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The Causal Effects of Generic Commodity Advertising

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Abstract: This creative component uses a natural experiment to estimate the causal effect of reduced generic almond advertising using the walnut industry as a control. After facing a legal battle, the Almond Board of California was ordered by a court to reduce their advertising for the 1994/95-1996/97 growing season. The results showed that the reduction in almond advertising had little to no effect on almond price and total industry revenue.

Introduction

Check-off programs are designed to increase producer prices by increasing consumer demand for a specific commodity. In the United States, many different check-off programs exist for various commodities, including beef, pork, eggs, dairy, grapes, and prunes. Typically, a board of directors elected by producers oversees the program funds and decides what activities to undertake. Typical activities include generic advertising, market research, nutritional research, and nutritional education. Examples of check-off programs include the Dairy Check-off program run by the National Dairy Promotion and Research Board (NDPRB) and the Beef Check-off run by the Cattlemen's Beef Board (CBB). Examples of well-known advertising campaigns by check-off programs are the "Got Milk" campaign created and funded by the NDPRB and the "Beef. It is What's for Dinner" campaign created and financed by the CBB.

A per unit tax is levied on producers of the specific commodity to fund the check-off program activities. Using the same examples as above, all US dairy producers must pay $0.15 to the NDPRB for every 100 pounds of milk they sell, while all US beef producers are required to pay $1 to the CBB for every beef animal they sell. These taxes are traditionally mandatory due to the potential for the free-rider problem as producers would have an incentive not to contribute if the programs were voluntary.[1] Ideally, the increase in price producers receive due to the increased demand from the check-off activities more than covers the tax burden on producers. However, if funds are used ineffectively, producers could be losing money on a program designed to benefit them. Therefore, it is essential to investigate if these programs are effective at increasing industry revenue.

Objective

Due to the possibility of inefficient use of funds leading to economic losses and the inability for most producers to opt out of the program, it is justified that some producers would question the effectiveness of the program. The goal of this creative component is to answer the following research questions:

1. Is the generic commodity advertising undertaken by the Almond Board of California effective?
2. Is there a causal relationship between promotion expenditure and almond price or total industry revenue?

Crespi and Sexton (2005) analyzed the effects of reduced promotion efforts on the almond industry using a two-stage least squares approach. However, no previous work has attempted to estimate the causal effect of reduced promotion on total industry revenue. A standard method for establishing causality is utilizing a natural experiment. A natural experiment is an experiment where subjects are designated to treatment and control conditions randomly by nature. The example analyzed and further discussed by this creative component affected the almond industry. From 1994/95-1996/97 growing years, the Almond Board of California (ABC)

[1] If other producers contribute, a producer can enjoy the program's benefits, as the activities benefit all producers of the commodity but would not incur the costs of providing these activities. Each producer faces this dilemma, so collective goods like generic advertising would be underfunded or not provided without regulation.

was court-ordered to reduce advertising due to legal battles. The 9th District Court of Appeals order provided the natural experiment needed to examine the causal effects of generic commodity advertising.

A difference in difference model will be used to evaluate the effect that reduced commodity promotion by the ABC from 1994/95-1996/97 had on almond industry revenue relative to the walnut industry. The results of this model will be compared to results using traditional techniques. For simplicity, moving forward, years will be referred to in the following manner. For example, the 1994/95 crop year will be referred to as 1994. So, the treatment years will be designated 1994-1996 moving forward, even though some periods are during the following calendar years.

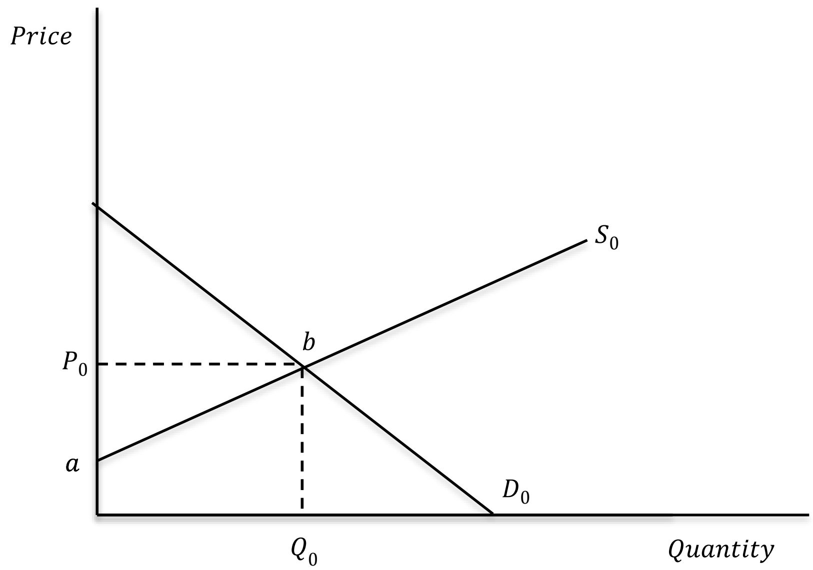
Literature Review

1. Theory of Generic Commodity Advertising

The motivation for check-off programs undertaking generic commodity advertising is due to the potential for increased producer surplus from price increases. This topic is best illustrated through a graphical representation of supply and demand curves. Figure 1 represents a market without generic commodity advertising. The supply curve, label S_0 represents the number of products producers are willing to supply for a specific price, with all other factors that could influence price held constant. Similarly, the demand curve labeled D_0 represents the number of products consumers are willing to purchase for a specific price, with all other factors influencing demand held constant. The equilibrium point, *b*, is the point where supply and demand will intersect. At this point, Q_0 units of the product will be produced/consumed for a price of P_0.

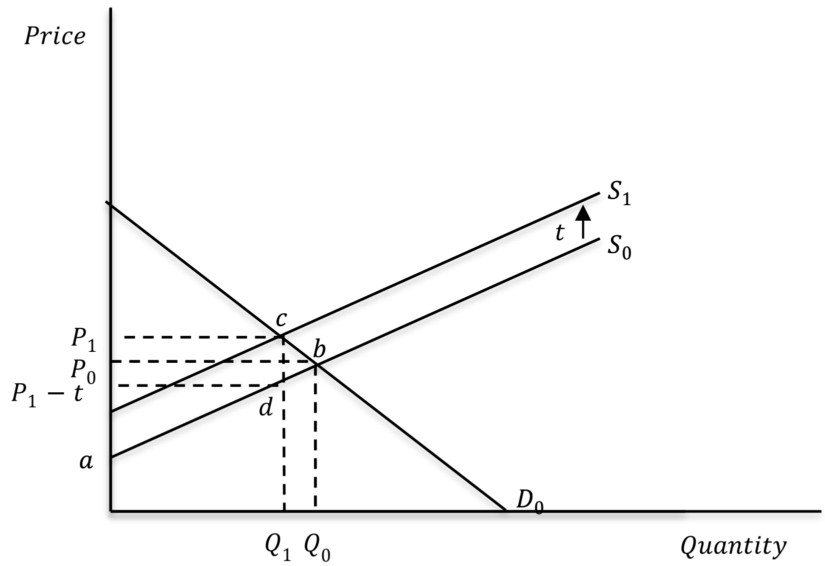
Producer surplus is commonly used as a welfare measure and can be calculated as the area above the supply curve and below the price. In Figure 1, the producer surplus is equal to the area of the triangle abP_0.

Figure 1.



