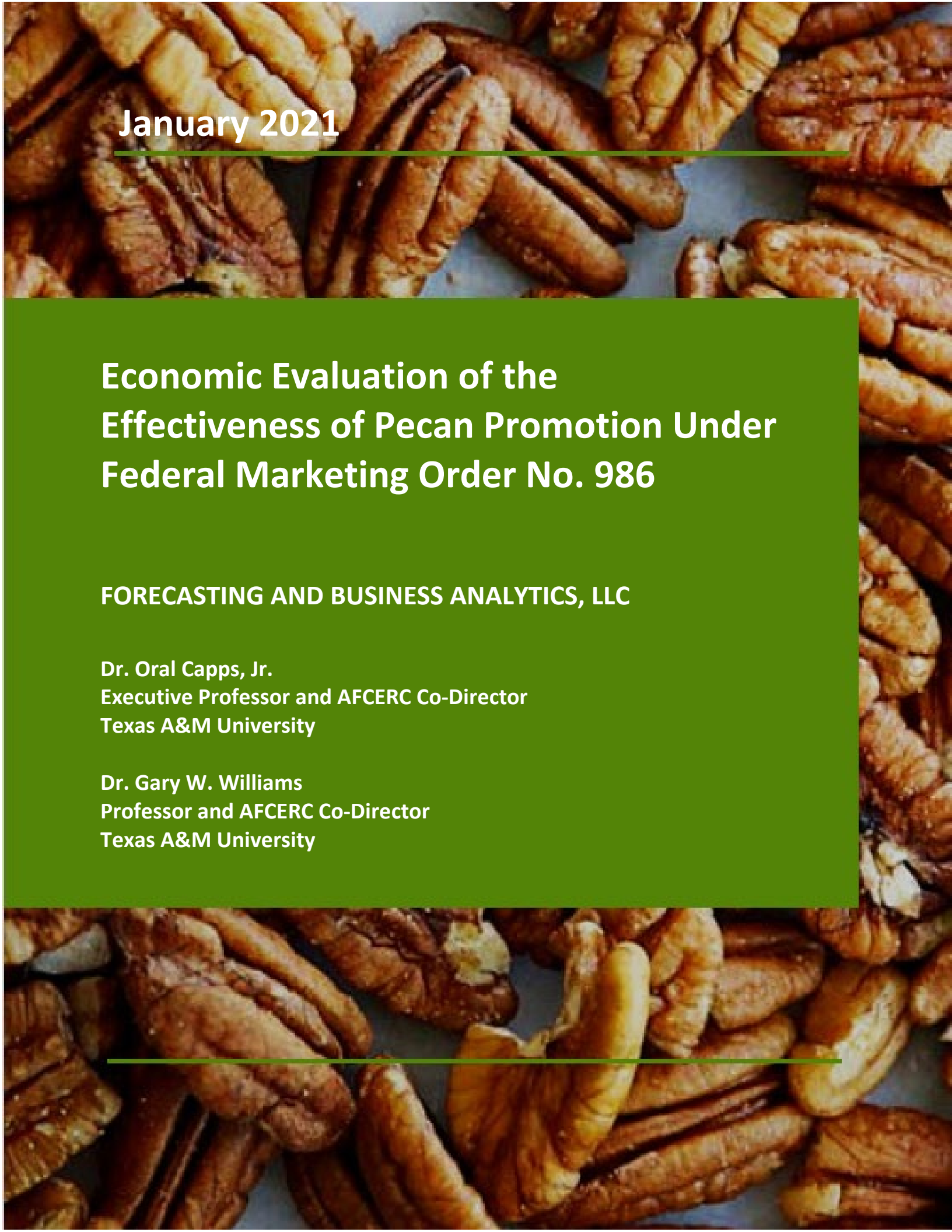

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Economic Evaluation of the Effectiveness of Pecan Promotion Under Federal Marketing Order No. 986

FORECASTING AND BUSINESS ANALYTICS, LLC

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ECONOMIC EVALUATION OF THE EFFECTIVENESS OF PECAN PROMOTION UNDER FEDERAL MARKETING ORDER NO. 986

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Abstract:

The overall objective of this study is to measure the economic effectiveness of APC activities and expenditures on generic pecan advertising and promotion activities. In addition, to support APC marketing and promotion activities, this report provides insights on consumer beliefs, awareness, attitudes, and purchasing behavior regarding tree nuts in general and pecans specifically via an online nationally representative survey. A primary conclusion is that, despite its relatively recent launch, the APC has effectively enhanced domestic and export demand for U.S. pecans over 2016/17 through 2019/20 through its generic promotion activities and generated a relatively high rate of return to pecan producers. The survey results identify key socio-demographic drivers associated with the decision to purchase pecans.

Acknowledgements:

We gratefully acknowledge funding for this project from the American Pecan Council. The APC provided assistance in understanding how the U.S. pecan industry functions and in providing their marketing and promotion expenditure data. We also are greatly indebted to Loren Burns, AFCERC Program Manager, and student workers for ancillary data collection and administrative support. In addition, we acknowledge the efforts of Dr. H.L. Goodwin with his assistance with the construction of the survey instrument and subsequent analysis of the survey data. Nevertheless, findings and conclusions are those of the authors and do not necessarily represent the views of the American Pecan Council or Texas A&M University.

FABA
FORECASTING AND BUSINESS ANALYTICS

A Limited Liability Company formed in Texas in 2001, FABA was founded on the belief that to utilize information effectively in a decision-making process, real world experience, sound econometric and statistical skills, and advanced analytical ability are necessary. FABA provides a mix of theoretical horsepower and real-world experience in designing and implementing research projects for its clients. FABA draws on resources with experience across many different private sector applications, with a common goal of utilizing econometric and statistical tools to create effective forecasting and other analytical tools that enable better decisions. FABA provides complete forecasting and business analytic solutions centering on the development of econometric/statistical models to aid decision-making in the business community in two ways: (1) analyses to better interpret the business, economic, and financial landscape and (2) forecasts to provide a better vison of the future.

EXECUTIVE SUMMARY

The overall objective of this study is to measure the economic effectiveness of APC activities and expenditures on generic pecan advertising and promotion activities. First, the relationship between APC pecan promotion expenditures and the domestic and export demands for U.S. pecans is statistically analyzed to answer two key questions: (1) What have been the effects of the pecan promotion program administered by the American Pecan Council on U.S. pecan markets and prices? (2) Have those expenditures benefited pecan producers who pay the assessments used to promote pecans? In addition, to support APC marketing and promotion activities, this report provides insights on consumer beliefs, awareness, attitudes, and purchasing behavior regarding tree nuts in general and pecans specifically via an online nationally representative survey.

The primary conclusion from the promotion analysis is that, despite its relatively recent launch, the American Pecan Council has effectively enhanced domestic and export demand for U.S. pecans over 2016/17 through 2019/20 through its generic promotion activities and generated a relatively high rate of return to pecan producers who have paid for the promotion over that period. The principal accomplishment of the APC domestic and export promotion program has been to support the annual average producer price of pecans about 24¢/lb (11%) above the level to which it might have fallen over the period of 2016/17 through 2019/20 if the promotion had not been done. Given APC promotion expenditures (including MAP funds but excluding administrative costs), the benefit-cost ratio for the APC promotion program for 2016/17 through 2019/20 is calculated at 9.9, meaning that the promotion returned $9.9 in profit to pecan producers for every dollar spent on promotion.

An important implication of the promotion analysis is that the pecan promotion program is vastly underfunded imposing a huge opportunity cost on pecan producers of potentially millions of dollars. For every dollar in additional assessment NOT paid by pecan producers and thus, not spent on pecan promotion, producers lose an average of $9.9 in additional profit. Of course, increases in checkoff assessment rates and total spending on promotion are usually accompanied by a reduction in the corresponding BCR. But with such a high estimated BCR, producers could profitably afford to increase the assessment rate substantially beyond current levels and still expect to generate a

quite reasonable rate of return comparable to the $2 to $6 per dollar of promotion earned by the beef, pork, cotton, soybeans, and other of the larger commodity promotion programs.

Note that the relatively high BCR calculated for the APC pecan promotion program is not indicative of the level of the impact of the program on the U.S. pecan industry, only the dollars returned per dollar invested. A better metric of impact is the change in key industry measures resulting from the promotion. For example, this study found that the APC promotion program can take credit for supporting the producer price of pecans by about 11% and saving producers $275.4 million (about 12%) in profit that would have been lost without the promotion, a remarkable achievement with rather modest promotion funds over a short period of time.

The main conclusions from the nationally representative consumer survey conducted in December 2020 are: (1) close to 9 out of 10 households purchase tree nuts; (2) two out of three households purchase pecans; (3) pecans ranked fourth in regard to favorite, second favorite or third favorite tree nut; (4) almost a quarter of respondents who purchase tree nuts do not purchase pecans; (5) the most common frequency of pecan purchase is annually; (6) the primary reason for non-purchases of pecans is non-preference for pecans, but cost/budgetary restrictions, dietary restrictions and allergies to pecans are also frequently cited as reasons for non-purchases; (7) roughly four out of five respondents purchase pecans at grocery stores, and nearly half purchase pecans at supercenters; (8) walnuts by far are the most popular substitute for pecans; (9) principal pecan images that come to mind include ingredient for cooking or pies, delicious/tasty desserts, family/holiday gatherings and memories, wholesome, snacks, heart-healthy/heart-smart, expensive, nutrition powerhouse, high caloric content, homegrown, and Texas/Southern states; (10) slightly more than 60% of respondents do not recall seeing or hearing messages that would encourage them to purchase pecans; (11) the predominant source of messaging concerning pecans comes from recipes; (12) slightly more than 40% of respondents revealed that lowering the price would make them more likely to purchase more pecans while nearly 30% placed emphasis on health and nutrition considerations in purchasing pecans; (13) close to 8% said nothing would make them more likely to purchase more pecans, and about 20% did not know what would make them more likely to purchase more pecans; and, finally, (14) only about 5% of the respondents were aware of the existence of the American Pecan Council, and (15) less than 2% have visited the APC website.

Key socio-demographic drivers associated with the decision to purchase pecans were found to be: (1) household size; (2) number of children; (3) education; (4) region; (5) age; and (6) household income. Race, gender, and ethnicity were not found to significantly affect the decision to purchase pecans. Household size is positively related to the likelihood of purchasing pecans, but the number of children living in the household is negatively related to the likelihood of purchasing pecans. College-educated respondents and households with higher income levels are more likely to purchase pecans relative to non-college-educated respondents and households with lower income levels. Older respondents aged 45 to 54, 55 to 64, and 65 and over are more likely to purchase pecans relative to younger respondents. Finally, respondents located in the West North Central, South Atlantic, and West South Central regions are more likely to purchase pecans than respondents located in the New England, Mid-Atlantic, East North Central, East South Central, and Pacific regions of the United States.

Bottom line, on the basis of the nationally representative survey, the primary target for American Pecan Council promotion appears to be older and relatively more wealthy households who are college-educated and reside in the West North Central, South Atlantic, and West South Central regions of the United States. These results should help stakeholders in the pecan industry to increase sales by targeting households who are more likely to purchase pecans. This research provides a benchmark for future studies concerning the decision to purchase pecans.

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ECONOMIC EVALUATION OF THE EFFECTIVENESS OF PECAN PROMOTION UNDER FEDERAL MARKETING ORDER NO. 986

Federal Marketing Agreement and Order (FMO) No. 986 (7 CFR part 986) established the American Pecan Council (APC) in August 2016 to represent growers and shellers from 15 states, namely Alabama, Arkansas, Arizona, California, Florida, Georgia, Kansas, Louisiana, Missouri, Mississippi, North Carolina, New Mexico, Oklahoma, South Carolina, and Texas (Pecans Grown in the States of Alabama, et al.; Order Regulating Handling, 2016). The FMO authorizes the APC to collect data, conduct research and promotion activities, and regulate the grade, size, quality, pack, and containers for pecans. Under the FMO, APC activities are paid for by assessments on the volume of pecans purchased from growers by first handlers. Beginning October 1, 2016, the assessment rate was set at $0.03 per pound for improved varieties and $0.02 per pound for native and seedling varieties and for substandard pecans handled (Pecans Grown in the States of Alabama, et al.; Establishment of Assessment Rates, 2017). Under the Order, the pecan industry is developing a coordinated program designed to strengthen the position of the U.S. pecan industry in the marketplace.

