Economic Evaluation of the California Walnut Board's Advertising and Promotion Programs: An Analysis of the Direct and Indirect Impacts

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Study Objectives

This research has two principal objectives: (1) quantify the direct impact of the California Walnut Board's (CWB) domestic marketing programs on walnut demand; and (2) quantify the broader macroeconomic impacts of CWB's marketing programs on employment, employment income, value-added, contributions to U.S. Gross Domestic Product (GDP), and tax revenue.

Methods

To address these important objectives, this study quantifies the relationship between the domestic marketing efforts of the CWB and the demand for California walnuts. The model is based on the economic theory of consumer demand. In theory, one expects CWB promotion and advertising to be beneficial to the California walnut industry because these activities increase the demand for California walnuts, which results in higher volume, price, and revenue for the industry. However, there are also other factors that affect demand for California walnuts.

In order to distinguish the impact of advertising and promotion on domestic demand for California walnuts from the impacts of other factors, an econometric framework is adopted. This enabled us to simultaneously account for the impact of several other factors affecting California walnut demand. These demand-determining factors (called "determinants" or "demand drivers") include the wholesale price of California walnuts, consumer income, and CWB promotion and advertising expenditures in the United States. The demand model measures the impact of these demand determinants on California walnut demand. In addition, a supply model is estimated in order to measure any potential "supply response" to a higher price due to CWB marketing efforts. Data on volume of walnuts marketed in the United States, wholesale walnut price, consumer income measured as the GDP of the United States, advertising expenditures, and promotion expenditures are collected on an annual basis for the period 1982-2016.

In addition to the econometric demand and supply models, a simulation model and an input-output U.S. economy-wide model are developed to investigate the study's questions. The simulation model uses parameter estimates from the demand and supply model to simulate California walnut demand with and without CWB advertising and promotion expenditures to measure the impact of these programs on California walnut demand and revenue. To gage the macroeconomic impacts, the difference between California walnut revenue with and without CWB advertising andf promotion is used in an input-output (IMPLAN-IMpact analysis for PLANning, Mig, Inc.) model to compute the broader economy-wide effects on employment, labor income, value added, total GDP, and state and federal tax revenue. Each model is next explained in more detail.

Econometric demand and supply models. The econometric model uses statistical methods with this time-series data to measure how strongly various California walnut demand factors are correlated with demand. For example, with this approach one can measure how important a change in the California wholesale walnut price is relative to a change in California walnut promotion in affecting demand for California walnuts.

The following factors are included in the specification of the econometric model to ascertain the extent, if any, of their impact on demand for California walnuts. California walnut demand is measured as domestic shipments, which is collected annually by the CWB. Each demand driver was tracked annually, so that the degree of correlation, if any, it has with changes in walnut demand can be computed.

1. **California walnut price:** This is measured as a unit value for California walnuts at the wholesale level as total expenditures for in-shell and shelled California walnuts divided by total volume of in-shell and shelled California walnuts. Changes in the California walnut price should be negatively associated with California walnut demand -- i.e., an increase in price should be associated with a decrease in quantity demanded.

2. **U.S. GDP**: We expect this variable to be positively associated with the demand for California walnuts, as GDP reflects the purchasing power of the consumers. That is, an increase in GDP is expected to increase the demand for California walnuts. The source for this variable is the Economic Report of the President.

3. **CWB walnut promotion expenditures:** This variable includes expenditures on all domestic demand enhancing activities by the CWB excluding media advertising. The source of data for this variable is the CWB.

4. **CWB walnut advertising expenditures:** This variable includes expenditures on all domestic media advertising activities by the CWB. The source of data for this variable is the CWB.

