Joint Annual Meeting, July 26-28, San Francisco, California 205413, Agricultural and Applied Economics Association.

Jeong, Sei. 2019. "The Change in Price Elasticities in the U.S. Beef Cattle Industry and the Impact of Futures Prices in Estimating the Price Elasticities." Paper presented at the *NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management* Minneapolis, Minnesota, April 15-16, 2019.

Julian, James W., Bernadine C. Strik, and Wei Yang "Blueberry Economics: The Costs of Establishing and Producing Blueberries in the Willamette Valley." Oregon State University Extension Bulletin AEB0022, 2011.

Kaiser, H.M. "An Economic Analysis of the Cattlemen's Beef Promotion and Research Board Demand-Enhancing Programs." Report to the Cattleman's Beef Promotion and Research Board. 2019.

Kaiser, H.M. "An Economic Analysis of the National Pork Board Checkoff program." Report to the National Pork Board, 2021.

Kaiser, H.M. "An Economic Evaluation of the California Walnut Board and California Walnut Commission: An Analysis of the Direct and Indirect Impacts." Report to the California Walnut Board, 2021.

Kaiser, H.M. "An Economic Analysis of the Generic Marketing Activities of the California Raisin Marketing Board." Report for the California Department of Justice, 2012.

Kaiser, H.M. “An Economic Analysis of Domestic Market Impacts of the Pear Bureau Northwest.” Report to the Pear Bureau Northwest, 2022.

Kaiser, H.M. “An Economic Analysis of the United Soybean Board’s Demand- and Supply-Enhancing Programs.” Report to the United Soybean Board, 2019.

Kaiser, Harry M. *An Economic Analysis of Domestic Market Impacts of the U.S. Highbush Blueberry Council*. Report Prepared for the U.S. Highbush Blueberry Council, 2020.

Marsh, John M. “Estimating Intertemporal Supply Response in the Fed Beef Market.” *American Journal of Agricultural Economics*: 76(1994):444-453.

Murray, B. C, R. H. Beach, W. J. White, C. Viator, N. Piggott, and M. Wohlgenant. (2001). *An Economic Analysis of the Cotton Research and Promotion Programs*. Raleigh, NC: Research Triangle Institute.

Richards, Timothy J. and Paul M. Patterson. *Evaluation of Grower-Funded Value-Added Activities by the United States Potato Board*. Report Prepared for the United States Potato Board, 2007.

Schmit, Todd, J. Carlos Reberte, and Harry M. Kaiser. (1997). ‘An Economic Analysis of Generic Egg Advertising in California, 1985-95.’ *Agribusiness: An International Journal*. 13: 365-73.

Ward, Ronald W. (2008). *Measuring the Impact from Generic Promotions on the Demand for Honey*. Gainesville, FL: Report Prepared for the National Honey Board.

Williams, Gary W., Oral Capps, Jr., and David A. Bressler. “Florida Orange Grower Returns from Orange Juice Advertising.” TAMRC Consumer and Product Research Report No. CP-01-04, Department of Agricultural Economics, Texas A&M University, 2004.

Yang, Jinbin. 2008. “Economic Analysis of Blueberry Investment in British Columbia.” M.S. Thesis. University of British Columbia, June.

Appendix Table. Data for blueberry demand econometric model, 1970-2023.