The introduction of generic commodity advertising through a check-off program introduces two shifts into the model, a supply shift and a demand shift. First, consider the effect of the check-off program on supply. A per unit tax is assessed on producers to fund the check-off advertising. This tax adds cost to producers, shifting the supply curve up at all levels by the amount of the tax. This shift is illustrated in Figure 2. The supply curve shifts up by t units (the amount of the check-off tax), creating a new equilibrium at point c with a new equilibrium price, P_1, and new equilibrium quantity, Q_1. However, producers are paying for the advertising, so the price received by producers is $P_1 - t$. The new producer surplus is the area of triangle $ad(P_1 - t)$, which is less than the area of triangle abP_0. At this point, producers are worse off. However, there is another shift to consider.

Figure 2.



The demand curve is also expected to shift up, as generic advertising should increase consumers' willingness to pay for the product at every price. The amount that demand shifts are variable and could be a substantial amount or a relatively small amount. One potential shift is illustrated in Figure 3. Here, the consumers' willingness to pay increases by *w* units at every point, causing the demand curve to shift out. This change in demand creates a new equilibrium point at *e*. Producers are now producing Q_2 units for a price of $P_2 - t$. The change in producer surplus due to the check-off promotion can be measured as the area below the new quantity and price minus the tax and above the old quantity and price, in this case, the trapezoidal area $P_0bf(P_2 - t)$. This area is positive, indicating that the check-off promotion program benefitted producers. Drawing the changes in supply and demand differently by changing the sizes of *t* and *w* will change the outcome.

Another example is given in Figure 4. In this example, *t* is relatively larger, and *w* is relatively smaller than in Figure 3. In Figure 4, *b* is the initial equilibrium, *e* is the new equilibrium.

Figure 3.

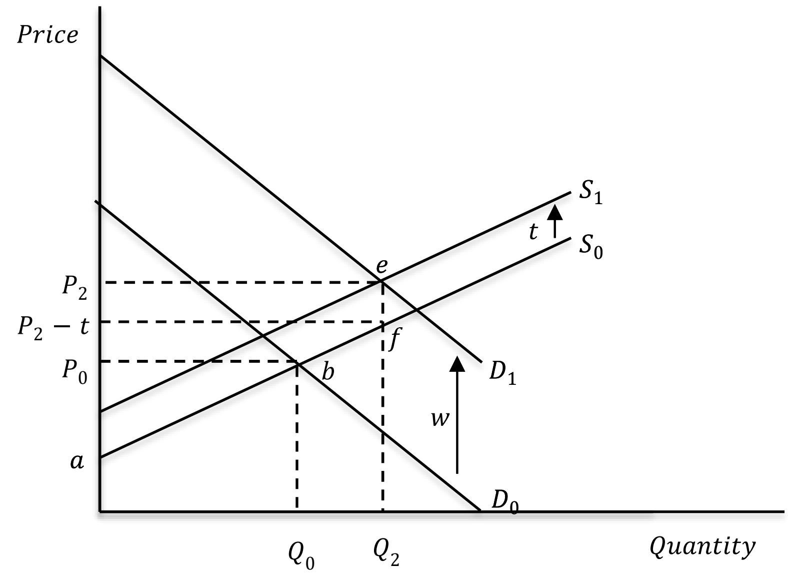
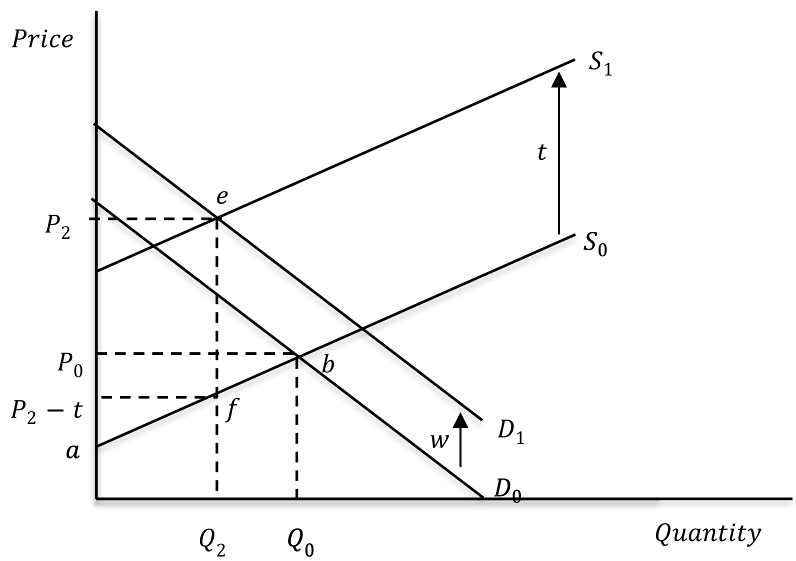


Figure 4.



under the check-off program, P_0 represents the initial equilibrium price received by producers, and $(P_2 - t)$ represents the price received by producers under the check-off program. The change in producer surplus due to the check-off program is measured as the trapezoidal area $P_0 bf(P_2 - t)$. However, notice in Figure 4 that $(P_2 - t) < P_0$. The new producer price under the check-off program is lower than the producer price before the check-off program, which means in this example, the program is reducing producer surplus. $P_0 bf(P_2 - t)$ can be treated as negative and represents the total loss to producers under the program.

The above has shown the potential methods through which check-off promotion programs can benefit producers and illustrated the potential to harm producers. Previous research in generic commodity advertising will be discussed in the next section to provide a background into previous methods used to assess the effectiveness of check-off programs.

2. Traditional Approaches for Measuring of Generic Commodity Advertising Effectiveness

Some producers constantly question commodity programs. Some feel they can get a better return on their investment from other sources than from the check-off program or simply feel it is unfair to have the program be mandatory. However, as mentioned earlier, without a mandatory requirement, the free-rider problem causes a lack of funding. Because producers are concerned about the program's effectiveness, many studies have been conducted in generic commodity advertising. This research focuses on the almond and walnut industries. The papers closed to this paper include Crespi and Sexton (2005), who looked at the almond industry, and Kaiser (2005), who looked at the walnut industry. The rest of this section of the literature review will first summarize these two papers and then discuss more generally the methods and conclusions of previous check-off promotion effectiveness in other industries.

Crespi and Sexton (2005) analyzed the effectiveness of the almond generic advertising program. They estimated a demand curve for the almond industry using OLS and found a positive elasticity of demand with respect to the promotion of 0.128. After confirming that this elasticity was positive, they defined a model to conduct a benefit-cost analysis of the check-off promotion program. They used their estimated demand equation and defined a constant elasticity of supply equation that was forced to pass through the points defined by the predicted demand model. This supply and demand equation system was estimated, and the marginal benefit-cost ratios (MBCR) were obtained from this estimation. The MBCR represents the gain over costs on the last dollar spent on the program. A MBCR of 1 is the most desirable as it indicates the program is at the optimum. A MBCR greater than 1 indicates the check-off program could be expanded, while a MBCR less than 1 indicates the check-off program should be scaled back. A Monte Carlo experiment was used to obtain confidence intervals for their point estimates. They found that the 95% lower bound of the MBCR was only below 1 for an assumed elasticity of supply of 2.56, which is the highest elasticity that could be found in previous literature. The elasticities of supply tested included 0.86, 1.0, 1.5, 2.0, and 2.56, and all the other elasticities had MBCR with lower 95% bounds greater than 1. Finally, they examined the effects of reduced promotion expenditure from 1994-96. Using their supply-demand framework, they estimated the MBCR of the ABC promotion program during 1990-93[2] and 1994-96[3] using the actual promotion expenditure and a counterfactual promotion expenditure that was estimated to be proportional with previous years expenses. They found the estimated MBCR from 1990-93 and the counterfactual 1994-96 were similar, but the MBCR from 1994-96 under actual advertising

[2] 1990-1993 were the four years immediately before the ABC's advertising reduction.
[3] 1994-96 were the three years in which the ABC was forced to reduce advertising expenditure.

levels was much higher. Crespi and Sexton concluded the ABC promotion program was effective, as even the lower bound of almost all MBCR was greater than 1. The advertising reduction caused almond producers a significant loss, as the MBCR went up significantly during the years of advertising reduction.