Title V of the 1996 Farm Bill[1] requires an independent evaluation of the effectiveness of all new and existing generic commodity promotion programs, not less than every 5 years, to assist Congress and the Secretary of Agriculture in ensuring that the objectives of the programs are met. In compliance with that legislation, the APC commissioned this initial study of its advertising and promotion activities which covers the period of 2016/17 through 2019/20. The overall objective of this study is to measure the economic effectiveness of APC activities and expenditures on generic pecan advertising and promotion activities. First, the relationship between APC pecan promotion expenditures and the domestic and export demands for U.S. pecans is statistically analyzed to answer two key questions: (1) What have been the effects of the pecan promotion program administered by the American Pecan Council on U.S. pecan markets and prices? (2) Have those expenditures benefited pecan producers who pay the assessments used to promote pecans? In addition, to support APC marketing and promotion activities, this report provides insights on

[1] Federal Agriculture Improvement and Reform (FAIR) Act of 1996, PL 104-727, 7 U.S.C. 7201 *et seq*.

consumer beliefs, awareness, attitudes, and purchasing behavior regarding tree nuts in general and pecans specifically from a nationally representative online survey.

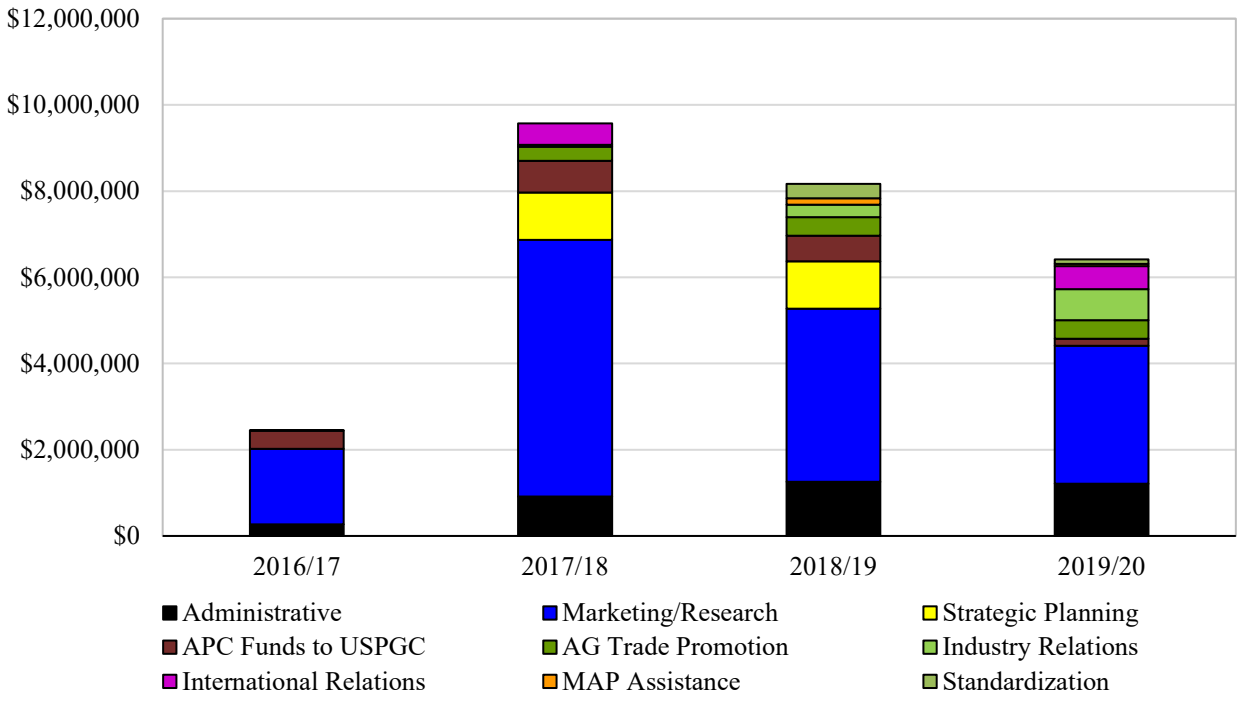
The statistical analysis focuses on the relationship between APC expenditures and the U.S. domestic and export demands for pecans over the first four years of the program (2016/17 through 2019/20). The results of that analysis were then incorporated into PecanMod, a recently developed model of the U.S. pecan industry (Capps and Williams, 2019), to measure the broader effects of APC expenditures on U.S. pecan production, consumption, inventory, trade, and prices. Once the market effects were determined, they were then used in a benefit-cost analysis of APC pecan promotion expenditures to determine the return to producers from those expenditures. In the analysis, the pecan producer benefit-cost ratio (BCR) is calculated as ratio of the additional producer net revenue (profit) generated by the APC promotion over the first four years of the program and the cost of the promotion over that period. Finally, to examine current consumer beliefs, awareness, attitudes, and purchasing behavior regarding pecans, we conduct and analyze the results of a nationally representative online survey of tree nut consumers.

This report first provides a detailed look at how pecan checkoff funds have been spent to promote pecans over the four years following the implementation of FMO No. 986 (2016/17-2019/20). Then a discussion of the economics of generic demand promotion is provided as background to the subsequent analysis of the APC pecan promotion program. The methodologies used in this study to measure the effectiveness of the pecan checkoff program and to elicit tree nut consumer responses regarding their beliefs, awareness, attitudes, and purchasing behavior regarding pecans are then outlined. Following is a discussion of the study results. Finally, the major conclusions of the study and implications for the management of pecan checkoff investments are considered.

AMERICAN PECAN COUNCIL PECAN PROMOTION EXPENDITURES

Since the establishment of FMO No. 986, the American Pecan Council has spent a total of $26.6 million of the funds collected from the assessments paid by pecan producers to promote U.S. pecans. Promotion expenditures began at about $2.4 million in 2016/17 and then peaked at nearly $9.6 million in 2017/18 before falling to $6.4 million by 2019/20 (Figure 1). The decline in expenditures in the most recent two years was the result of a decline in assessments

Figure 1: APC Expenditures by Category, 2016/17-2019/20



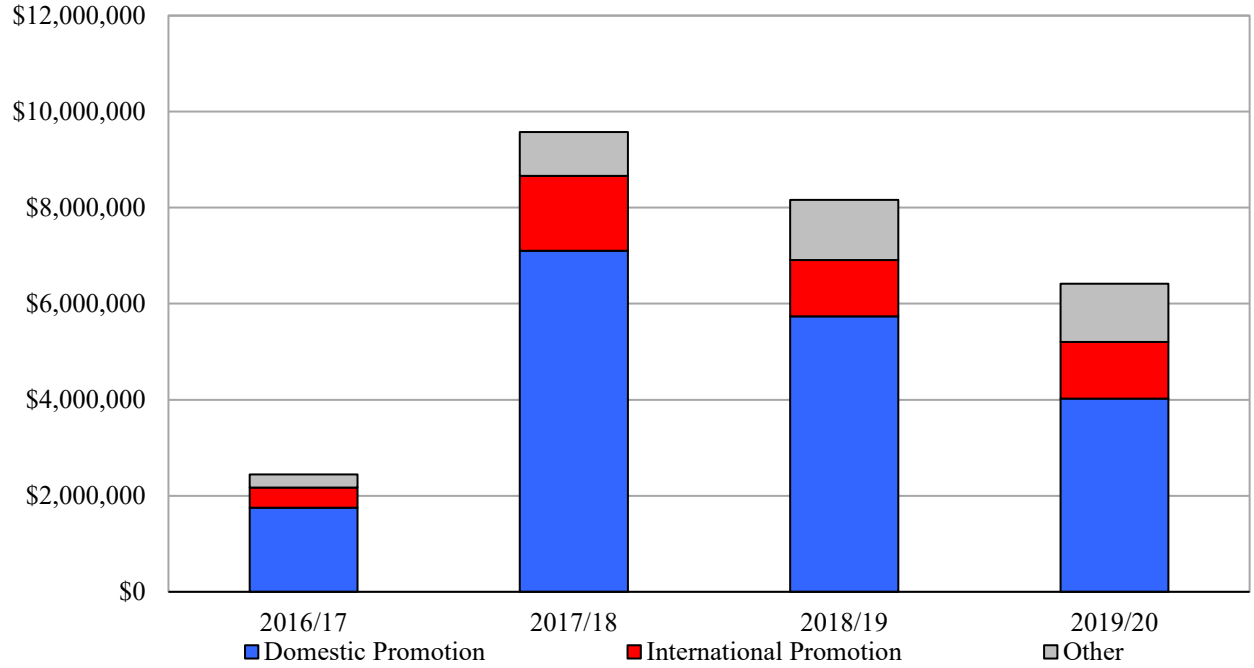
Source: Created by authors with data provided by American Pecan Council (2020).

as the market value of pecans dropped in those years. A wide variety of promotional activities has been supported by the expenditure of the assessment funds, including marketing/research (56.1%), strategic planning (8.3%), funds provided to the U.S. Pecan Grower's Council (USPGC) (7.2%), industry relations (4.0%), agricultural trade promotion (4.5%), international relations (3.9%), standardization (1.7%), and Market Access Program (MAP) assistance (0.7%) as well as administrative activities[2] of various types (13.8%) (Figure 1).

Just over 86% of the funds ($22.9 million) were expended in direct (non-administrative) pecan promotion activities in two categories over 2016/17 through 2019/20: (1) domestic promotion (70%) and (2) international promotion (16.3%) (Figure 2). APC domestic promotion expenditures amounted to a total of $18.6 million allocated to marketing and research (80.2%), strategic planning (11.8%), industry relations (5.6%), and standardization (2.4%) (Figure 3).

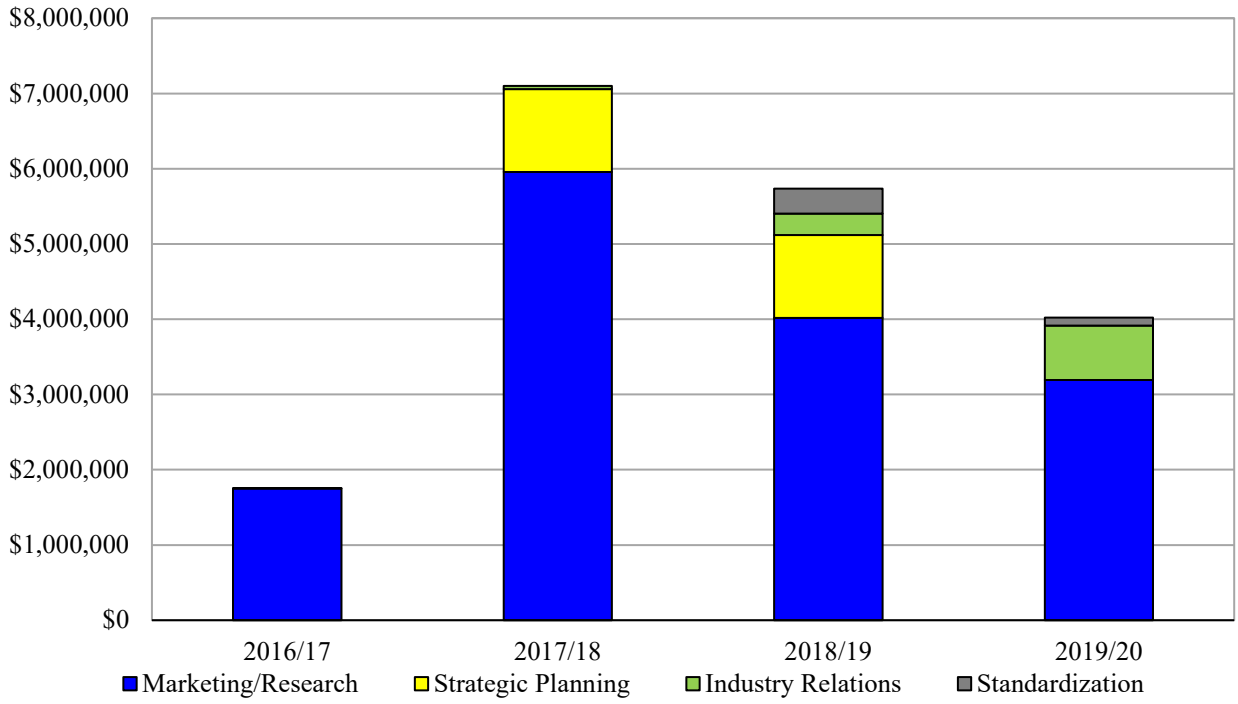
[2] Administrative activities include expenses in the "General and Administrative" category plus related expenses in the following categories: compliance, finance, personnel, APC expenses, and capital items.