Year	Consumer Price Index 2023=1	Real Personal Income Bil $2017	Weighted Blueberry Price $/lb	Per Capita Blueberry Consumption Ounces	Real Blueberry Promotion 1000 $	U.S. Population Mil	Strawberry Weighted Price $/lb
1970	0.1	3,272	0.23	6.9	35	204.0	0.24
1971	0.1	3,397	0.25	7.1	30	206.8	0.25
1972	0.1	3,605	0.32	5.6	32	209.3	0.26
1973	0.1	3,783	0.33	7.4	33	211.4	0.30
1974	0.2	3,752	0.33	7.3	46	213.3	0.32
1975	0.2	3,837	0.31	6.8	41	215.5	0.34
1976	0.2	4,051	0.40	6.4	43	217.6	0.36
1977	0.2	4,222	0.53	5.1	38	219.8	0.37
1978	0.2	4,407	0.66	5.1	45	222.1	0.35
1979	0.2	4,511	0.52	6.8	50	224.6	0.43
1980	0.3	4,497	0.49	6.6	59	227.2	0.45
1981	0.3	4,560	0.56	6.9	65	229.5	0.46
1982	0.3	4,626	0.64	7.0	72	231.7	0.53
1983	0.3	4,888	0.72	7.9	102	233.8	0.50
1984	0.3	5,145	0.50	8.6	243	235.8	0.46
1985	0.4	5,412	0.58	9.5	190	237.9	0.49
1986	0.4	5,635	0.63	9.5	262	240.1	0.54
1987	0.4	5,826	0.68	9.3	192	242.3	0.54
1988	0.4	6,069	0.91	9.9	195	244.5	0.51
1989	0.4	6,246	0.68	10.2	240	246.8	0.52
1990	0.4	6,372	0.68	11.4	212	250.2	0.52
1991	0.4	6,384	0.71	9.3	296	253.5	0.51
1992	0.5	6,619	0.89	12.3	282	256.9	0.58
1993	0.5	6,849	0.68	13.5	337	260.3	0.51
1994	0.5	7,115	0.64	13.0	215	263.5	0.56
1995	0.5	7,324	0.63	14.9	185	266.6	0.56
1996	0.5	7,579	0.91	11.8	248	269.7	0.52
1997	0.5	7,864	0.94	13.2	170	273.0	0.61
1998	0.5	8,282	0.65	13.8	249	276.2	0.67
1999	0.5	8,727	0.83	15.4	242	279.3	0.68
2000	0.6	9,167	0.95	15.8	276	282.4	0.60
2001	0.6	9,394	0.82	16.8	425	285.2	0.71
2002	0.6	9,633	0.89	17.4	425	288.0	0.66

2003	0.6	9,938	1.03	17.5	673	290.6	0.70
2004	0.6	10,312	1.13	20.0	704	293.3	0.64
2005	0.6	10,677	1.28	20.1	867	296.0	0.65
2006	0.7	10,987	1.67	22.4	947	298.8	0.68
2007	0.7	11,254	1.78	22.7	1,263	301.7	0.78
2008	0.7	11,271	1.42	27.8	1,396	304.5	0.80
2009	0.7	11,124	1.13	32.1	1,431	307.2	0.82
2010	0.7	11,336	1.37	34.0	1,998	309.8	0.87
2011	0.7	11,528	1.78	35.3	2,296	312.0	0.89
2012	0.8	11,686	1.65	38.0	2,821	314.2	0.87
2013	0.8	11,890	1.35	42.6	2,679	316.5	0.92
2014	0.8	12,226	1.46	44.5	3,622	318.7	1.00
2015	0.8	12,639	1.48	47.5	4,789	321.0	0.76
2016	0.8	12,949	1.25	55.6	5,435	323.3	1.19
2017	0.8	13,291	1.64	52.8	5,995	325.3	1.18
2018	0.8	13,655	1.58	60.0	6,282	327.1	1.00
2019	0.8	13,928	1.50	63.8	6,547	328.6	1.23
2020	0.8	13,577	1.47	68.8	6,097	329.7	1.06
2021	0.9	14,718	1.64	73.8	6,191	330.7	1.36
2022	1.0	15,091	1.73	76.6	7,026	333.1	1.30
2023	1.0	15,426	1.59	70.3	7,351	335.4	1.35

Methodological Details

The purpose of this section on the Appendix is to provide a more detailed discussion of the econometric model and the computational procedures for the ROI.

Econometric Model.

The estimated blueberry demand equation is specified on a per capita basis using a logarithmic specification and the regression output is presented below.