Kaiser (2005) analyzed the effectiveness of the walnut generic advertising program, using methods very similar to Crespi and Sexton (2005). He first estimated a demand equation using OLS and found a positive elasticity of demand with respect to the promotion of 0.005. Moving forward, he established a framework like Crespi and Sexton (2005), using his estimated demand equation and a supply equation with constant elasticity of supply to create his market model. Again, like Crespi and Sexton, he tested multiple assumed elasticities of supply ranging from (0.5-3.0) in increments of 0.5 and found that the lower 95% confidence level of the estimated MBCR was above 1 for all estimates of the elasticity of supply except for an assumed elasticity of supply of 3.0, which is very high. Therefore, Kaiser concluded that the walnut check-off promotion program was effective.

Similar studies have been conducted on other commodity promotions that also concluded other programs were effective. Alston *et al.* (1996) analyze table grape generic advertising and found a relatively high MBCR, indicating the advertising was very effective and could be increased. Alston *et al.* (1998) examined generic advertising for prunes and found it to be effective and could be increased. Kaiser (1997) examines the dairy industry check-off promotion programs and finds them effective. Similarly, Schmitt *et al.* (2005) examine the effectiveness of generic advertising of chicken eggs and find the program effective. All the papers discussed so far have found the programs to be effective. However, there are also studies in other industries that find the opposite.

The effectiveness of the beef check-off program has provided some of the most controversies in generic commodity advertising analysis. Ward and Lambert (1993) used a single equation demand model in their analysis and found the program effective, with a MBCR of 5.71. However, Brester and Schroder (1995) used a Rotterdam model to examine the branded and generic beef advertising over the same period. They found branded advertising to be effective but generic advertising to be ineffective. Similarly, Kinnucan and Xiao (1997), Benson, Breidt, and Schroeter (2002), and Boetel and Liu (2003) all found generic beef advertising to be ineffective. Coulibaly and Brorsen (1999) attempted to replicate Ward and Lambert's (1993) beef demand model but found that the results became insignificant with minor changes to the data and period. However, Kaiser (2016) more recently examined the beef check-off, examining each program undertaken by the program individual, and concluded that all efforts undertaken by the beef check-off program were beneficial. The above illustrates the controversy surrounding the beef check-off program and the possibility that check-off programs are ineffective. One program found to be ineffective does not suggest all programs are ineffective as differences could exist across programs and products. However, the contrasting conclusions regarding the beef check-off program do motivate research into other products. Different methods of analysis provided different conclusions about the beef check-off program. Difference methods should be used to examine other industries as well as it is essential to identify which check-off programs are effective.

As shown above, most prior research utilizes equilibrium models to estimate producer surplus, changes in producer surplus from changes in promotion, and eventually estimates MBCR from the equilibrium model. These papers also typically conclude that the generic advertising program of interest is beneficial. However, when using other approaches, like the

Rotterdam model used by Brester and Schroder (1995), the effectiveness of check-off programs is questioned. This paper will contribute to the literature by utilizing a different approach to address the effectiveness of generic commodity advertising. A difference-in-difference model will be used to analyze a natural experiment that affected the ABC. The ABC was court-ordered to reduce generic promotion expenditure from 1994-1996. This method will identify the causal relationship between check-off program promotion efforts, price and total industry revenue while controlling other factors that influence revenues and provide new insight into the effectiveness of check-off programs.

3. Almond Board of California Legal Issues

From 1994-1996 the ABC was forced to drastically reduce its promotion program due to a legal battle. The ABC's policy for collecting check-off contributions differs from many other check-off programs. Assessments are collected by handlers (processors of almonds) from producers, and then these assessments are passed on to the ABC. However, the handlers can claim credits against the assessment due to the ABC if they contribute to almond advertising themselves. The advertising of the handlers must meet the requirements as set by ABC. Many almonds produced in the United States are used as added ingredients to cereal or ice cream products. Handlers, including Saulsbury Orchards and Cal-Almond Inc., who filed the lawsuit against the ABC, contributed to advertising for the cereal and ice cream that their almonds were put in as additives. Handlers were denied credit for their advertising expenditures from the ABC. The ABC had a rule that products must be made of over 50% almonds to be considered for the credit. Other handlers, such as Blue Diamond Almonds, were given credit for their advertising expenditures, as they primarily process and sell whole almonds. The refusal of ABC to credit

Saulsbury Orchards and Cal-Almond Inc. for their advertising eventually led these handlers to challenge the almond marketing order in court.

In 1993 the 9th District Court of Appeals heard Cal-Almond Inc. v. US Department of Agriculture. The court ruled in favor of Cal-Almond Inc. as the USDA provided no evidence that the ABC's advertising or the advertising of handlers who received credit was more effective at increasing almond demand than the handlers who did not receive credit. The court ordered the ABC to refund the total amount the handlers should have received in credits since 1980. During the years directly after the court ruling, the board drastically reduced its advertising expenditure to compensate for the payments it needed to make to producers. Promotion averaged $9.0 million per year in the three years preceding the suspension and fell to an average of $3.9 million per year during the years of the legal proceedings (Crespi and Sexton, 2005).

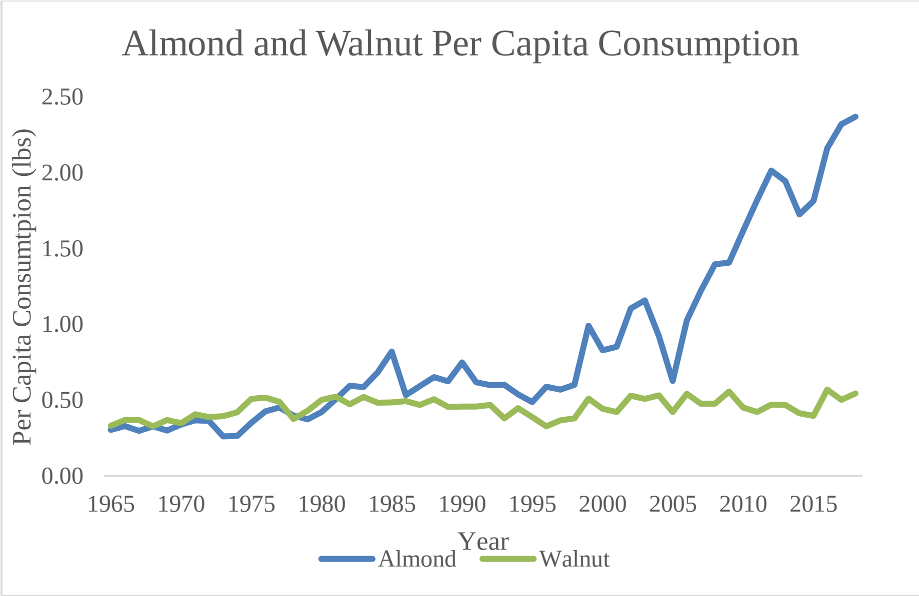
4. Comparison of US Almond and Walnut Industries

In the econometric model outlined later, the walnut industry is used as a control for the almond industry to determine the causal effect of promotion efforts. Here the similarities of the almond and walnut industries are discussed to provide a defense for the use of walnuts as a control for almonds. The similarities in production practices and consumption of the two tree nuts indicate that walnuts can serve as a suitable control for almonds.