Figure 2: APC Expenditures for Domestic and International Promotion, 2016/17-2019/20



Source: Created by authors with data provided by American Pecan Council (2020).

Figure 3: APC Domestic Promotion Expenditures by Type, 2016/17-2019-20



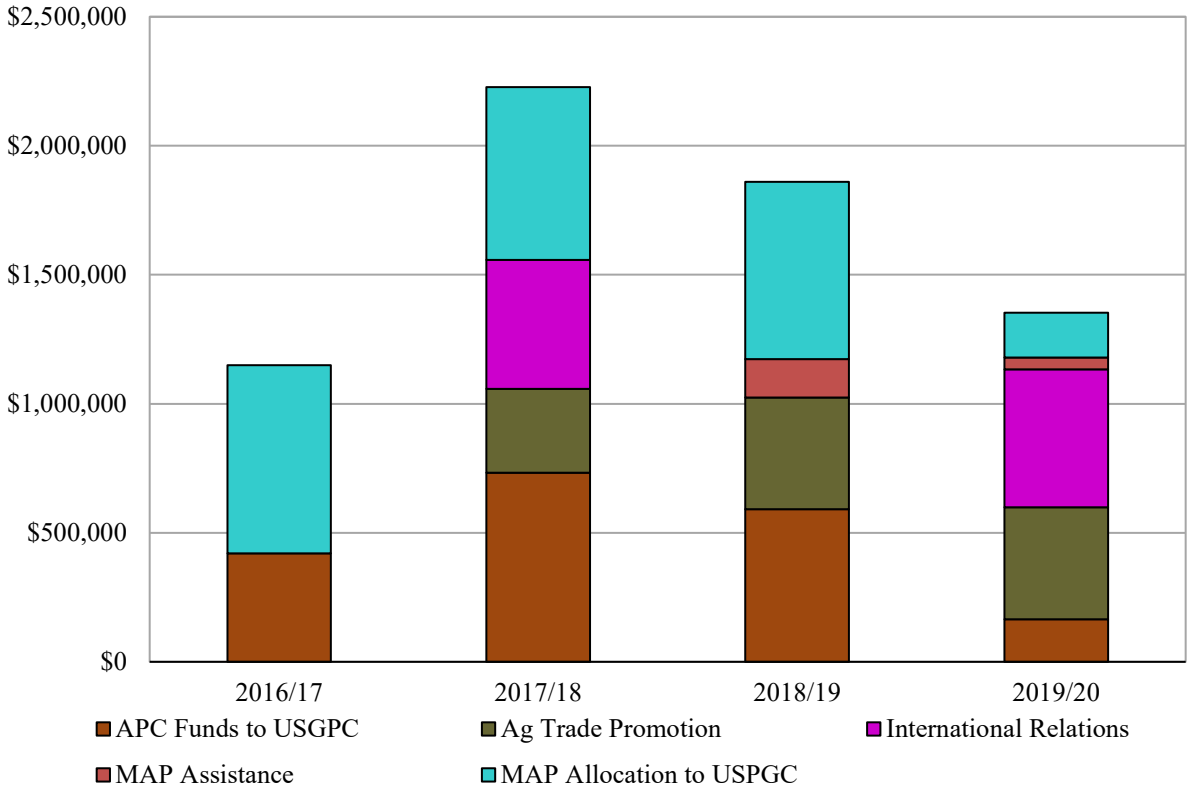
Source: Created by authors with data provided by American Pecan Council (2020).

Marketing/Research expenditures were primarily for marketing activities developed by Weber Shandwick, Aspire, Digital Media, and I-Heart Radio, and others to promote pecans in U.S. markets. All activities are targeted to identified demographic consumer audiences and are measured for the impact of marketing messages designed to motivate customers to seek out pecans actively ("pull" promotional strategy). *Strategic Planning* expenditures encompassed a two-year project to evaluate the whole pecan industry which established the basic statistics and consumer information needed to ensure that APC had a targeted market strategy. The results and data were invaluable to ensure that the industry was completing activities needed to increase consumer demand, consumption, and top-of-the-mind awareness. Once the strategic planning was completed, the *Industry Relations* category expenditures communicated the marketing and consumer outreach to the pecan industry. This category also includes expenditures for auditing, market surveys, and getting the word out to the industry on APC activities. Additionally, expenditures are made for sponsorships to get the industry and consumers that attend association trade shows thinking about pecans. Sponsorships for magazines and articles also are included in this category. Expenditures made in early years under the category "Communication" to get the message out to the industry on APC activities subsequently were incorporated into the Industry Relations category. "Data & Statistics" was another early APC expenditure category that also has since been incorporated into Industry Relations. Expenditures for data and statistics include the costs of all the data that is gathered based on forms returned to the APC. Data are compiled and then shared with the industry to give growers the best audited data of the industry while keeping handlers honest on what is being produced and delivered to the market. These data assist the industry in determining activities needed to take their product directly to the customer ("push" promotional strategies) while understanding supply and demand considerations to market their crop. Finally, *Standardization* expenditures were for two programs in progress to assist the U.S. pecan industry. The first is an Assurance Quality Program (AQP) designed to create a voluntary standard that growers and handlers may use to certify that their growing and handling practices meet certain criteria. The purpose is to showcase the assurance program to customers and grow consumer confidence that pecans meet or exceed a certain industry criterion. Once certified, the grower or sheller markets their pecans with a certified seal outlining their dedication to produce a safe and quality nut. The second program in progress is a mandatory grade and standard that would be certified by a third party. Once certified, all nuts entering the marketplace would have to meet

the mandatory government standard. This certification would assist in providing consistency in the marketplace and reward the industry for quality products.

International promotion expenditures by APC from producer assessments over the same period totaled far less than for domestic promotion at $4.3 million and consisted of activities in four categories: (1) APC funds to the USGPC to support their international promotion program (44.1%), (2) agricultural trade promotion (27.5%), (3) international relations (23.9%), and (4) Market Access Program Assistance (4.5%) (Figure 4). In addition to the funds from producer assessments under FMO No. 986, funds expended to promote U.S. pecans in foreign markets included nearly $2.3 million in MAP funding provided by USDA to the USPGC bringing the total funds expended for international promotion of pecans to $6.6 million over 2016/17 through 2019/20. APC provided *Funds to USPGC* to support their marketing activities in international markets. Upon completing the Strategic Plan, a signed deal between the USPGC and the APC was reached on international marketing activities. Because the APC is the largest organization that represents all segments of the industry, the APC now submits the applications and oversees all international activities. USPGC will assist the APC in coordinating activities in China and Southeast Asia. The contract between APC and USPGC is reviewed annually. *Agricultural Trade Promotion* expenditures were for activities such as research and studies, along with market representation. With the MAP program being overseen by the APC, categories will be condensed into the specific country markets. This category specifically focuses on marketing activities for specific countries, China, and the EU. These dollars are industry dollars and are in addition to the MAP program dollars received from USDA. All of these dollars are used for marketing and intended to motivate foreign buyers to search for and purchase U.S. pecans ("pull" marketing strategies). *International Relations* expenditures were for activities such as international market research, international association memberships, travel, and international relations consulting. *Market Access Program Assistance* was for consulting and putting together the needed grants, documents, data, and statistics for Market Access Program (MAP) and Emerging Market Program (EMP) funding. *MAP Allocation to USPGC* were dollars granted to the industry by USDA for international marketing activities. These dollars must be matched by the industry. Activities included in these areas include trade shows, market research, point of sale activities, and market representatives. Since the McKinsey studies, these dollars will be used for more international

Figure 4: APC International Promotion Expenditures by Type, 2016/17-2019/20



Source: Created by authors with data provided by American Pecan Council (2020).

"pull" marketing activities while other trade associations and individual companies will focus on international "push" marketing activities (i.e., taking pecans directly to foreign customers through whatever means to ensure customers are aware of U.S. pecans at the point of purchase).

THE ECONOMICS OF GENERIC DEMAND PROMOTION

The primary objective of any generic commodity promotion program is to foster the growth and profitability of the production of that commodity. Ultimately, individual producers contributing to the program expect that the funds will be spent in such a way that they will be individually better off than they would have been without the promotion program. What can reasonably be expected of a generic demand promotion program in terms of the market effects and the effects on producers? This section explores various aspects of the economics of

generic commodity promotion as background to the subsequent analysis of the pecan promotion activities under FMO No. 986.

The Supply Response to Generic Demand Promotion

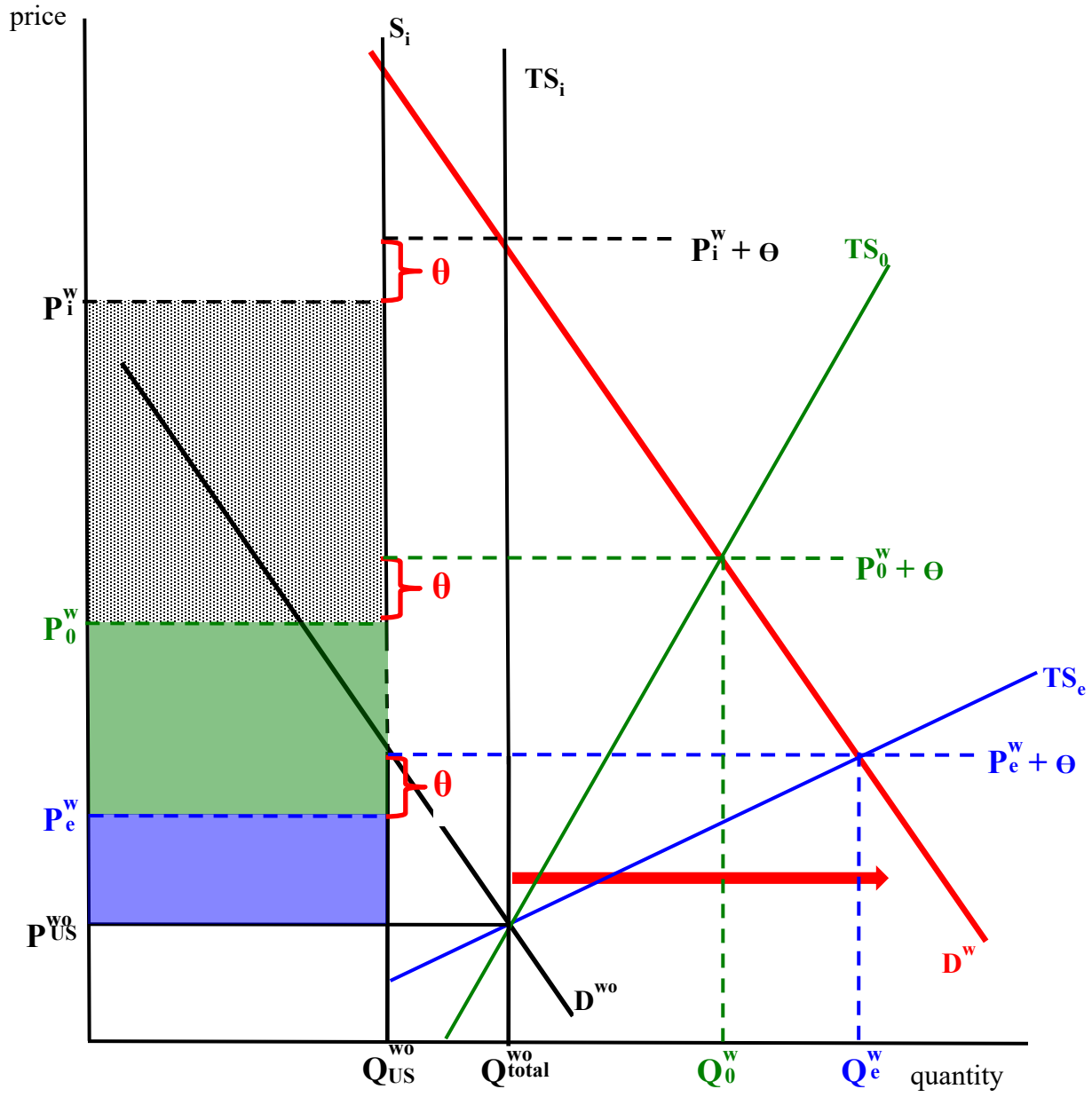
The objective of promotion is to shift out demand and, thereby, increase the market price on a higher volume of sales over time. Indeed, promotion programs that successfully move out the demand curve raise market prices. In raising the price, however, they also stimulate a greater level of production than would have occurred which moderates the extent of the price increase. The critical link between supply response and the effectiveness of promotion is illustrated in Figure 5 which focuses on the *short-run* given that the APC has been promoting pecans for only four years.