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

On the supply side of the market, the following grower supply model is also estimated with annual data from 1980-2016:

$$\ln(SHIP_t) = \beta_0 + \beta_1 \ln(PRICE_{t-1}/CPI_{t-1}) + \beta_2 \ln(SHIP_{t-1}) + \beta_3 \ln(T_t)$$

where: $SHIP_t$ are annual shipments of California walnuts in year t, $PRICE_{t-1}/CPI_{t-1}$ is the California walnut price in year t-1 deflated by the Consumer Price Index for all items, $SHIP_{t-1}$ are California walnut shipments in year t-1, and T_t is a linear trend term equal to 1 for 1980, 2 for 1981, etc. Like the demand model, the supply model is estimated in double logarithmic form, and hence the supply elasticities are given by the estimated β values. It is assumed that producers have a naïve price expectations scheme, which is represented in the model by the inclusion of the price lagged by one time period.

Simulation Model. Based on the demand model for California walnuts, the model results are used to simulate the impacts of two California walnut promotion/advertising scenarios on California walnut demand. The first scenario simulated is a baseline scenario where all independent variables are set equal to their historical values for the most recent 5-year period, 2012-2016. The second scenario simulated is a counterfactual scenario where all variables except promotion and advertising expenditures are set to their historical levels, and CWB advertising and promotion expenditures are set to zero[1]. Since both scenarios are identical except for their promotion/advertising expenditure levels, the difference in California walnut demand between scenarios provides a measure of the impact of promotion/advertising on demand.

U.S. Economy-Wide Input-Output Model. California walnut promotion/advertising benefits a range of stakeholders beyond the growers that fund the promotion activities. For example, local agro-input suppliers benefit from additional purchases of inputs, and local workers benefit from either higher wages, or jobs. Federal, state and local governments also benefit from the incremental taxes associated with growers' earnings. To examine this, an "input-output" model of the California macro-economy was used to simulate the macroeconomic impacts of the two scenarios on advertising and promotion funding levels described in the paragraph above. In comparing these two scenarios, the implied incremental impacts on employment, labor income, value added, tax revenue, and GDP associated with having the CWB advertising and promotion is measured. The results provide a summary measure of the broader macroeconomic impact of the CWB.

A well-known, and well-regarded input-output model called IMPLAN (IMpact analysis for PLANning, Mig, Inc.) is used to model the macroeconomic impacts of CWB advertising and promotion spending on the broader California economy. IMPLAN uses a large-scale input-output database representing nearly every industry in California at the ZIP code, county, and state level.

The model is first solved for at the entire state-level to determine what the benefits of CWB advertising and promotion is for California as a whole. Then, a similar analysis of the direct and indirect benefits of CWB advertising and promotion is conducted separately for the top 5 walnut producing counties in the state.

[1] Since the econometric model is estimated in double logarithmic form, expenditures could not be set to zero since the logarithm of zero is undefined. Instead, advertising and promotion expenditures are set to a small percentage of their actual historical levels for this time period.

Demand Model Results

To address the potential problem of price endogeneity, an instrumental variable regression approach is used in which the California walnut price is regressed on a set of variables, which includes all exogenous variables from the demand equation. Hence, the model consists of two equations: (a) a price equation used as an instrumental variable for the endogenous California walnut price; and (b) a demand equation for California walnuts, which includes the predicted California walnut price from the price equation as one of the exogenous (instrumental) variables.

The estimated demand equation for California walnuts is reported in Table 1. The equation fit the data well; for instance, the R-square indicates that 91% of the variation California walnut volume 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.

All econometric diagnostic tests for potential statistical problems with the model indicates that the model is free of serial correlation and heteroscedasticity. The Durbin Watson statistic and the Breusch-Godfrey Serial Correlation LM test reported in the table suggest that the resulting estimated equation is free from serial correlation problems. In addition, White's Heteroskedasticity test indicated that the null hypothesis of no heteroskedasticity could not be rejected. No multicollinearity is detected. Hence, the model is free from potential statistical problems.

All elasticities reported in Table 1 are average values over the period 1982-2016. The estimated demand equation suggests that the price of California walnuts is a significant demand driver explaining annual variations in California walnut demand. The estimated own-price elasticity is –0.417, which implies that a 1% increase in the California walnut price would result in a 0.417% decrease in California walnut quantity demanded, holding all other demand determinants constant.