In the United States, almonds and walnuts have similar production practices. Both are grown almost exclusively in California's Central Valley, with some producers growing both products. Over 99% of US walnuts are grown in California (California Walnut Board, 2021). Similarly, California is the only state that produces almonds commercially, according to the USDA. Because both nuts are almost exclusively grown in the same region, shocks such as weather will similarly affect each industry. Likewise, both nuts grow on trees grown in rows, take 3-5 years to reach maturity, and both nuts are harvested with a similar process that involves shaking the trees and sweeping the nuts up off the ground.

The consumption of almonds and walnuts is not as comparable as their respective production processes, however much of this divergence is very recent. One example of consumption differences is the use of almonds to produce non-dairy almond milk, while the production of non-dairy walnut milk is not as popular. Non-dairy almond milk consumption began to gain popularity during the 2000s and continued to increase throughout the 2010s. Per capita availability (a measure commonly used to approximate consumption) of almonds averaged 1.11 lb./capita from 2000-10, while walnut per capita availability averaged 0.49 lb./capita. Similarly, as non-dairy almond milk consumption continued to increase post-2010, as examined by Stewart *et al*. (2020), it may explain the further divergence of almond and walnut per capita availability from 2011-18, where almond per capita availability averaged 2.02 lb./capita and walnuts per capita availability averaged 0.46 lb./capita. However, before the 2000s, especially during this analysis period, the per capita consumption between the two nuts was very close. From 1980-97, the per capita availability of almond availability averaged 0.60 lb./capita while walnut availability averaged 0.46 lb./capita (USDA, 2021). One can see the differences in per capita consumption more clearly in Figure 5.

Figure 5.



For further comparison, the correlation between almond and walnut prices and per capita consumption was also examined. These correlations were calculated for a period prior to 2000, 1980-2000, a period after 2000, 2001-2018, and over these two periods together, 1980-2018. The results are presented in Table 1. The correlations for almond and walnut prices and quantities are greater in the period prior to 2000 than the period after 2000. Furthermore, the correlation between the prices of the two nuts is stronger than the correlation of the quantities. These positive correlations offer support for the use of walnuts as a control group for almonds.

Table 1. Correlation of Almond and Walnut Prices and Almond and Walnut Quantities

Period	Correlation - Prices	Correlation – Per Capita Consumption
1980-2000	0.57	0.21
2000-2018	0.53	0.16
1980-2018	0.51	0.27

It is a strong assumption to assume that walnuts are a perfect control for almonds. However, the similarities between the industries and correlations of price and quantity offer support for this assumption. Both commodities are tree nuts typically consumed as whole nuts individually, in nut mixes, or as additives in various products like ice cream, cereal, and baked goods. Furthermore, the correlation of prices and per capita consumption between almonds and walnuts was positive, with stronger correlations present prior to the 2000's.

Conceptual Framework

Two different frameworks will be used to analyze the effectiveness of commodity programs. First, methods like those discussed in Section 1 of the literature review will be used. Second, a difference-in-difference technique utilizing the natural experiment of reducing almond promotion will be analyzed.

1. Traditional Methods

Before estimating the causal effect through a difference in difference framework, previous methods discussed in the literature review will be used to analyze the data and confirm the results of previous studies. Specifically, Crespi and Sexton (2005) and Kaiser (2005) will be reexamined to confirm the previously reported results. The conceptual framework used by Crespi and Sexton (2005) and Kaiser (2005) is outlined below.

A demand function for both nuts will be estimated. The general demand equation to be estimated for both nuts if given by

$$Q = f(P, PS, EXP, PROMO, \boldsymbol{X})$$

where Q represents the quantity demanded of a commodity per capita, P is the real price of the product (nominal price with adjusted for inflation), PS represents the real price of a substitute commodity, EXP represents real consumer disposable income, $PROMO$ represents real promotion expenditure, and $\boldsymbol{X}$ represents a vector other covariates. Other factors could include things unique to one commodity. While almonds and walnuts are similar, different covariates will be used for each nut. Demand curves for each industry will be further specified below.

First, the demand equation that will be used for almonds is given by,

$$Q_{ALMD} = f(RP_{ALMD}, REXP, RPROMO_{ALMD})$$

where Q_{ALMD} represents per capita almond consumption, RP_{ALMD} represents the real price of almonds, $REXP$ represents real US consumer income, and $PROMO_{ALMD}$ represents the real combined promotion expenditure of the ABC and Blue Diamond Almonds.

A notable exclusion from the above demand curve is the price of substitutes and/or complements. Crespi and Sexton did not include substitutes or complements in their demand equation. As cited by Crespi and Sexton, Alston (1995) concluded that almonds have no significant substitute in the US. Alston notes filberts are an important substitute in European markets, as the confectionery industry uses them in place of almonds during high almond prices, but that in the US, almonds are primarily consumed as a snack in the US, which makes significant substitutes less relevant. Pecans, filberts, and walnuts were tested as potential substitutes for almonds to confirm this finding, and no significant results were found. Therefore, no substitutes or complements were included in the final demand equation. Crespi and Sexton also had no other covariates in the demand equation they estimated. Therefore, no other covariate has been included in this demand curve.

Next, the demand curve for walnuts is given by,

$$Q_{WAL} = f(RP_{WAL}, RP_{ALMD}, RP_{PECAN}, REXP, RPROMO_{WAL}, WOMEN)$$

where Q_{WAL} represents per capita walnut consumption, RP_{WAL} represents the real price of walnuts, RP_{ALMD} represents the real price of almonds, RP_{PECAN} represents the real price of pecans, $REXP$ represents real US consumer income, $PROMO_{WAL}$ represents the real combined promotion expenditure of the Walnut Marketing Board, and $WOMEN$ represents the proportion of women in the US workforce.

The above demand equation is like the demand equation estimated by Kaiser (2005). Unlike almonds, which had no relevant substitutes and/or complements, two potential substitutes and/or complements, almonds, and pecans are included in the final demand equation for walnuts. Both the price of almonds and the price of pecans were included by Kaiser (2005). Both are thought to be potential substitutes for almonds as snacks for nuts. Interestingly, almonds are included as a potential substitute for walnuts, but the reverse is not true. After testing, almond prices did appear to affect walnut demand, but the reverse was not true. This interesting finding will be discussed in more detail in the "Results" section. The proportion of women in the workplace is also included as an additional covariate. Kaiser (2005) included the proportion of women in the workforce in the demand equation he estimated for walnuts. After discussions with the Walnut Board, he hypothesized that a higher proportion of women in the workforce would lead to a lower amount of baked goods, and through that framework, a lower number of walnuts purchased to include in baked goods. Kaiser found the coefficient of this variable to be statistically significant, so the proportion of women in the workplace was included in this demand equation.