Assume, for example, that promotion activities of the APC shifts out the total demand for pecans (domestic and export) in a given year from D^{wo} (black line) to D^{w} (red line) as depicted in Figure 5 (where "wo" and "w" mean "without" and "with" promotion, respectively). In Figure 5, the supply of pecans available from U.S. producers is considered to be unresponsive to prices (price-inelastic in economics jargon) in the short-run as illustrated in Figure 5 as the vertical supply curve (S_i) which reflects the lengthy time lag in the U.S. pecan production response to changing prices. Some response of U.S. native pecan supply could occur over a shorter period of time as native producers harvest more of their pecans as prices increase. However, native pecans make up a small percentage of total U.S. pecan production. Consequently, a *substantial* response of U.S. pecan supply to a promotion-induced pecan price increase could not have been possible over the four years since the establishment of FMO No. 986 and APC generated promotion activities with the assessment fees collected from producers.

Even though the U.S. pecan supply cannot change much in response to a price increase from promotion in the short run, supplies of imported pecans can be more price responsive to some extent because Mexico can divert some of its pecan exports to higher-priced U.S. markets as a result of pecan promotion[3]. Figure 5 illustrates three possible short-run pecan market scenarios representing different levels of pecan import supply response to a promotion-induced increase

[3] U.S. supplies of pecans might also increase as the volume U.S. exports declines to take advantage of higher prices in the domestic market. This response is netted out of the demand increase from promotion in Figure 5.

Figure 5: Pecan Demand Promotion and Pecan Supply Response in the Short Run



in the price of pecans: (1) a TOTAL supply that is highly responsive to price (the blue line labeled TS_e), (2) a less price responsive TOTAL supply (the green line labeled TS_0), and (3) a TOTAL supply that is completely unresponsive to price (the black line labeled TS_i). In each of the three cases, the level of pecan imports in Figure 5 is the horizontal difference between the respective total supply curve (TS) and the perfectly inelastic (vertical) U.S. pecan supply curve (S_i). The blue

total supply curve (TS_e) is shown relatively price elastic because the supply of pecans coming from Mexico are assumed to be relatively responsive to price changes in that scenario. In contrast, the green total supply curve (TS_0) is shown as less price elastic because the supply of pecans from Mexico is assumed to be less responsive to price changes. Finally, the black total supply curve (TS_i) is drawn as perfectly inelastic because imports from Mexico are assumed to be unresponsive to price changes. Imports still occur but they do not change in response to price changes in the short run.

With no promotion, the U.S. price of pecans in Figure 5 is P_{US}^{wo} and the total quantity of pecans produced and consumed is Q_{total}^{wo} of which Q_{US}^{wo} are U.S.-produced pecans and the remainder are pecan imports. Following the APC promotion expenditures which shift the total pecan demand curve from D^{wo} to D^{w}, if the import supply response to the resulting higher prices in the U.S. market is vigorous as represented by the total supply curve TS_e in Figure 5, total pecan supplies in the U.S. market would equal Q_e^w and imports would equal Q_e^w - Q_{US}^{wo} facilitating a total U.S. consumption level of Q_e^w. Consistent with Chang and Kinnucan (1991), the checkoff assessment behaves like a per unit tax on sales of U.S. pecans. Graphically, the effect is manifest as producer prices lower than market prices by the amount the assessment per unit (θ). In this case, the U.S. producer price of pecans is P_e^w and the price paid by buyers is $P_e^w + \theta$ (where θ is the per unit assessment on U.S. producer sales of pecans).

Note that most of the effect of the pecan promotion in this first case is an increase in total pecan sales from Q_{total}^{wo} to Q_e^w in Figure 5 rather than a price increase (P_{US}^{wo} to P_e^w). Also note that the increase in U.S. market sales of pecans comes totally from imported pecans because U.S. pecan production cannot increase to any extent in the short run. Nevertheless, the price increase in this scenario boosts revenues to U.S. producers by the amount of the blue shaded area in Figure 5 as a result of the price increase. Because no additional costs are required to earn those additional revenues, the blue shaded area also represents the additional profit earned by U.S. producers from APC promotion over the last four years (2016/17 - 2019/20) in this scenario. If U.S. plantings of pecan trees in response to the price increase from promotion is also vigorous in response to continued promotion, U.S. produced pecans in future years would begin to compete with imported pecans over time as a result of promotion in previous years resulting in fewer sales of Mexican

pecans into U.S. markets in future years. The net benefit (profit) to producers from promotion will be positive unless the U.S. long-run supply curve is perfectly price elastic (flat). In this case, the promotion program could generate a loss to producers if the producer profit generated by the demand promotion (the blue shaded area) is less than the cost of the promotion.

A more likely scenario is represented by the less price-elastic green pecan total supply curve TS_0 in Figure 5. In this case, the same promotion-induced shift in the U.S. demand for pecans would result in a greater increase in the producer price of pecans (P_{US}^{wo} to P_0^w) and a smaller increase in pecan sales (Q_{total}^{wo} to Q_0^w). This case is actually similar to the previous case except that the import supply of Mexican pecans does not respond so vigorously to the price increase. In the short run, U.S. pecan producers face the same temporal problem that few additional U.S. supplies of pecans can be made available for eight years or more following an increase in demand from the promotion. Again, almost all the increase in sales volume in Figure 5 over the short run would be supplies from Mexico and from reduced U.S. pecan exports. Over time, of course, as pecan trees previously planted due to the promotion-induced increase in U.S. prices begin to yield additional pecans, more of the additional sales due to the promotion will begin to be U.S. pecans and less from imports. In the short period of the last four years of APC promotion expenditures, however, the higher price (P_0^w) on about the same level of U.S. pecan production would increase producer revenue (profit) by the blue plus the green shaded areas in Figure 5. As long as the producer profit generated by the demand promotion is greater than the cost of the promotion, producers gain from the promotion. The amount of the gain depends on multiple factors including how effectively the APC promotes pecan demand, how much is spent on promotion, and how price responsive demand, production, and import supplies are to any price increase prompted by the APC promotion.

In the third scenario, import supplies are assumed to be as unresponsive to a price increase generated by promotion as domestic supplies would be. Thus, the total U.S. supply of pecans (U.S. and imports) would be illustrated as the black, perfectly inelastic supply curve (TS_i) in Figure 5. In this scenario, the same demand increase from promotion (D^{wo} to D^w) would result in a much higher price increase of P_{US}^{wo} to P_i^w and, thus, a profit increase of the gray shaded area plus both the blue and green shaded areas in Figure 5. Just like the two previous cases, U.S. production cannot increase to any extent (except for some additional harvest of native pecans) in response to the price

increase during the short period of four years over which the APC has promoted pecans. Thus, as in the previous scenarios, any gains to producers from APC promotion in this scenario comes primarily from supporting the farm price of pecans. Unlike the previous two cases, however, imports do not respond to the price increase, implying an inability of Mexico to divert exports from other destinations and the inability of Mexican producers to generate additional production and exports during the short four-year period of 2016/17 to 2019/20. The result is a larger increase in producer revenue from the promotion than in the previous two cases which is the additional profit earned and the net benefit to producers from promotion in this scenario.

The problem of the response to advertising in an industry without supply controls like pecans was first discussed in a now classic article by Nerlove and Waugh (1961) which focused on orange juice and the returns to orange producers. Nevertheless, relatively few studies of the effects of advertising have considered the possibility of a supply response. Kinnucan, Nelson, and Xiao (1995) determined that supply response completely eliminated returns to advertising of catfish over time. Studies of the soybean checkoff program (Williams 1985; Williams, Shumway, and Love 2002; Williams, Capps, and Bessler 2009; Williams, Capps, and Lee 2014) concluded that although the program was effective in expanding demand and generated a high benefit-cost ratio, the increase in the farm price of soybeans has been modest as the result of supply expansion. Carman and Green (1993) found that avocado producers benefitted from generic advertising during the initial years of the program (1960s and mid-1970s) but that supply expansion eventually led to negative returns from continued advertising. While avocado producers existing at the time the advertising program was initiated benefitted, they concluded that "as acreage expanded, prices were forced down toward a level that would have existed for a smaller acreage without advertising. Now real returns per acre for avocados are similar to those that would have occurred without the advertising, but the advertising has become a built-in cost." They question whether there are long-run benefits to advertising in an industry without supply controls.