U.S. GDP has a positive and statistically significant impact on California walnut demand. Specifically, holding all other demand determinants constant, a 1% increase in U.S. GDP would result in a 0.931% increase in California walnut demand. Since this elasticity is positive, California walnuts are what economists refer to as a "normal good, which means as incomes rise, so does the demand for the good in question. This is the most important demand driver in the model.

Most importantly to this analysis are the elasticities associated with CWB advertising and promotion. Both the advertising and the promotion elasticities are positive and statistically significant. The results indicated that a 1% increase in CWB advertising expenditures would result in a 0.017% increase in demand for California walnuts, holding all other demand factors constant. A 1% increase in CWB promotion expenditures would result in a 0.012% increase in demand for California walnuts, holding all other demand factors constant. These results mean that the statistical evidence supports the notion that both the advertising and promotion efforts of

the CWB have the effect of increasing the demand for California walnuts over the time period 1982-2016.[2]

It is useful to compute a "confidence interval" for the advertising and promotion elasticity estimates. This is advantageous since econometric estimates are "point estimates," which are estimates rather than exact measures. That is, there is uncertainty about the precision of these estimates and therefore it is useful to construct confidence intervals around these point estimates. The confidence intervals give a lower and upper bound to the point estimate where one can be reasonable confidant that the true measurement lies. The 99% confidence interval for the advertising elasticity estimated here is (0.006, 0.028) and for the promotion elasticity is (0.005, 0.02). The lower bound for both advertising (0.006) and promotion (0.005) are still positive, which indicates that we can be 99% confident that the true elasticities have a positive impact on California walnut demand.

Table 1. Estimated elasticities for the California walnut demand equation, 1982-2016.

Demand determinant	**Elasticity***	**p-value****
California walnut price	-0.417	0.000
U.S. GDP	0.931	0.000
CWB advertising expenditures	0.017	0.000
CWB promotion expenditures	0.012	0.000
Durbin-Watson statistic:	1.77	
R-squared:	0.95	

* Elasticity measures the percentage change in California walnut demand given a 1% change in any demand determinant, holding constant all other determinants.

** The p-value is a measure of how statistical significant from zero the elasticity is and the closer the p-value is to zero, the more statistically significant the elasticity; generally p-values less than 0.100 are considered statistically significant.