Dependent Variable: LOG(Q)
Included observations: 53 after adjustments
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	-4.154557	1.260366	-3.296309	0.0019
LOG(P/CPI)	-0.138670	0.074227	-1.868186	0.0680
LOG(RINC)	0.544434	0.171002	3.183785	0.0026
LOG(SBP/CPI)	0.314720	0.153256	2.053551	0.0456
LOG(PROM/CPI)	0.139757	0.049664	2.814062	0.0071
LOG(Q(-1))	0.538691	0.120778	4.460184	0.0001

R-squared	0.987563	Mean dependent var	2.815523
Adjusted R-squared	0.986240	S.D. dependent var	0.818585
S.E. of regression	0.096024	Akaike info criterion	-1.742170
Sum squared resid	0.433367	Schwarz criterion	-1.519118
Log likelihood	52.16750	Hannan-Quinn criter.	-1.656395
F-statistic	746.3927	Durbin-Watson stat	2.545780
Prob(F-statistic)	0.000000	Wald F-statistic	857.3787
Prob(Wald F-statistic)	0.000000		

Where: Q is per capita fresh plus processed blueberry production, P is the weighted average grower price for fresh and processed blueberries, CPI is the Consumer Price Index for All Items (2023=1), RINC is real personal income (in chained 2017 billion dollars), SBP is the national average grower price for strawberries, and PROM is USHBC promotion expenditures in $1,000.

A convenient feature of the logarithmic specification (LOG) is that each of the estimated coefficients is the demand elasticity for the variable in question.[4] The estimated equation fit the data well; for instance, the adjusted R-square indicates that over 98% 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 (except strawberry price) are all statistically significantly different from zero at the

[4] 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.

5% significance level or better. The strawberry price is statistically significant at the 7% significance level. Hence, the estimated demand model is deemed appropriate for this analysis.

To address the potential problem of price endogeneity, an endogeneity test is performed on the blueberry price, which consisted of the following. First, the blueberry price is regressed on all other explanatory variables in the blueberry demand equation. The residuals from this regression are then included in the original blueberry demand equation, and a t-test on the estimated coefficient on this residual term is used to test the null hypothesis that the blueberry price is exogenous. In this case, the t-value on the residual term is not statistically significant and the null hypothesis therefore could not be rejected. Hence, ordinary least squares is used to estimate the blueberry demand equation.

Average Benefit-Cost Analysis

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.[5]

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 $At = Q_t^D / R_t^\varepsilon$ 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 defined value, A_t, varies by year

---

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

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.

For this simulation, an estimate of the own-price elasticity of supply is necessary. The only study that has done this is an M.S. thesis in 2008, which estimated blueberry supply response to price changes in British Columbia (Yang 2008). This study found an average short-run elasticity of 0.22, which is very consistent with estimated supply responses of strawberries, raspberries, and blackcurrants for the United Kingdom of 0.30, 0.21, and 0.29, respectively, from a previous older study (again the only one found) for the period 1946-58 (Jones, 1961, 1962). So, in this study, we use a value of 0.22 for the supply response.

Given the simulation procedures described above, the change in net economic benefits due to the USHBC promotion effort is computed for each year from 2019 to 2023 as the difference in net revenue between the following two scenarios: (1) historic or baseline scenario with USHBC promotion expenditures set to actual levels, and (2) 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 ($489,000 in 2023 dollars), 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 demand.

The change in net revenue is computed as follows:

(3) $\Delta NR_t = (R_t\, Q_t - R'_t\, Q'_t)\, M_t$,

where $R_t\, Q_t$ represents total revenue (net return per pound times quantity sold) to blueberry growers for the baseline scenario with 100% USHBC promotion expenditures, $R_t'\, Q_t'$ represents total revenue to blueberry growers for the no-USHBC scenario, and M_t represents a net margin factor for blueberry growers which translates total revenue into net revenue (net of production costs). It is 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.[6]

An average return on investment (ROI) is computed and is equal to:

(3) $ROI = \Delta NR_t / \Delta Cost_t$

where: ΔNR_t is defined in (3) and $\Delta Cost_t$ is equal to the change in costs between the two USHBC scenarios.

[6] 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 2023 price ($1.59) in this study, 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%.