The Conflicts from Simultaneously Promoting Domestic and Export Demand

To pecan producers demand is demand. As long as someone purchases their product, it doesn't really matter whether it is a foreign or a domestic consumer. An increase in demand increases price whether it is foreign demand or domestic demand. However, what happens to U.S. domestic and

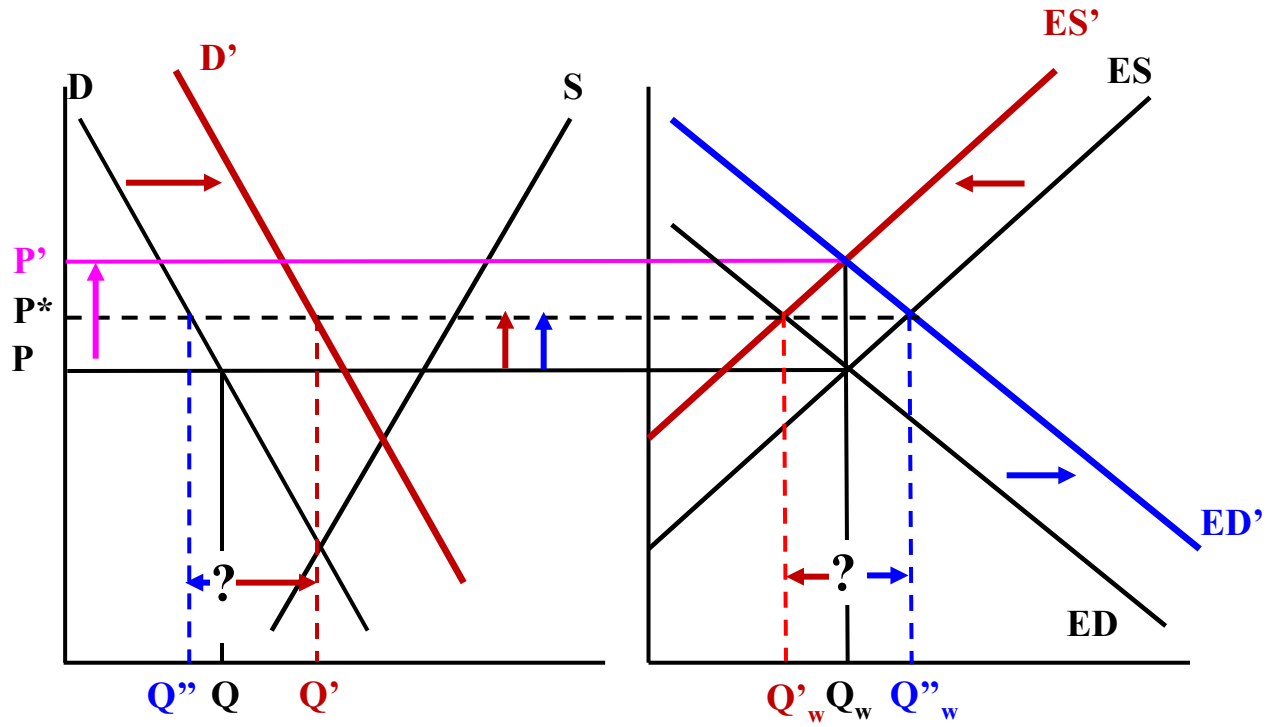
export sales of pecans depends on whether the promotion is domestic or international. Figure 6 illustrates the problem in the case of U.S. pecan promotion. The left panel of Figure 6 illustrates the domestic U.S. supply and demand for pecans over time (black curves S and D, respectively, in Figure 6). The horizontal difference between domestic supply and demand is the long-run U.S. supply of pecans available for export at each price (that is, the supply not consumed by domestic users and, therefore, available for export) shown as the black ES curve (export supply) in the right panel of Figure 6. The export demand for U.S. pecans is the downward sloping black export demand (ED) curve in the right panel of Figure 6.

Pecan promotion activities that increase ONLY domestic demand over time is shown in the left panel of Figure 6 as a shift of the domestic demand to the right (the red line marked D'). With greater domestic demand, the U.S. supply of pecans available for export at every price is now less which is shown as a leftward shift of the ES curve in the right panel of Figure 6 to the red excess supply curve marked ES'. The consequence would be an increase in price to P* and a higher level of domestic use to Q' but a lower level of exports to Q'_w because of the increase in domestic use of the available supply.

If, instead, the checkoff funds are used ONLY to promote the export demand for pecans over time (a shift of the excess demand curve from ED to the blue line marked ED' in Figure 6), the consequence is, again, a long-run increase in the price of pecans to P* but this time accompanied by a greater (not lower) level of exports to Q''_w. Note that the domestic use of pecans declines to Q" due to the greater volume of available U.S. pecan supplies going to export markets.

Consequently, domestic demand promotion over time results in lower exports and higher domestic use whereas export demand promotion results in lower domestic use but higher exports. Both raise the market price. Thus, if both domestic and export demand are simultaneously promoted over time so that both the domestic demand and the foreign demand curves for pecans shift to the right (a shift of D to D' in the left panel of Figure 6 and a shift of ED to ED' in the right panel of Figure 6), the result is an even higher price achieved (P') over time than with only domestic or only export demand promotion alone. The consequences for pecan exports and for domestic use of pecans over time, however, are ambiguous, that is, they could be higher or lower than Q_w and Q, respectively, over time. If checkoff expenditures and promotion effectiveness are sufficiently greater for export

Figure 6: Trade-offs from Promoting Domestic and Export Demand at the Same Time



demand promotion compared to domestic demand promotion, the net results over time again would be an increase in the pecan price but exports could increase to a level greater than Q_w and domestic consumption to a level less than Q. If promotion expenditures and promotion effectiveness are sufficiently greater for domestic promotion than for export promotion over time, the net consequences would still be an increase in price but exports would be lower than Q_w and domestic use could be higher than Q. This latter case is most likely for pecans because APC expenditures on domestic promotion are more than four times greater than for export promotion. Thus, whether promotion shifts domestic demand by relatively more or less than export demand, the pecan price tends to increase over time. Perhaps surprisingly, however, despite export promotion efforts, exports could actually decline because of a disproportionately large investment in domestic demand promotion over time relative to foreign demand promotion. Conversely, despite efforts to promote domestic demand, domestic use could actually decline over time with a disproportionately large simultaneous investment in export promotion.

The Relationship between Checkoff Spending and Demand Promotion

In addition to the various complications of supply response and the conflicts from promoting both domestic and export demand at the same time, the linkage between investments in demand promotion of any type and the anticipated market effects is further complicated by a number of well documented characteristics of the response of sales to advertising and promotion programs, including: (1) the magnitude of the sales response to promotion, (2) the minimum promotion threshold, (3) the delay effects of promotion, (4) the lagged or carryover effects of promotion, (5) the decay of promotion effects, and (6) advertising and promotion 'wearout'.

Research has shown that the *response of sales to advertising* is normally positive and statistically significant but fairly small in magnitude or elasticity (Ward, 2006). Also, research has demonstrated that some *minimum level of promotion expenditures* and messages are normally required for the expenditures to begin having any effect. Below that level, promotion expenditures may be simply unable to generate sufficient recall or awareness to motivate consumers.

Even if investments in promotion activities are well above the minimum threshold level, there may be a *delay effect of promotion,* that is, a delay between the time that the investment is made and the market impact of the investment is expected depending on the type and objective of the promotion program. Thus, attempts to measure the effectiveness of the promotion effort in the early stages of a checkoff program may yield disappointing results.

Promotion expenditures also tend to have *lagged or carryover effects*. Expenditures in a given period often do not have their full impact within that period but continue to impact sales over an extended period of time. Generic promotion activities, like those generally funded by pecan checkoff dollars in both the domestic and foreign markets, are generally directed toward longer-term responses and, therefore, have often been found to generate lengthy lagged or carryover effects (Forker and Ward, 1993). Promotion activities also often display *decay effects* over time. That is, despite persisting over time to some extent, the effects of a promotion activity will not last forever and eventually begin to fade at some point.

Advertising 'wearout' is also possible. Even though the continual exposure of an advertising message to consumers can help stem the decay effects of promotion expenditures, after long

periods of exposure to a particular message, additional promotion expenditures on that message normally have decreasing impacts on sales.

Figure 7 illustrates a typical pattern of promotion effects on sales. Following the initial treatment (expenditure) at point A, there is usually some delay before the expenditures begin having an effect on sales at point B, assuming that the promotion expenditures are above some threshold level. The maximum impact of the initial treatment in Figure 7 is eventually reached after which there is some decay in the sales effects. The decay from the initial treatment can be avoided and aggregate sales boosted if additional expenditures are made before the decay begins (point B).

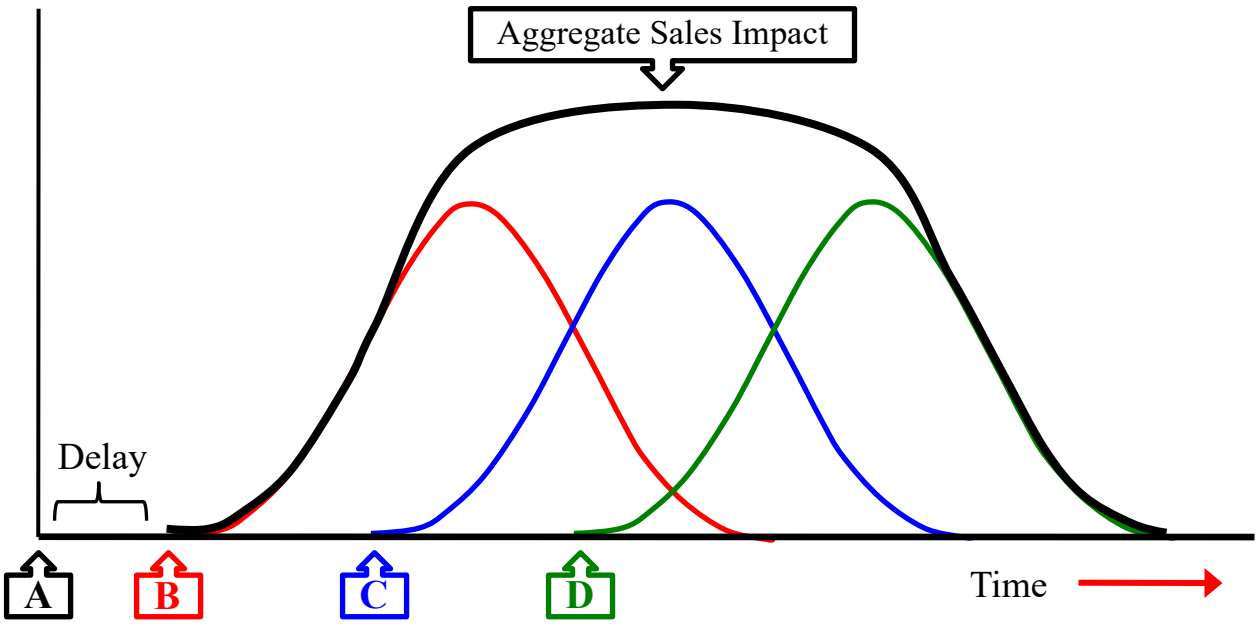
Continued promotion treatments (expenditures) (points C and D) can maintain the aggregate level of sales achieved with the first two treatments (dark black line in Figure 7). Higher and higher expenditures, however, can push sales to higher levels while a drop off in the level of promotion expenditures results in a decay in the sales effects. If promotion activities are ended altogether, the level of sales will taper off toward the pre-promotion program level over time. Research suggests, however, that because promotion programs may achieve some permanent change in user behavior, sales will not drop all the way back to pre-program levels after a promotion campaign. Forker and Ward (1993) note that without the decay phenomenon, there would be no reason for continued expenditures on promotion activities after the initial effort.

Overview of Research on the Effectiveness of Commodity Checkoff Programs

Early evaluation of the effectiveness of and producer returns from commodity checkoff programs relied largely on anecdotal evidence and simple comparisons of gross promotion expenditures against changes in prices, profitability, and utilization of the commodities being promoted. When commodity markets and producer profits as well as checkoff program expenditures are all growing, this approach to evaluation can yield a persuasive upward-sloping graphical relationship between promotion expenditures and market prices, demand, and profits.

The problem with this comparison-of-checkoff-expenditures-to-market-variables approach to evaluating a checkoff program is that many factors other than checkoff expenditures affect the markets for agricultural commodities, many of which have considerably greater influence on commodity markets than checkoff programs. Market events like changes in the costs of production

Figure 7: Delay, Carryover, and Decay Effects of Demand Promotion



A = Initial treatment B = First effects begin C = Second treatment D = Third treatment

inputs, weather (e.g., hurricanes), currency exchange rate fluctuations, changes in the performance of U.S. and foreign macroeconomies, changes in consumer buying habits, changes in government policies, and global events like the COVID-19 pandemic, to name just a few, can move markets up or down over a given time period despite what checkoff programs may be doing to influence markets. This problem becomes rather apparent when commodity markets experience downturns despite continued expenditures by the related checkoff programs. If checkoff programs take credit for increased producer prices and profits when checkoff expenditures and markets are growing, then they are usually forced to take the blame for failing to prevent a reduction in producer prices and profits when markets decline. The need to isolate and measure the unique contribution of commodity checkoff programs to the performance and profitability of the related commodity markets has led researchers to devise improved means of evaluating the effectiveness and stakeholder returns from those checkoff programs.