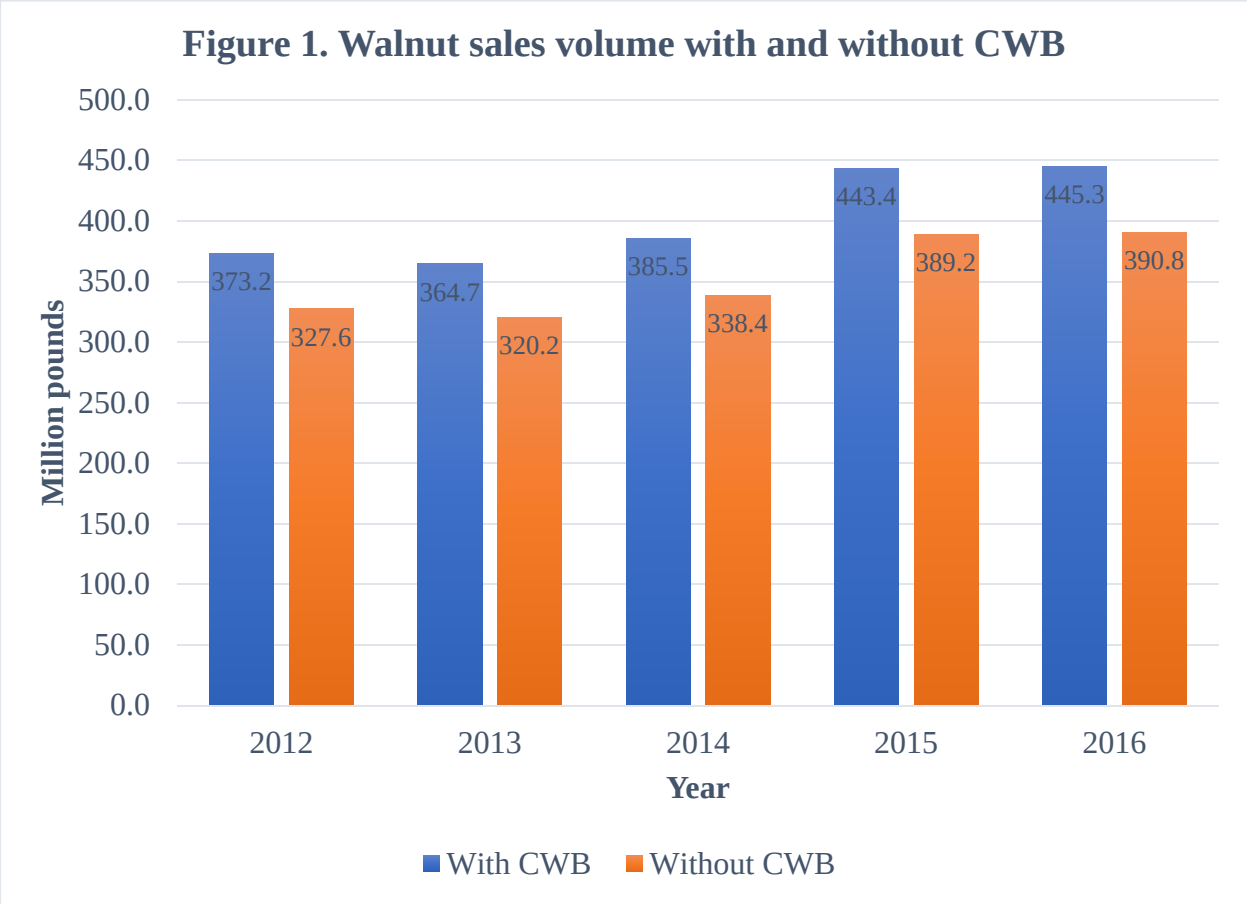
Simulation Results

The econometric results above indicate that the CWB's advertising and promotion activities have had a positive and statistically significant effect on California walnut demand. Next, the estimated demand model is simulated for two scenarios. Recall that the first scenario (with advertising and promotion scenario) simulated market conditions assuming that the CWB's

[2] The model was also estimated by combining advertising and promotion expenditures. The combined impact had an overall elasticity of 0.0136, i.e., a 1% increase in advertising plus promotion expenditures would result in a 0.0136% increase in California walnut demand, holding all other demand drivers constant.

advertising and promotion programs are in effect over the period 2012-2016. This is a baseline or historical scenario with which to compare the second counterfactual scenario. The second counterfactual scenario is a "without advertising and promotion" scenario, where it is assumed that there is no CWB and hence no walnut advertising and promotion. In this second scenario, advertising and promotion expenditures are set equal to zero. In this latter scenario, all demand determinants except CWB advertising and promotion expenditures are set equal to their historic levels. The difference between these two scenarios gives the total impact of CWB advertising and promotion on the demand for California walnuts.

Figure 1 displays the simulation results for annual California walnut demand for 2012-16. This figure shows clearly the positive impact on California walnut domestic shipments due to the CWB's advertising and promotion activities. From 2012 to 2016, the CWB advertising and promotion activities increased domestic shipments by 251 million pounds in total, or 50 million pounds per year. This represents an annual average increase in domestic shipments of 12.2%.



While these results indicate a positive impact of CWB's advertising and promotion programs on California walnut shipments, what remains a key concern is the impact the CWB

has had on industry profitability compared with advertising and promotion costs. The increase in California walnut demand due to the CWB's advertising and 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. Hence, in order to evaluate the full effect of the CWB's advertising and promotion programs on quantity and price, one needs to incorporate the supply response of California walnuts into the model. To do this, an estimate of the supply response by California walnut growers is necessary.