The demand equations to estimate and the motivation for the inclusion/exclusion of certain covariates for each industry were outlined. The functional form of the variables will be discussed in the “Results” section. After estimating the demand function, the elasticity of demand with respect to the promotion will be calculated. The elasticity of demand with respect to promotion relates the percentage change in promotion expenditure to the percentage change in quantity demanded. A positive elasticity indicates quantity demanded increases as the promotion expenditure increases. The general equation for elasticity is given by,

$$\alpha = \frac{\partial Q}{\partial X}\frac{X}{Q}$$

where α is the elasticity of demand with respect to X, Q is the quantity demanded of the product of interest, and X represents the variable the elasticity is being measured with respect to. This could include a promotion, own price, the price of a substitute or complement, or any other variable included in the demand curve. Using this formula, the elasticities for every variable included in each demand function will be estimated. After the elasticity of demand with respect to own price and promotion is calculated, the MBCR will be approximated using the equation from Alston *et al.* (1998).

The MBCR represents the gain over costs on the last dollar spent on the program. A MBCR of 1 is the most desirable as it indicates the program is at the optimum. A MBCR greater than 1 indicates the check-off program could be expanded, while a MBCR less than 1 indicates the check-off program should be scaled back.

Alston *et al.* (1998) presents a model to approximate MBCR using the equation,

$$\mu = Q\frac{\partial P}{\partial a} = Q\frac{\partial Q}{\partial a}\left|\frac{\partial P}{\partial Q}\right| = \frac{\alpha}{|\eta|}\frac{\nu}{a} = \frac{\alpha}{|\eta|\iota}$$

where μ is the MBCR, ν is the value of sales, Q is the quantity, P is the price, a is the expenditure on promotion, η is the elasticity of demand with respect price, α is the elasticity of demand with respect to promotion, and $\iota = a/\nu$ is the promotion intensity.

2. Difference-in-Difference

The reduction in almond advertising during 1994-1996 provides a natural experiment to analyze the effects of reduced check-off expenditure on the almond industry. During this time, the California Walnut Board faced no legal challenges and carried out promotion efforts as usual. The walnut industry will be used as a control group for the almond industry. The common difference in difference approach with two commodity groups in two time periods will be used to identify the effects of reduced advertising on price and total industry revenue.

First, the price difference-in-difference equation is,

$$RP_{ct} = \beta_0 + \beta_1 ALMD_c + \beta_2 Q_{ct} + \sum_{i=1980, i\neq 1993}^{1997} \beta_i YEAR_i + \delta(ALMD_c \times TIME_t) + \epsilon_{ct}$$

where RP_{ct} represents the price of the commodity, c, at the year, t, $ALMD_c$ is a dummy variable equal to 1 when the industry is almonds and 0 otherwise, $TIME_t$ is a dummy variable equal to 1 when the year is 1994-1996 and 0 otherwise, Q_c is the quantity supplied of commodity, c, at the year, t, $\sum_{i=1980,i\neq 1993}^{1997} \beta_i YEAR_i$ captures the yearly fixed effects on both industries and ϵ_{ct} represents the error. The coefficient of the interaction term δ captures the treatment effects on the treated during the treated period, and coefficient on this term is the parameter of interest.

Similarly, a difference-in-difference model using total industry revenue as the outcome variable was analyzed as well. The final equation is,

$$TR_{ct} = \beta_0 + \beta_1 ALMD_c + \sum_{i=1980, i\neq 1993}^{1997} \beta_i YEAR_i + \delta(ALMD_c \times TIME_t) + \epsilon_{ct}$$

where TR_{ct} represents the commodity total revenue to commodity industry, c, at the time, t, $ALMD_c$ and $TIME_t$ are dummy variables representing the almond industry and the treatment period as discussed earlier, $\sum_{i=1980,i\neq 1993}^{1997} \beta_i YEAR_i$ captures the fixed effect on both industries each year across the whole period, and ϵ_{gt}. Again, the coefficient of the interaction term δ captures the treatment effects on the treated during the treated period, and the coefficient on this term is the parameter of interest.

The major assumption of this approach is parallel trends between the treated and untreated groups. The parallel trends assumption assumes the two industries move in parallel prior to the treatment and would continue to move in parallel if the treatment had not occurred. If the parallel trends assumption does not hold, any differences between the two industries would be captured in the model's error term when the regression is run. As discussed in the "Literature Review" section, almond milk in the market did not become large until the 2000s. However, and as will be discussed in the "Data" section, the data used is from 1980-1997.

Data

Data on almonds were obtained from Crespi and was used by Crespi and Sexton (2005)[4]. This data was originally obtained from the Almond Board of California, USDA, International Monetary Fund, and Blue Diamond Almond. The almond data contained yearly observations from 1961 to 1997, but only data from 1980-1997 was used as this overlapped with the walnut data. The variables used from this data set included nominal price of almonds, nominal US per capita private expenditure, CPI, and ABC promotion expenditures, and Blue Diamond Promotion expenditures. The price of almonds represents the per pound price producers received for almonds. Nominal US per capita private expenditure is measured in dollars and provides a measure of US consumer disposable income. The CPI was used to adjust prices to real terms. The CPI was set equal to one in 1998, the year after the set ends. To calculated total promotion expenditure in the almond industry, the ABC and Blue Diamond promotion expenditures were added together as the ABC credited Blue Diamond for promotion expenditures in the method described in Section 2 of the “Literature Review” section.

[4] I would like to thank Dr. Crespi for kindly providing data for this project.

The data on walnuts were obtained from Kaiser and was the data set used in Kaiser (2005)[5]. Data from Kaiser (2005) was originally obtained from the Walnut Marketing Board. This data set contained yearly observations from 1980 to 1999, but only data from 1980-1997 was used as this overlapped with the almond data set. The variables used from this data set included nominal walnut price, nominal pecan price, number of women in the workforce, and nominal Walnut Marketing Board promotion expenditure. Walnut price represents the price producers received for walnuts. Similarly, the price of pecans represents the price producers received for pecans.

Per capita quantities of walnut and almonds were obtained from the USDA ERS Food Availability (per capita) Data System (USDA, 2021). Food availability is used as a proxy for consumption. Total consumption was calculated by summing annual production, imports, and beginning stocks, then subtracting exports and ending stocks. This was adjusted to per capita consumption by dividing by the US population.

The price data was transformed to fit the purposes of this study. All dollar amounts, including almond, walnut, and pecan grower prices and almond and walnut promotional expenditures, were converted to real terms by dividing by the CPI, where CPI equaled 1 in 1998. An additional variable, total industry revenue, was obtained by multiplying real price and per capita quantity for the almond and walnut industries. The definitions of key variables are provided in Table 2. Summary statistics for these key variables are provided in Table 3.

[5] I would also like to thank Dr. Kaiser for kindly providing data for this project as well.