A standard method of determining if advertising and promotion is economically feasible has been to calculate a benefit-cost ratio (BCR) which corresponds to the *average* return to producers who pay for the promotion per dollar spent on advertising and promotion. A BCR calculated as the

market sales revenue or cash receipts (net of promotion costs) received by producers per promotion dollar spent on advertising and promotion is referred to as a *revenue BCR* (RBCR). Some researchers have preferred to report the *marginal* BCR which is the increase in returns to stakeholders from a $1 (or 1%) increase in promotion expenditures.

When any additional production costs are first netted out of the additional producer revenue calculated to be generated by the program, the resulting BCR can be referred to as a *profit BCR* (PBCR). Sometimes researchers use an economic measure of the increase in producer economic welfare (referred to as producer surplus) generated by a promotion program instead of revenue or profit to calculate a *surplus BCR* (SBCR). A profit and a surplus BCR should provide roughly equivalent measures of the return to producers from investments in demand promotion. To account for the time value of money, researcher often discount the calculated BCR for a promotion program to present value by first discounting the calculated returns to stakeholders over time before dividing by total advertising and promotion expenditures to generate a *discounted BCR* (DBCR). However calculated, an estimated BCR of greater than 1 is taken as an indication that the program is beneficial because sales, profits, or economic surplus have increased by more than one dollar for every dollar spent on advertising and promotion. On the other hand, a BCR of less than 1 is taken to mean that advertising and promotion do not pay since each dollar spent generates less than a dollar in additional sales, profits, or economic surplus.

Most studies of commodity checkoff programs have found that advertising and promotion increase the return to producers by more than the cost of the corresponding advertising and promotion programs. In most cases, the calculated BCRs have been found to be much in excess of 1. For almond promotion, for example, Alston, et al. (2017) calculated a BCR of 6.2 (Table 1). Other studies focusing on diverse commodities likewise reported returns to producers from their respective advertising and promotion programs per dollar spent on promotion in the range of about $4 to $17 (Table 1). Williams, Capps, and Hanselka (2018) reported a weighted average across the BCRs of a large set of the existing commodity promotion programs of $6.90 per dollar spent on promotion. That is, in general, commodity advertising and promotion has been found to generate returns to producers (and/or other stakeholders) by more than enough to cover the costs of the respective advertising and promotion activities.

Table 1: Returns to Generic Commodity Promotion, Selected Studies

Commodity Promotion Group	Study	Benefit-Cost Ratio[a]	
		Average	Marginal
Almond Board of California	Alston et al. (2007)		6.2
American Egg Board	Ward (2012)		11.14
American Lamb Board	Ghosh and Williams (2016)	14.44	
Cattlemen's Beef Promotion and Research Board	Kaiser (2014a)		11.2
Cotton Board	Capps, Williams, Hudson (2016)	3.6	
Dairy (All Dairy)	USDA (2020a)	4.35	
Hass Avocado Board	Carman, Saitone, Sexton (2013)	5.68	
Mushroom Council	Richards (2016)		1.24[b]
National Honey Board	Ward (2014)	13.12	
National Mango Board	Ward (2016)	10.51	
National Peanut Board	Kaiser (2014b)		10.4
National Pork Board	Kaiser (2012a)		17.4
National Watermelon Promotion Board	Kaiser (2012b)	27.73	
Potatoes USA	Richards and Kaiser (2012)		2.92
Propane Education and Research Council	ICF International (2007)	7.0	
Softwood Lumber Board	SLB Annual Report (2015)	15.55	
United Sorghum Checkoff	Capps, Williams, Málaga (2013)	8.48	
United Soybean Board	Williams, Capps, and Lee (2014)	5.2	
U.S. Highbush Blueberry Council	Kaiser (2015)		9.07
Median over all BCRs		8.48	
Simple average over all BCRs		9.31	
Weighted average[c] over all BCRs		6.90	

Source: Based on Williams, Capps, and Hanselka (2018).

[a] For the few studies that report both short-run and long-run BCRs, only the short-run BCRs are shown here. Also, for studies that report a range of values, an appropriate midpoint or average value is used.

[b] No overall BCR reported. Used average of short-run direct BCRs reported for retail and food service demand.

[c] Weighted by amount of expenditures for promotion by respective commodity promotion group.

STUDY METHODOLOGY

This section first discusses the methodology used to measure the effectiveness of the pecan checkoff program and to measure the return to pecan producers from their investment in the pecan checkoff program. Then, the methodology used to examine current consumer awareness, attitudes, and usage regarding pecans is discussed.

Measuring the Effectiveness of the Pecan Checkoff Program

The first step in the process of measuring the effects of APC promotion activities on U.S. pecan markets and the returns to producers was to modify PecanMod, an econometric simulation model of the U.S. pecan industry developed by Capps and Williams (2019), to account for the promotion activities of the American Pecan Council over 2016/17 through 2019/20. This process required a re-estimation of the econometric equations in PecanMod for domestic and export demand to account for APC promotion expenditures in those four years.

Econometric analysis allows the measurement of this relationship between APC promotion expenditure and the domestic and export demands for pecans through controlling for other factors that may affect each demand, thus, isolating the specific effect of APC promotion expenditures on those demands. The econometric analysis covers the time period of 1980/81 (October/September) through 2019/20. Promotion expenditures enter the model only in 2016/17 through 2019/20. The result of this process was a measure of the change in the U.S. domestic pecan demand and the U.S. export demand in response to APC domestic and export promotion, respectively at fixed prices, controlling for the effects of all other variables.

The next step in the process was to use PecanMod to simulate pecan price and markets effects resulting from APC domestic and export demand promotion expenditures. The simulation results allow the measurement of the contribution of the APC promotion program not only to the levels of U.S. pecan supplies, demands, and prices but also to pecan producer revenue and profit over the study period.

The last step in this process was the use of the results from the first two steps to calculate the return to pecan producers associated with their investment in pecan promotion through the promotional

activities of the APC. Even if the APC promotion program successfully increased the demand for U.S. pecans, the important question for U.S. pecan producers is whether or not the cost to them of the assessments they have paid, which funds APC promotion programs, has outweighed the additional revenues and/or profit that they may have earned as a result of the program. Put another way, producers want to know what the return has been to the dollars they have contributed to promoting U.S. pecans and, therefore, whether those funds might have been more profitably invested elsewhere. Addressing these questions requires a benefit-cost analysis of the returns to pecan producers from the additional revenues and profit generated by the APC promotion program. To this end, pertinent benefit-cost ratios (BCR) for the APC domestic and export demand promotion programs over 2016/17 through 2019/20 are calculated that represent economic measures of return on investment (ROI) to the APC promotion programs.

Econometric Methodology

PecanMod is a structural/economic model or economic representation of the U.S. pecan industry. The basic structure of the model is depicted in Figure 8[4]. In the model, the supply-side activities (utilized native and improved variety pecan production (in- shell and converted to a shelled basis), beginning stocks, and imports) at the top of Figure 8 interact with demand-side activities (domestic utilization, export demand, and ending stocks) at the bottom of Figure 8 to determine producer prices (U.S. average, native, and improved) as well as export and import prices in a given year in the middle of Figure 8. The producer prices in that year then affect the production of improved and native pecans in the following year (dotted lines represent time lags). Together with import supplies and beginning stocks in the following year (which are ending stocks in the previous year), production in the following year interacts with demand activities in that year to determine prices in that year which then impact production in the following year and so on. Because no retail price of pecans is available (red box in Figure 8), the producer price (shelled basis) is used in the model as a proxy assuming that the two prices are positively correlated.

The schematic representation of PecanMod in Figure 8 is laid out as a corresponding set of 14 equations in Figure 9. Each equation represents one of the 14 boxes in Figure 8. The variable names

[4] See Capps and Williams (2019) for more details on PecanMod.

Figure 8: PecanMod Structure

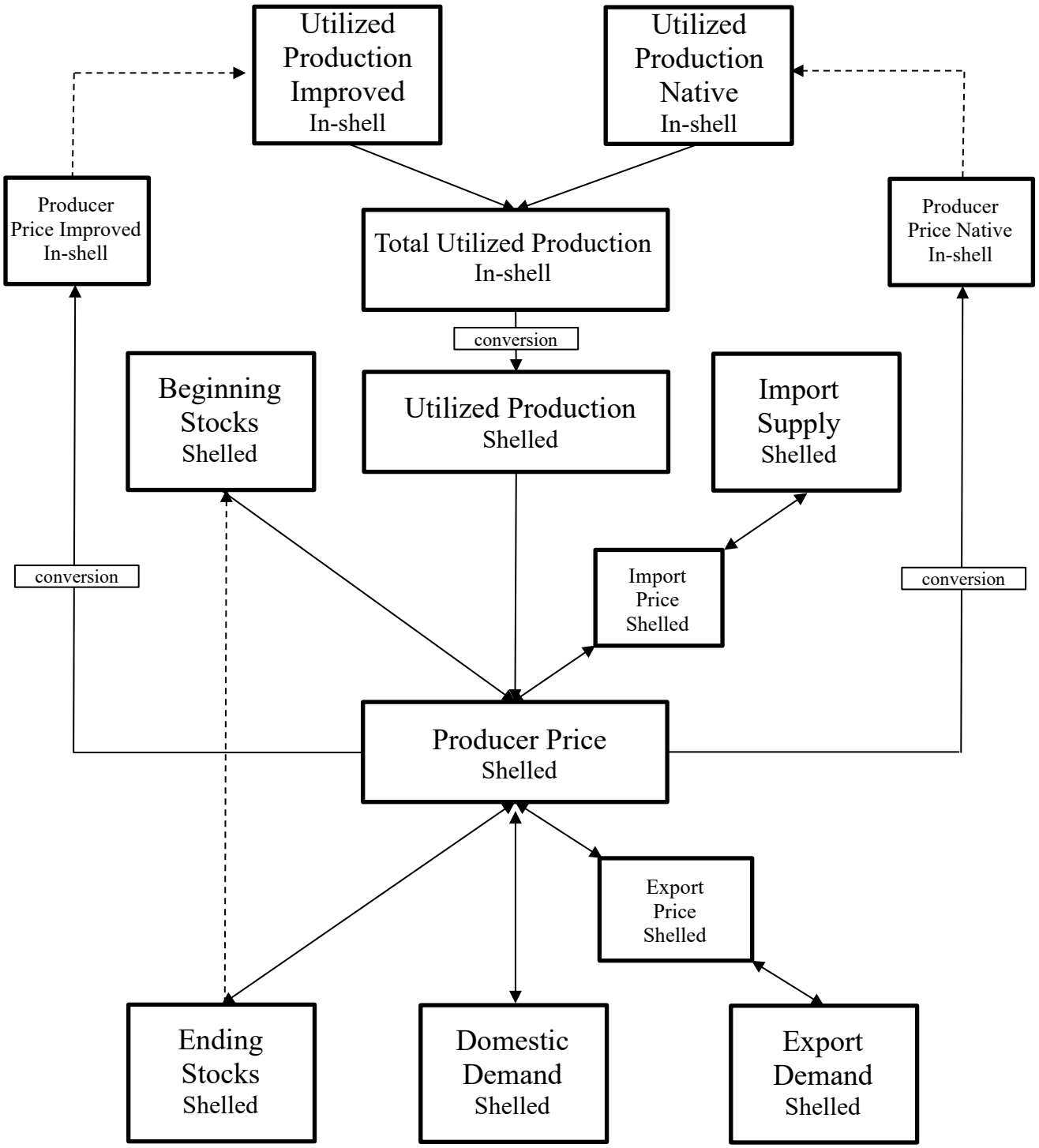


Figure 9: PecanMod Equations

(1)	$S_i = S_i (P^e_i, \alpha_{si})$	Improved pecan production (in-shell)
(2)	$S_n = S_n (P^e_n, \alpha_{sn})$	Native pecan production (in-shell)
(3)	$S_p = S_i + S_n$	Total in-shell pecan production identity (in-shell)
(4)	$S_u = ØS_p$	Total utilized production (in-shell conversion to shelled identity) (Ø = conversion rate)
(5)	$S_m = S_m (P_m, \alpha_{sm})$	Import pecan supply (shelled)
(6)	$D_u = D_u (P_u, \beta_{du})$	Domestic pecan utilization (shelled)
(7)	$E_u = E_u (P_u, \beta_{eu})$	Ending stock demand for pecans (shelled)
(8)	$D_x = D_x (P_x, \beta_{dx})$	Export demand for pecans (shelled)
(9)	$E_{ut-1} + S_u + S_m = D_u + D_x + E_u$	Market clearing condition (shelled)
(10)	$P_i = P_i(P_u/ Ø, \theta_{pi})$	Price linkage ($P_{improved}$ to $P_{shelled\ market}$)
(11)	$P_n = P_n(P_u/ Ø, \theta_{pn})$	Price linkage (P_{native} to $P_{shelled\ market}$)
(12)	$P_m = P_m(P_u, \theta_{pm})$	Price linkage (P_{import} to $P_{shelled\ market}$)
(13)	$P_x = P_x(P_u(1+\tau), \theta_{px})$	Price linkage (P_{export} to $P_{shelled\ market}$)
(14)	$P_p = Ø\ P_u$	Price linkage ($P_{unshelled}$ to $P_{shelled}$)
14 unknowns: $S_i, S_n, S_p, S_u, S_m, D_u, E_u, D_x, P_i, P_n, P_m, P_x, P_u, P_p$		