Accordingly, the supply model previously discussed is estimated with annual data from 1980-2016. The estimated supply model fit the data well with an coefficient of variation of 0.72. The estimated long-run price elasticity is 0.26. This indicates that holding all other supply factors constant, a 1% increase in price leads to a 0.26% increase in quantity supplied. This estimated "supply response" is used in the simulation model to compute the impact of CWB advertising and promotion on price.

The simulation procedure begins on the demand side, where predicted quantities of domestic California walnut 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 CWB advertising and promotion then affect the level of production and the resulting walnut price. Specifically, the supply function is defined as:

(1) $Q_t^S = A_t P_t$
where $At = Q_t^D / P_t^{\varepsilon}$ and

where P_t is the price per pound in year t, and ε is the own-price elasticity of supply (0.26). 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.

Table 2 lists the average annual impacts of the CWB on the California walnut industry for the last five years. It is clear that the CWB positively impacted the California walnut market. For instance, the findings indicate that had there not been any CWB advertising and promotion from 2012-16, the walnut price would have been $0.42 lower, on average. In other words, advertising and promotion by the CWB resulted in the wholesale walnut price being 22% higher, on average, in the past five years.

Because both the price and shipments were higher due to CWB advertising and promotion, so too was total revenue. The results suggest that had there not been CWB advertising and promotion, total industry revenue would have been $208 million lower per year. Furthermore, industry-wide producer surplus (which is a measure of net revenue by economists) would have been $165 million lower each year. Based on an average cost of $10.53 million per year for advertising and promotion programs, each dollar invested in advertising and promotion, on average, returned $19.75 back in total revenue and $15.67 back in net revenue.

Table 2. Average annual impacts of CWB advertising and promotion programs on California walnut industry, 2012-16.

Item	2012-16 Impact
Change in California walnut price due to CWB ($/lb.)	0.42
Change in advertising and promotion costs ($ million)	10.53
Change in total revenue (price times quantity) ($ million)	208.00
Change in producer surplus ($ million)	165.00

Broader Economy-Wide Impacts

Advertising and promotion benefits a range of stakeholders beyond the growers that fund the promotion activities. For example, local input suppliers benefit from additional fertilizer or pesticide purchases, and local workers benefit from either higher wages, or more harvesting and post-harvest processing jobs. Federal, state and local governments also benefit from the incremental taxes associated with growers' earnings.

The magnitude of each of these spillover, or "multiplier," effects depends upon how the commodity in question is produced and sold. If a particular commodity is machine-harvested, for example, the labor input will be very low, but the local capital expenditure, mechanic employment, and software investment will be greater than otherwise. Each of these relationships can be summarized in an "input-output model" that contains data on the technical relationships between each input supply industry, the outputs for the industry in question (incremental total revenue due to advertising and promotion), and broader macroeconomic outputs such as employment, labor income, value-added, and GDP. Here we use the most recent version of IMPLAN to simulate the impacts of CWB walnut advertising and promotion. The direct impact of the CWB is the average annual incremental increase in industry-wide total revenue ($208 million per year for the entire state). This amount was inputted into the IMPLAN model as the direct effect to compute the broader economy-wide effects of the CWB advertising and promotion on California's economy. In addition, the broader economic effects of the CWB are computed for the top 5-walnut producing counties in California using similar procedures. For each of these five counties, the percentage share of walnut production was used to allocate the direct effect of the state's total $208 million effect, e.g., San Joaquin County had 17.4% of walnut production in 2017, and it was therefore assumed that the direct effect of the CWB for that county was 17**.4**% times $208 million, which equals $36.08 million. The direct effect for the county is then inputted into the IMPLAN model for that county to compute the broader economy impacts for that county.