Table 2. Definitions of Key Variables

Variable	Description	Units
RP_ALMD	Average annual price received by the grower for almonds	Real dollars per pound (adjusted to 1998)
Q_ALMD	Annual per capita quantity of almonds consumed	Pounds of almonds
TR_ALMD	Annual total revenue of the almond industry	Real price multiplied by per capita quantity
RPROMO_ALMD	Real combined promotion expenditure of the Almond Board of California and Blue Diamond Almonds	Real dollars (adjusted to 1998)
RP_WAL	Average annual price received by the grower for walnuts	Real dollars per pound (adjusted to 1998)
Q_WAL	Annual per capita quantity of walnuts consumed	Pounds of walnuts
TR_WAL	Annual total revenue of the walnut industry	The real price multiplied by per capita quantity
RPROMO_WAL	Real promotion expenditure of the Walnut Marketing Board	Real dollars (adjusted to 1998)
RP_PECAN	Average annual price received by the grower for pecans	Real dollars per pound (adjusted to 1998)
REXP	Real US domestic consumption expenditure	Real dollars (adjusted to 1998)
WOMEN	Number of women in the workforce	1000's people

Table 3. Summary Statistics of Key Variables

Variable	Obs.	Mean	St. Dev.	Min	Max
RP_ALMD	18	1.73	0.56	1.16	2.91
Q_ALMD	18	0.598	0.092	0.422	0.821
TR_ALMD	18	1190.64	240.64	851.68	1719.04
RPROMO_ALMD	18	1.11e+07	4741806	2188572	2.10e+7
RP_WAL	18	0.72	0.13	0.52	0.95
Q_WAL	18	0.455	0.055	0.422	0.821

TR_WAL	18	0.329	0.070	0.253	0.468
RPROMO_WAL	18	754151	366427	0	1067380
RP_PECAN	18	1.051	0.296	0.661	1.684
REXP	18	18010.44	1907.67	14982.03	20818.81
WOMEN	18	51000	5680	42117	59873

Results

The results of the estimated models presented in the "Conceptual Framework" section are presented in this section. First, the results of the traditional technique are presented in Section 1. The results of the difference-in-difference approach are present in section 2 of this section.

Section 1 - Estimation of Demand Curves

The results of the models used in the traditional approach are presented in this section. The demand equations for almond are walnuts to be estimated given by:

$$Q_{ALMD} = f(RP_{WAL}, REXP, RPROMO_{ALMD},)$$

$$Q_{WAL} = f(RP_{WAL}, RP_{ALMD}, RP_{PECAN}, REXP, RPROMO_{WAL}, WOMEN)$$

Before estimating these equations, a functional form must be specified. Two popular forms identified by Kinnucan and Zheng (2005) are the double log form and the linear form (with the promotion variable entering in the square root form). These forms avoid entering the promotion or advertising variables into the function linearly as this would imply constant returns to advertising, which is not likely. Functional forms using decreasing returns are more widely accepted, and the above studies all used functional forms that satisfy this requirement. Kaiser (2005) used the double log form to estimate the walnut demand curve. Crespi and Sexton (2005) examined both forms when estimating the demand for walnuts but reported troubles estimating the double log, so they ultimately settled on the linear form.

Both functional forms were used to analyze both industries in this analysis. Problems estimating the double log form in the almond industry were not encountered. The elasticities of the models are reported, so the coefficients are comparable. A convenient feature of the double log form is the coefficients can be interpreted as elasticities. To estimate the elasticities of the linear form, the general equation to estimate elasticity was used. The estimated elasticities and their t-stats are reported in Table 4 and Table 5 for almonds and walnuts, respectively.

Table 4. Estimated Coefficients of Almond Industry

Variables	Ln Form		Linear/Square Root Form	
	Elasticity	(t-stat)	Elasticity	(t-stat)
RP_ALMD	-0.347***	(-3.66)	-0.282***	(-3.10)
REXP	0.387	(-1.40)	0.336	(1.10)
RPROMO_ALMD	0.0644	(-1.11)	0.103	(1.41)
Constant	-5.174	(-1.57)	0.448	(1.74)
Observations	18		18	
Adj. R-squared	0.52		0.45	
t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1				

First, consider the almond industry in Table 4. The elasticity of demand with respect to promotion is 0.0644 (0.103) using the natural logarithm form (linear/square root form). This means a 1% increase in the promotion expenditure on almonds leads to a 0.064 (0.103) percent increase in the per capita demand for almonds. Both elasticities are not statistically different from zero. This positive relationship is expected, and the magnitude is like the elasticity estimated by Crespi and Sexton (2005), who estimated the elasticity of demand with respect to the promotion of 0.128. Crespi and Sexton’s estimated elasticity was statistically different from zero. The data set used by Crespi and Sexton was larger, containing yearly observations from 1962-97, which likely lead to the presence of significance for their estimated elasticity of demand with respect to promotion.

The elasticity of demand with respect to own price (almond) is -0.347 (-0.282) using the natural logarithm form (linear/square root form). This means a 1% increase in the price of almonds leads to a 0.347 (0.282) percent decrease in the per capita quantity of almonds demanded. Both results are statistically different from zero at the 99% confidence level. This negative relationship is expected, as consumers are expected to demand less of a product as the price of the product rises.

Table 5. Estimated Elasticities of Walnut Industry

Variables	Ln Form		Linear/Square Root Form	
	Elasticity	(t-stat)	Elasticity	(t-stat)
RP_WAL	-0.129	(-0.76)	-0.136	(-0.83)
RP_ALMD	-0.141*	(-1.98)	-0.094	(-1.64)
RP_PECAN	0.143**	(2.41)	0.113**	(2.25)
REXP	3.479*	(1.88)	2.800	(1.61)
WOMEN	-3.993**	(-2.51)	-3.405**	(-2.43)
RPROMO_WAL	-0.00292	(-0.48)	-0.018	(-.031)
Constant	8.446**	(3.04)	0.797***	(6.98)
Observations	18		18	
Adj. R-squared	0.76		0.77	
t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Next, consider the walnut industry in Table 5. The elasticity of demand with respect to promotion is -0.003 (-0.018) using the natural logarithm form (linear/square root form). This means a 1% increase in the promotion expenditure on walnuts leads to a 0.003 (0.018) percent decrease in the per capita quantity of walnuts demanded. Both results are not statistically different from zero. Kaiser (2005) found a positive elasticity of demand with respect to the promotion of 0.005, with the result being statistically different from zero. The data set used here is smaller than the data set used by Kaiser, and this is likely the reason the result is statistically equal to zero.

The elasticity of demand with respect to own (walnut) price is -0.129 (-0.136) using the natural logarithm form (linear/square root form). This means a 1% increase in the price of almonds leads to a 0.129 (0.136) percent decrease in the quantity demanded per capita of walnuts. This result is statistically equal to zero. Kaiser also found an own-price elasticity of demand to be statistically equal to zero as well. Again, this negative relationship is expected because consumers are expected to demand less of a product as the price of the product rises.

After calculating the elasticities above, the MBCR can be approximated using the method from Alston (1998) that was presented in the “Literature Review” section. The promotion intensity is calculated as the total amount spent on promotion divided by total industry revenue. The MBCR is calculated for the whole data set and for the years 1991-97 to compare the period of interest 1994-96 to the "normal" years directly around this period. The same estimated elasticities are used for each calculation, but the promotion intensities vary by year. The estimated MBCR for the almond and walnut industry are presented in Table 6 and Table 7, respectively.

The approximated MBCR of the almond industry is positive and greater than one. In all the years presented above, the MBCR is greater than 1. This indicates the almond check-off promotion programs are working effectively, and promotion expenditure could be increased. Moreover, the MBCRs are much higher during 1995-96 due to the reduction in advertising and relatively constant total revenue.

This suggests that the almond industry moved farther away from the optimal level of promotion expenditure during these years and was harmed by the court-ordered reduction in check-off promotion expenditure.