are defined in Figure 10. The relationships representing six key industry activities are represented in equations (1) and (2) (improved and native pecan production), equation (5) (pecan import supply), equation (6) (domestic pecan utilization), equation (7) (ending stock demand), and equation (8) (pecan export demand) in Figure 9. Equations (10) through (14) represent the various price linkages in the model. Four of the equations in PecanMod as represented in Figure 9 are identities to link various activities such as the addition of native and improved in-shell pecan supplies into a total in-shell pecan supply in equation (3), the conversion of total in-shell supply to shelled supply in equation (4), and the conversion of the shelled producer price to an in-shell basis in equation (14). Equation (9) is a market clearing condition requiring that total supply of shelled pecans equal the total demand for shelled pecans in each year. In the other ten equations, the econometric

Figure 10: PecanMod Variable Definitions

Endogenous Variables:

S_i = U.S. improved pecan production (in-shell basis)

S_n = U.S. native pecan production (in-shell basis)

S_p = U.S. total in-shell production (in-shell basis)

S_u = U.S. total utilized production (in-shell converted to shelled)

S_m = U.S. pecan import supply (shelled basis)

D_u = U.S. domestic pecan utilization (shelled basis)

E_u = U.S. ending stock demand for pecans (shelled basis)

D_x = U.S. export demand for pecans (shelled basis)

P_i = U.S. producer price of improved pecan varieties (in-shell)

P_n = U.S. producer price of native pecans (in-shell basis)

P_m = U.S. price (import unit value) of imported pecans (shelled basis)

P_x = U.S. price (export unit value) of exported pecans (shelled basis)

P_u = U.S. average producer pecan price (shelled basis)

P_p = U.S. average producer pecan price (in-shell basis)

Exogenous Variables:

Ø = conversion rate (in-shell to shelled)

α = exogenous drivers (shift variables) of the respective supply equations, including variables like inflation, prices of competing crops, technological change, etc.

β = exogenous drivers (shift variables) of the respective demand equations, including variables like income, prices of other nuts, population, inflation, etc. where β_{du} and β_{dx} are, respectively, domestic pecan demand promotion and pecan export demand promotion.

θ = exogenous drivers (shift variables) of the respective price equations, including variables like exchange rates, transportation costs, etc.

procedure identifies statistically significant drivers of each market activity and the statistical relationship between them. The estimated coefficients (structural parameters) provide measures of the change in each market activity in the model from a change in the respective explanatory (driver) variable.

Equations (6) and (8) in the model in Figure 9, representing domestic demand for pecans and export demand for pecans, were modified to include the effects of APC promotion of the respective demands for pecans. In essence, APC expenditures were added to those two equations as shift variables (β_{du} and β_{dx}, respectively) and then re-estimated. The long history of the analysis of generic advertising and promotion programs has demonstrated rather conclusively that such promotion programs have carryover effects as discussed earlier. That is, expenditures in a given year do not have their full effect on demand in the period of expenditure but rather the effects are distributed over a number of periods. Thus, to represent the effects of promotion expenditures over time, "goodwill" variables (G) were constructed as distributed lag structures. For domestic and export demand, the goodwill variables at time t ($G_{du,t}$ and $G_{dx,t}$, respectively) were constructed as:

$$(1) \qquad G_{du,t} = \sum_{i=0}^{m} w_i f\left[\beta_{du,t-i}\right]$$

$$(2) \qquad G_{dx,t} = \sum_{i=0}^{m} w_i f\left[\beta_{dx,t-i}\right]$$

where $\beta_{du,t-i}$ refers to current and lagged domestic demand promotion expenditures for lags i = 0, 1, …, m, $\beta_{dx,t-i}$ refers to current and lagged export demand promotion expenditures for lags i = 0, 1, …, m, w_i are lag weights, and f corresponds to a square root transformation to account for the diminishing returns to promotion expenditures. The promotion expenditures in each the domestic and export demand equation (β_{du} and β_{dx}, respectively) must be deflated to properly account for the actual purchasing power of the promotion expenditures over time. The resulting structure of G in each demand equation allows for carryover effects of advertising on demand. To account for these carryover effects and determine the lag weights (w_i), we use the Almon polynomial distributed lag (PDL) formulation commonly used in the analysis of advertising effectiveness (see, for example, Williams, Capps, and Dang 2010, and Ghosh and Williams 2016). Theory provides relatively little guidance as to the structure and length of these dynamic processes. Conventionally, researchers, through the use of statistical criteria like the Akaike Information Criterion (AIC), the Schwarz Loss Criterion (SLC) or the Hannan-Quinn Criterion (HQC), allow the data to suggest the optimal number of lags (the subscript i in equations (1) and (2)) to include in the specification.

The use of the PDL formulation eliminates collinearity among the lagged promotion variables and saves degrees of freedom associated with estimation of the model. The PDL structure reveals the nature of the effect of the respective promotion expenditures on the U.S. and export demands for U.S. pecans. The search for the pattern and time period over which the promotion expenditures affect each demand involved a series of nested OLS regressions. For each lag formulation and each demand equation, lags of up to four years were considered and for the PDL, up to fourth degree polynomials with alternative choices of head and tail restrictions. Based on model selection criteria AIC, SLC, and HQC, a second order PDL of lag length of one year with endpoint constraints was selected for domestic demand promotion as well as for export promotion.

Counter-Factual Simulation Methodology

The first objective of this study as discussed earlier is to answer the question: What have been the effects of the pecan checkoff program administered by the American Pecan Council on U.S. pecan markets and prices? To answer that question, we use PecanMod with the revised domestic and export demand equations to conduct a counterfactual simulation analysis over the 2016/17 through 2019/20 period during which FMO No. 986 was implemented and authorized to use producer assessments to conduct the promotion of pecan sales.

The process of analyzing the effects of an economic event like demand promotion on markets using an econometric model such as PecanMod is referred to as counter-factual simulation. The "simulation" of a model is simply the mathematical solution of a set of equations, such as the 14 equations of PecanMod. A *baseline* simulation is the simulation of the model to determine how closely the model replicates the actual, historical values of the variables in the model, such as the supply, demand, trade, and price variables in PecanMod, over history. A number of statistical measures (known as validation statistics) are used to determine how closely the model comes to tracking the actual values of such market activities. A baseline simulation of PecanMod was conducted previously over the period of 1980/81 through 2018/19 as reported by Williams and Capps (2019). They report that the model validation statistics for the baseline simulation indicate the model does an excellent job of tracking the historical functioning of the U.S. pecan industry.

A counterfactual simulation analysis actually requires two simulations of the model for each scenario analyzed. The first simulation assumes that nothing has changed over the time period of analysis, that is, nothing in the market is different than what actually occurred over history. This simulation is actually just the *baseline* simulation generated to determine the validity of the model. In the context of a counterfactual analysis, the baseline simulation is referred to as the "with" simulation because the simulated values of the industry variables (supply, demand, price, etc.) include the effects of the event being analyzed (such as the effect of pecan demand promotion). Thus, the *with* scenario represents actual history, that is, the level of supply, demand, prices, trade, etc. in the U.S. pecan industry that **include** any effects on those markets of the event being analyzed.

The second scenario simulated with the model in a counter-factual analysis is referred to as the *without* scenario analysis and is conducted by setting the values of some exogenous model variable representing the event to be analyzed (such as the APC expenditures to promote U.S. pecan demand over 2016/17 - 2019/20) at levels different from the historical levels for that variable and then simulating the model again over the same time period to generate new values for the industry variables (production, consumption, trade, prices, etc.). Because the new levels of the model variables in the *without* scenario are generated by changing only the level of an exogenous variable representing an event like pecan demand promotion, they represent the levels of the prices and quantities that would have occurred in the industry over history if that event had not occurred. In the case of APC expenditures to promote pecan demand, the *without* scenario assumes that such expenditures never occurred from 2016/17 through 2019/20. The simulated levels of the industry variables (supply demand, prices, etc.) in this scenario, therefore, represent the levels of those variables that would have occurred during those years if the APC had not existed or did not promote pecan demand.

Differences in the simulated levels of the industry variables in the model (supplies, demand, prices, trade, etc.) in the *with* scenario from those in the *without* scenario are then taken as direct measures of the effects of the event being analyzed, such as the effects of the APC pecan demand promotion. Because no other exogenous variable in the model (e.g., level of inflation, exchange rates, income levels, agricultural and trade policies, etc.) other than APC expenditures on pecan demand promotion is allowed to change in either scenario, this process effectively isolates the effects of

the APC demand promotion on the pecan industry. That is, the simulated differences between the values of the endogenous (industry) variables from the *with* scenario and from the *without* scenario provide direct measures of the historical effects of the APC promotion (and **only** that event).

The price and quantity effects in the counter-factual simulation depend critically on several parameters in the model, including most importantly: (1) the responsiveness of the U.S. pecan production to price changes (that is, price elasticity of U.S. pecan production), (2) the responsiveness of U.S. pecan demand to price changes (that is, the price elasticity of U.S. pecan demand), (3) the price responsiveness of the export demand for U.S. pecans (that is, the U.S. pecan export demand price elasticity), (4) the price responsiveness of U.S. pecan imports (that is, the price elasticity of U.S. pecan import supply); (5) the price responsiveness of U.S. pecan inventories; (6) the responsiveness of U.S. pecan demand and of U.S. export demand to promotion expenditures (that is, the domestic and export demand promotion elasticities), and (7) the level of promotion expenditures for domestic and export demand promotion.

These price and promotion elasticities (short- and long-run) were derived through econometric estimation of the behavioral equations of PecanMod as discussed earlier. Given that the APC pecan promotion program has been in place for only four years, the estimated short-run price elasticities estimated for U.S. pecan production were used in the analysis, implying no response of improved production to the promotion over that period and only a small response of native production. The estimated short-run price elasticities were also used in the equations for the other variables in PecanMod as well such as the U.S. pecan import supply.