Using 2017 as a basis, the IMPLAN model is solved to determine the indirect, induced, and total effects of CWB advertising and promotion activities. Recall that the "direct" effect of the CWB is the incremental increase in industry-wide revenue to the industry due to the higher

price and shipments due to advertising and promotion activities. The indirect effects are the impacts beyond the direct effect to the general economy, and IMPLAN divides them into two effects: “indirect” and “induced.” The indirect effects are changes in inter-industry transactions as supplying industries respond to increased demand from the directly affected industries. For example, the increase in California walnut industry shipments due to advertising and promotion would lead to increased purchases of inputs and services from growers, and the indirect effect of IMPLAN captures this. The induced effects reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors. The increase in money circulated to the local community has a multiplier effect that enhances the local economy.

The CWB had substantial impacts on the general economy as illustrated in Table 3, which includes the impacts on the entire state as well as in the 5-top walnut producing counties. This table displays the impacts of CWB advertising and promotion on employment numbers, employment income, value added (a measure of the incremental profit generated not only for walnut growers, but for input suppliers, packers, and wage-earners as well), and total economic output (measured as GDP).

For the entire state, the direct effect of the CWB’s adding $208 million in walnut-industry had positive spillover effects to the general economy, including:

- Increasing employment by 2,742 people;
- Increasing employment income by $182 million;
- Increasing total value added by $254.3 million; and
- Increasing GDP by $419.3 million.

The county-effects are listed in Table 3 as well.

The CWB also had a beneficial impact on generating federal, state and local tax revenue. The results from IMPLAN indicate that CWB advertising and promotion generated $38.6 million in national tax revenue, $20 million in state tax revenue for a total of $58.6 million.

Therefore, it is clear that the CWB not only has benefited the California walnut industry, but has had positive indirect benefits to the general economy of California as well as the local communities where production is taking place.

Table 3. Direct, Indirect, Induced, and Total Effects of CWB advertising and promotion activities on state and top 5 walnut producing counties, 2016.

				Total Value Added	
California	Impact Type	Employment (number)	Labor Income (dollars)	(dollars)	GDP (dollars)
	Direct Effect	1,115	97,101,894	121,865,148	208,000,003
	Indirect Effect	878	43,764,529	58,165,001	90,083,509
	Induced Effect	750	41,467,599	74,223,211	121,193,919
	Total Effect	2,742	182,334,021	254,253,360	419,277,431
				Total Value	
Stanislaus	Impact Type	Employment	Labor Income	Added	GDP
County	Direct Effect	145	11,379,820	11,161,158	19,050,000
	Indirect Effect	73	3,227,096	3,950,208	5,770,439
	Induced Effect	65	2,806,941	5,066,808	8,301,952
	Total Effect	284	17,413,857	20,178,174	33,122,392
Sutter				Total Value	
County	Impact Type	Employment	Labor Income	Added	GDP
	Direct Effect	151	9,876,503	10,645,578	18,170,000
	Indirect Effect	76	3,126,651	3,919,776	5,754,412
	Induced Effect	56	2,304,662	4,454,641	7,422,684
	Total Effect	283	15,307,816	19,019,995	31,347,096
Tulure				Total Value	
County	Impact Type	Employment	Labor Income	Added	GDP
	Direct Effect	84	9,838,574	11,184,609	19,090,000
	Indirect Effect	78	3,103,237	3,747,924	5,441,982
	Induced Effect	45	1,730,726	3,469,444	5,828,761
	Total Effect	207	14,672,537	18,401,977	30,360,743
				Total Value	
Butte County	Impact Type	Employment	Labor Income	Added	GDP
	Direct Effect	324	13,514,227	19,000,447	32,430,001
	Indirect Effect	93	5,157,508	6,289,116	8,790,616
	Induced Effect	96	4,064,524	7,648,651	12,832,454
	Total Effect	513	22,736,259	32,938,214	54,053,070
				Total Value	
San Joaquin	Impact Type	Employment	Labor Income	Added	GDP
County	Direct Effect	180	15,838,161	21,138,927	36,080,001
	Indirect Effect	134	6,170,424	7,513,723	10,555,259
	Induced Effect	91	3,883,696	7,216,003	11,707,999
	Total Effect	404	25,892,281	35,868,653	58,343,258