Table 6. Almond MBCR

	The elasticity of Demand with Respect to Own Price	Elasticity of Demand with Respect to Promotion	Promotion Intensity (promotion expenditure/total sales)	Marginal Benefit-Cost Ratio
Whole Data Set	-0.347	0.0644	0.040	4.63
1991	-0.347	0.0644	0.046	4.02
1992	-0.347	0.0644	0.026	7.22
1993	-0.347	0.0644	0.025	7.39
1994	-0.347	0.0644	0.020	9.39
1995	-0.347	0.0644	0.009	20.04
1996	-0.347	0.0644	0.007	25.41
1997	-0.347	0.0644	0.024	7.87

Table 7. Walnut MBCR

	Elasticity of Demand with Respect to Own Price	Elasticity of Demand with Respect to Promotion	Promotion Intensity (promotion expenditure/total sales)	Marginal Benefit-Cost Ratio
Whole Data Set	-0.129	-0.00292	0.004	-6.02
1991	-0.129	-0.00292	0.005	-4.62
1992	-0.129	-0.00292	0.004	-5.65
1993	-0.129	-0.00292	0.005	-4.97
1994	-0.129	-0.00292	0.006	-3.65
1995	-0.129	-0.00292	0.005	-4.50
1996	-0.129	-0.00292	0.005	-4.83
1997	-0.129	-0.00292	0.005	-4.85
*Note: The Marginal Benefit-Cost Ratio should not be interpreted to be different than zero. The elasticity of demand with respect to promotion is not statistically different than zero. The MBCR was approximated using this value, so the approximation of the MBCR is also statistically equal to zero.				

The approximated MBCR of the walnut industry is negative because the elasticity of demand with respect to promotion was estimated to be negative. However, the estimated elasticity of demand with respect to promotion is statistically equal to zero. Because the elasticity of demand with respect to promotion is used to approximate the MBCR, one can interpret the MBCR of the walnut industry as equal to zero. One cannot conclude that the generic advertising undertaken by the Walnut Marketing Board was ineffective because the results are not statistically significant.

Section 2 - Difference in Difference Approach

Before moving to the results of the difference-in-difference model, first the identifying assumption of parallel trends must be discussed. For the parallel trends assumption to hold, the selection bias in both periods must be equal. Essentially, the movement of the almond and walnut industry must be parallel before the reduction in almond advertising and is assumed to remain parallel in the absence of treatment. To evaluate the validity of the parallel trends assumption, an event study was conducted. The reduction in almond promotion occurs in 1994 and lasts until 1996. The expected result is coefficients statistically equal to zero leading up 1994. Then from 1994-1996, the expected result is negative values statistically different from zero. Finally, if the coefficient in 1997 is statistically equal to zero, that implies the treatment effect ended prior to 1997. However, if the coefficient in 1997 is statistically different from zero this may imply the treatment effect is lingering and does not necessarily break the parallel trends assumption.

The equations for the event study are,

$$RP_{ct} = \beta_0 + \beta_1 ALMD_c + \beta_2 Q_{ct} + \sum_{k=-6,k\neq-1}^{3} \beta_k LEAD_k + \sum_{k=-6,k\neq-1}^{3} \beta_k (ALMD_c \times LEAD_k) + \epsilon_{ct}$$

$$TR_{ct} = \beta_0 + \beta_1 ALMD_c + \sum_{k=-6,k\neq-1}^{3} \beta_k LEAD_k + \sum_{k=-6,k\neq-1}^{3} \beta_k (ALMD_c \times LEAD_k) + \epsilon_{ct}$$

The above equations have variables like those presented in the difference-in-difference equations. The notable difference is $LEAD$, which is not included in the difference-in-difference equation. $LEAD$ is defined as the number of years before or after 1994, the initial event. Essentially, $LEAD$ represents leads and lags around the event. Also, to isolate the effects around the event, $|LEAD| \leq 6$. This means that any year greater than 6 years away from 1994 is also given a $LEAD = \pm 6$. In this data set, there are no years more than six years after 1994. However, there are years six years earlier than 1994 in the data set, and thus those years were all assigned a $LEAD = -6$.

In general, the year directly preceding the event is dropped in the analysis to be used as the control. In this case, that is 1993, and thus $k \neq -1$ in the equation above. In total five leads: 1980-1988, 1989, 1990, 1991, and 1992, and three lags: 1995, 1996, and 1997, were designated. The coefficients of the interaction term, $(ALMD_c \times LEAD_k)$, are the coefficients of interest. The estimated coefficients of the interaction term from the event study equations are presented in Figure 6 and Figure 7, respectively. The point on the graph represents the point estimate of each, and the line represents the 95% confidence interval around that point. For a point to be statistically different from zero, zero cannot be included in the confidence interval. In both graphs, the confidence interval of all estimated coefficients includes zero. This means that there were no significant differences between almonds and walnuts leading up to the event, which supports the parallel trends assumption. However, it also suggests that there was no significant difference in almond price or total revenue caused by the reduction in almond promotion. The coefficient of interest in the difference-in-difference model will likely be statistically equal to zero as well due to the lack of statistical significance in the event study.

Figure 6.

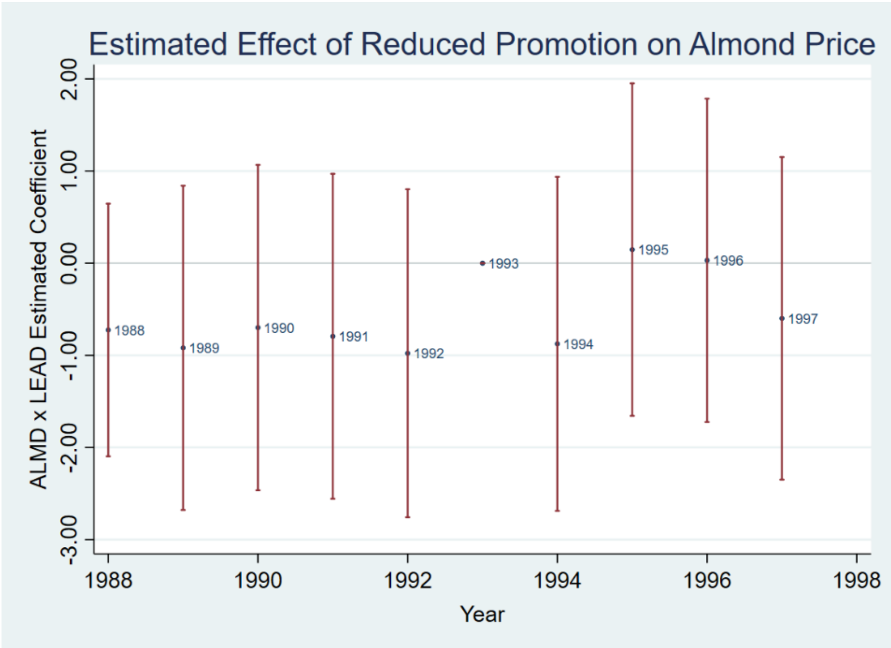
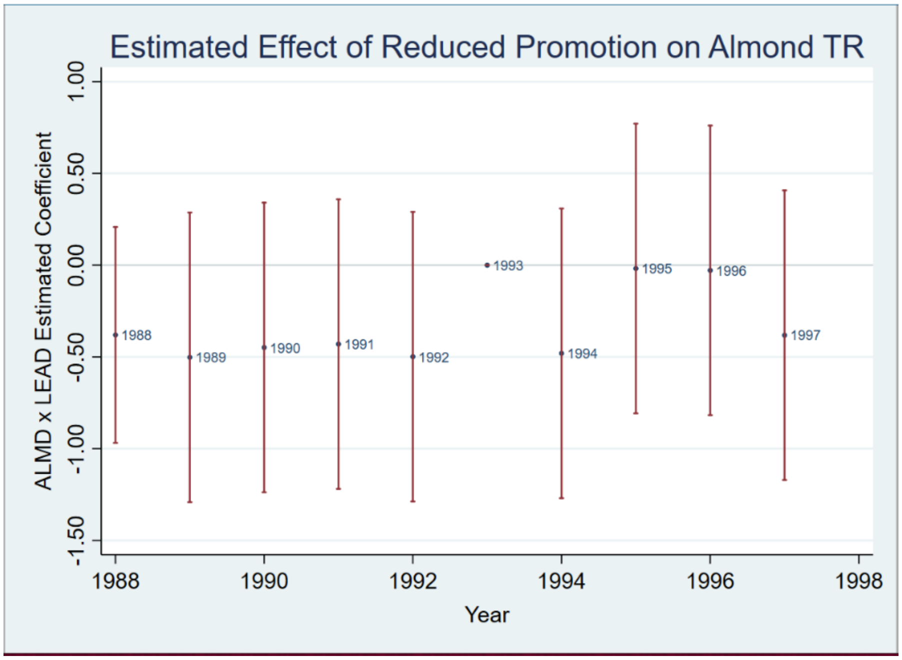


Figure 7.



The results of the two difference-in-difference models are specified in the conceptual model framework. The two difference-in-difference models are given again below. As a reminder, the first uses price as the explanatory variable, and the second uses total industry revenue.

$$RP_{ct} = \beta_0 + \beta_1 ALMD_c + \beta_2 Q_{ct} + \sum_{i=1980, i \neq 1993}^{1997} \beta_i YEAR_i + \delta(ALMD_c \times TIME_t) + \epsilon_{ct}$$

$$TR_{ct} = \beta_0 + \beta_1 ALMD_c + \sum_{i=1980, i \neq 1993}^{1997} \beta_i YEAR_i + \delta(ALMD_c \times TIME_t) + \epsilon_{ct}$$

The results of these equations are presented in Table 8 and Table 9, respectively. The estimated coefficients are reported, with their t-statistics in parentheses. Asterisks are used to denote statistical significance at the levels indicated at the bottom of the tables.

The results of the first equation, using price as the outcome variable, are reported in Table 8. Included are the results running the model without Q_{ct} included as a control for comparison. The model containing Q_{ct} better fit the data, and the coefficient of Q_{ct} was significant, so the model containing Q_{ct} was favored. The coefficient of $(ALMD_c \times TIME_t)$ is the coefficient of interest and is estimated to be 0.463. If this result was significant, that would suggest that the reduction of promotion during the treatment period caused the price of almonds to increase by $0.463/lb. However, this result is not statistically different from zero at the 10% significance level; therefore, the reduction in advertising can be interpreted to have little to no effect on almond price.

The other results are not surprising. The coefficient of $ALMD_c$ is positive and statistically different from zero at the 1% confidence level. This is not surprising as almond prices were consistently higher than walnut prices in the data, and this term captures that difference. The coefficient of Q_{ct} is negative and statistically different from zero at the 10% confidence level. This is expected as one expected price to decline when the quantity available increases. The remaining estimated coefficients are the constant and the yearly fixed effects.

Table 8. Price Difference-in-Difference Results

Variables	Quantity Included		No Quantity Control	
	Coefficient	(t-stat)	Coefficient	(t-stat)
$(ALMD_c \times TIME_t)$	0.463	(1.61)	0.442	(1.39)
$ALMD_c$	1.251***	(6.58)	0.937***	(7.23)
Q_{ct}	-2.236*	(-2.11)	N/A	N/A
Constant	1.957***	(3.88)	1.02***	(3.93)
Fixed Effects	Yes	Yes	Yes	Yes
Observations	36		36	
Adj. R-squared	0.76		0.70	
t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1				

The results of the second equation using the total revenue of the outcome variable are reported in Table 9. The coefficient of $(ALMD_c \times TIME_t)$ is the coefficient of interest and is estimated to be 0.203. This also suggests that the reduction of almond advertising caused almond industry revenue to increase during the treatment period. Like the previous difference-in-difference model, this result is not statistically different from zero. So, the results suggest the decrease in advertising by the Almond Board of California did not cause a significant reduction in total industry revenue.

Table 9. Total Revenue Difference-in-Difference Results

Variables	Including Quantity	
	Coefficient	(t-stat)
$(ALMD_c \times TIME_t)$	0.203	(1.45)
$ALMD_c$	0.640***	(11.16)
Constant	0.487***	(4.25)
Fixed Effects	Yes	Yes
Observations	36	
Adj. R-squared	0.76	
t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Conclusions

Check-off programs are designed to benefit producers. The effect of almond check-off generic commodity advertising was examined in two different methods. First, using previous methods, the elasticity of demand with respect to promotion was estimated for both the almond and walnut industries, and MBCRs were approximated. If the promotion program is effective, a necessary condition is a positive elasticity of demand with respect to promotion. The elasticity of demand with respect to promotion was estimated to be positive in the almond industry and negative in the walnut industry, though both estimates were statistically equal to zero. This is likely due to the small sample size. Prior research concluded both were beneficial using similar methods with larger sample sizes. (Crespi and Sexton, 2005 and Kaiser, 2005).

The effectiveness of the almond check-off promotion program was also examined using a natural experiment. From 1994-96 the ABC was court-ordered to reduce their promotion expenditure. During the period of the reduced promotion, the price of almonds and total industry revenue was expected to decrease because reducing advertising was hypothesized to reduce demand, and by that, reduce price and total industry revenue as well. Using the walnut industry as a control, an event study was conducted, and a difference-in-difference model was estimated to evaluate this hypothesis. The event study illustrated there was no significant difference between the almond and walnut industries leading up to the event but also suggested that the reduction in almond advertising had no significant effect. The difference-in-difference model indicated that the reduced promotion by the ABC had little to no effect on almond price and total industry revenue. These results did not support the hypothesis.

There are a few potential conclusions to consider. One conclusion is that check-off programs are ineffective and previous methods for evaluating the effectiveness of promotion programs were inadequate. Previous research did not examine the causality of promotion expenditure. This difference-in-difference approach suggests that the reduction in almond industry advertising had no negative effect on the almond price or industry revenue. It is possible previous conclusions of the positive benefits of the program were due only to the correlation between industry revenue and price. Other papers discussed in the literature review, such as Brester and Schroder (1995), found generic advertising to be ineffective, so this conclusion is possible. However, the difference-indifference method used in this paper has potential shortcomings that diminish the strength of this conclusion.

Increasing the sample size, identifying a better control group, and implementing supply considerations are potential strategies to improve upon this approach. The biggest obstacle this study faced was a lack of precision due to a small data set. Only 18 yearly observations for each industry were used, and only 3 observations were during the event period. Obtaining quarterly data or increasing the sample period could help address the problem and lead to more precise results. Furthermore, identifying a better control group could also increase the precision of this approach. Almond consumption was more volatile than walnut consumption over time. Therefore, the movement of almond consumption and prices may not always be captured by the walnut industry. Though the parallel trends assumption did hold, the sample size was very small, giving the coefficients a large confidence interval. The validity of the parallel trends assumption would be stronger if a larger sample size were used. Finally, considering supply shifters my also improve the precision and accuracy of the model. The effect of demand on almond and walnut prices was considered, but supply shocks were not accounted for in this model. Because both commodities are grown with similar production practices in the same geographic location, supply shocks were assumed to be insignificant. However, it is possible a supply shock could move the price and quantity of either nut in the opposite way of the demand shocks considered, which would affect the accuracy of the results. Considering potential supply shocks would therefore improve the validity of the results of this model.

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