Benefit-Cost Analysis Methodology

The results of the counterfactual analysis are used in a benefit-cost analysis to achieve the second objective of this study by answering the question: Have the promotion expenditures by the American Pecan Council benefited pecan producers who pay the assessments that are used to promote pecans? If the econometric and counterfactual analyses determine that there has been little or no impact of APC pecan promotion on domestic or export demand for U.S. pecans, then obviously U.S. pecan producers have received little or no benefit from their investment in pecan promotion. If the analyses determine that promotion has indeed enhanced the demand (domestic

and/or export) for U.S. pecans, then the critical question is whether the gains realized by pecan producers as a result of the promotion expenditures have been sufficient to more than pay for their costs in financing the promotion. That is, has the APC pecan promotion program run at a loss or a profit over the first four years of APC operations (2016/17 - 2019/20) from the perspective of the pecan producers who paid for the promotion? Have the market effects induced by promotion expenditures over those four years been substantial enough to generate sufficient additional returns to producers to more than cover their cost of financing the promotion? If not, then the conclusion would be that the program should be discontinued because the program costs more than it returns to producers. On the other hand, if the returns generated more than cover the costs, the program would be deemed a successful investment opportunity for pecan producers.

To measure the return to pecan producers from their investments in APC pecan demand promotion, the gain in revenue and profit to producers from that promotion program as discussed earlier in connection with Figure 5 are calculated using the results of the counterfactual simulation analysis. The differences between the levels of producer revenue and profit assuming there has been no pecan promotion (calculated using the *without promotion* counterfactual simulation scenario results) are subtracted from the levels of producer revenue and profit that producers actually received (the *with promotion* scenario results) and used as the "benefit" to producers for calculating benefit-cost ratios (BCRs) to U.S. pecan producers over the four years the APC promotion program has been in operation (2016/17 - 2019/20).

Two BCRs are calculated in this study for the four-year period of APC promotion: (1) the Net Revenue BCR (NBCR) and (2) the net economic surplus or profit BCR (SBCR). The NBCR is calculated as the additional producer revenue generated over the period of promotion (R) net of the cost of the promotion (E) per dollar of promotion expenditure (E) over that period:

$$(3)\quad \text{NBCR} = \frac{\sum_{t=1}^{T} R_t - E_t}{\sum_{t=1}^{T} E_t} \quad .$$

The SBCR is calculated by replacing the R (the additional producer industry revenue as a result of promotion) in equation (3) with the additional profit earned by the industry as a result of the promotion (S) calculated as:

(4) $$\text{SBCR} = \frac{\sum_{t=1}^{T} S_t - E_t}{\sum_{t=1}^{T} E_t}$$.

The BCRs provide measures of the net revenue (equation (3)) or the profit (equation (4)) earned by U.S. pecan producers per dollar of APC expenditures on pecan promotion. For the purposes of generic promotion program evaluations, a BCR of greater than 1.0 indicates that the promotional efforts have benefited producers because the benefit they earn from the promotion (net revenue and/or profit) increases by more than one dollar for every dollar spent on promotion over the period of analysis. On the other hand, a BCR of less than 1 indicates that the promotion has been an unprofitable investment for producers since each dollar spent generates less than a dollar in additional benefit (net revenue or profit) over the four years of the program.

Analyzing Consumer Awareness, Attitudes, and Usage Regarding Pecans

To obtain information concerning beliefs, awareness, attitudes, and purchasing behavior about tree nuts in general and pecans in particular, we constructed and administered a nationally representative online consumer survey to a panel of U.S. residents using SurveyMonkey (www.surveymonkey.com), a powerful and well-known online survey software application. The survey responses provide *qualitative* feedback relevant to APC marketing and promotion activities. They also are a unique source of data for analysis and serve as a baseline going forward concerning awareness, attitudes and purchasing behavior of consumers concerning pecans.

The questions included on the survey are exhibited in the Appendix of this report. The survey begins with questions related to tree nuts in general and then proceeds with questions related specifically to pecans. The list of survey questions dealing with tree nuts include: (1) which tree nuts (e.g. almonds, walnuts, pecans, pistachios, macadamia nuts) were purchased in the past year; (2) reasons why tree nuts were not purchased in the past year; (3) favorite, second favorite, and third favorite tree nuts; (4) main source(s) of information about tree nuts; (5) recall of seeing or hearing any advertising for any type of tree nuts; (6) frequency of purchasing tree nuts; (7) form of purchase of tree nuts (in the shell; raw, shelled; roasted, salted; roasted, unsalted; candied; and flavored); (8) type of packaging of tree nuts (bulk, bag, can, and snack-size); and (9) where tree nuts were purchased.

The list of survey questions dealing specifically with pecans include: (1) frequency of purchase of pecans; (2) reasons why pecans were not purchased in the past year (if applicable); (3) form of purchase of pecans (in the shell; raw, shelled; roasted, salted; roasted, unsalted; candied; and flavored); (4) type of packaging of tree nuts (bulk, bag, can, and snack-size); (5) where pecans were purchased; (6) which tree nuts would serve as substitutes for pecans; (7) what comes to mind when thinking about pecans; (8) recall of seeing or hearing any advertising for pecans; (9) recall of seeing or hearing any messages that encourage the purchase of pecans; (10) what specifically would increase the likelihood of purchasing pecans; (11) awareness of the existence of the American Pecan Council; and (12) visiting the website of the American Pecan Council.

We also capture demographics of tree nut consumers including gender, race (white, black, Asian, and other), ethnicity (Hispanic or non-Hispanic), education level, income level, household size, number of children in the household, age, and state/region. This information will allow the APC to target segments of the U.S. population in the marketing and promotion of pecans. We provide a formal statistical analysis of the national survey data via the use of qualitative choice models known as logit/probit models later in this report.

ECONOMIC EVALUATION OF THE APC PECAN PROMOTION PROGRAM

The economic evaluation of the APC pecan promotion program follows the methodology outlined in the preceding section. First, the results of the analysis of the market impacts and returns to producers from the APC pecan checkoff program are presented. Then the results of the nationally representative online survey of tree nut consumer awareness, attitudes, and usage regarding pecans are discussed.

Analysis of the Effectiveness of the APC Pecan Checkoff Program

In this section, the results of an econometric analysis of the effects of the promotion program on U.S. domestic and export demands for pecans are first presented. The econometric results are then used in a counterfactual simulation analysis of the impacts of the APC pecan promotion program on U.S. pecan markets, prices, and trade. Finally, the simulation results are used in a benefit-cost analysis to determine the ROI to pecan producers from the APC pecan checkoff program.

Econometric Analysis of U.S. Pecan Demand and Promotion

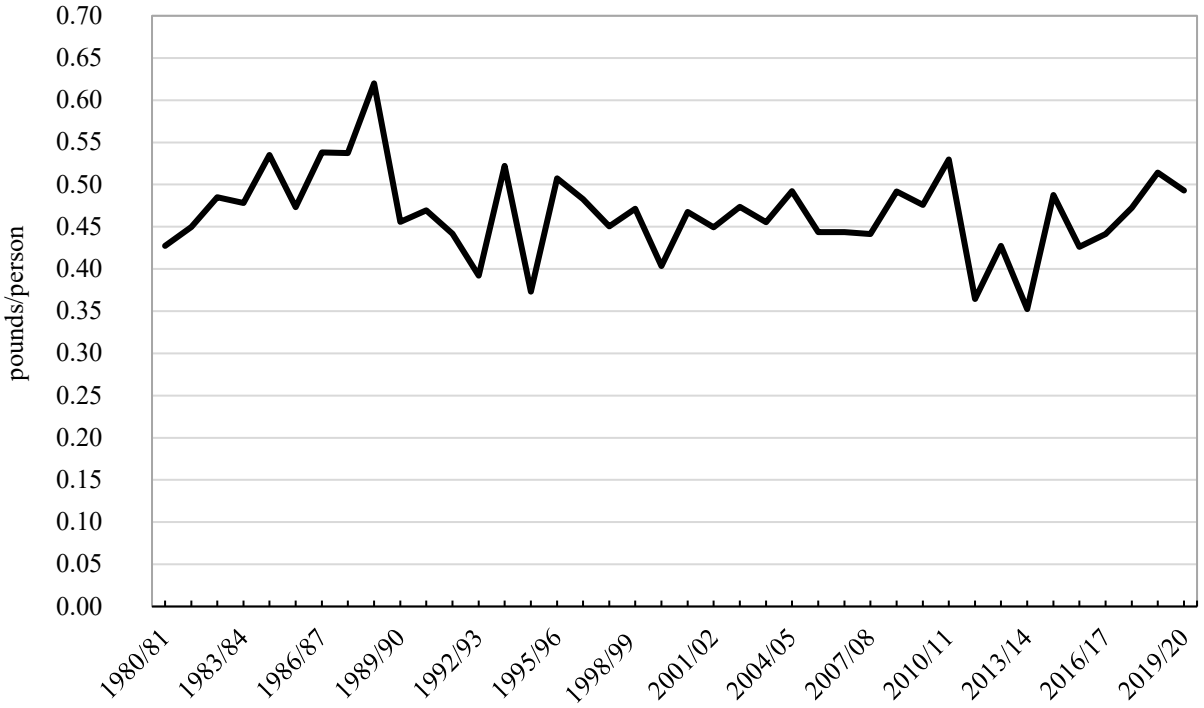
PecanMod is the econometric model used for the analysis of the effectiveness of the APC pecan promotion program over the four years of its existence (2016/17 - 2019/20). The model is discussed in some detail in Capps and Williams (2019). PecanMod does an excellent job of tracking the historical functioning of the U.S. pecan industry. The R^2 statistics for all behavioral equations are close to 1, indicating that the model explains most of the variability in improved and native pecan production, pecan import supply, domestic pecan utilization, ending stocks, pecan export demand, and the various price linkages in the model. In addition, the mean absolute percent error (MAPE) for the respective equations ranges from 1.89% to 19.76%, another indicator of excellent performance. In fact, most of the MAPE metrics are below 10%. Finally, all Theil U2 statistics are less than 1, a necessary condition for model validation. To use PecanMod for this analysis, the equations for the domestic demand for pecans and for the export demand for pecans were re-estimated to test for the statistical significance of APC promotion expenditures as drivers of the respective demands following the procedure outlined in the methodology section.

Domestic Pecan Demand and Promotion

The econometric analysis of domestic pecan demand covers the October/September marketing years of 1980/81 to 2019/20. The dependent variable in the econometric analysis is the per capita domestic use of pecans to account for the effects of population. Per capita domestic use of pecans ranged from 0.35 pounds to 0.62 pounds between 1980/81 and 219/20, averaging 0.47 pounds over that period and 0.49 in 2019/20 (Figure 11).

The set of explanatory factors include the nominal season average grower price of pecans (weighted average, shelled basis, measured in cents per pound), the nominal season average grower price of all tree nuts (weighted average, shelled basis, measured in cents per pound), real per capita disposable income in 2012 dollars, the Consumer Price Index (1982-84=100) to account for inflation, a trend variable (0, 1, 2, …) which is a proxy to account for tastes and preferences, dummy variables for years 1988, 1994, 2010, and 2013 (D1988, D1994, D2010, and D2013) to account for qualitative events, and nominal demand-enhancing APC domestic program expenditures in dollars. The data sources include the Fruit and Tree Nuts Yearbook (USDA, 2020b), the Non-Citrus Fruits and Nuts Summary (USDA, various issues), the Federal Reserve

Figure 11: Per Capita Domestic Use of Pecans, 1980/81-2019/20



Source: USDA (2020b).

Economic Data Base (FRED) (2020) for macroeconomic variables such as disposable personal income and the Consumer Price Index, and American Pecan Council (2020) for the level of expenditures for domestic marketing activities.

The descriptive statistics associated with the non-discrete explanatory variables are exhibited in Table 2. The nominal price of pecans ranges from 114.84 cents per pound to 544.12 cents per pound over the period 1980/81 to 2019/20, averaging 271.67 cents per pound. The nominal price of all tree nuts ranges from 94.99 cents per pound to 422.39 cents per pound over the same period, averaging 188.23 cents per pound. Real per capita disposable personal income measured in 2012 dollars varies from $21,775 to $47,255 over that period, averaging $33,185. Of particular importance is the nominal expenditures made by the APC for domestic marketing activities. From 1980/81 through 2015/16, there were no pecan promotion expenditures. From 2016/17 through 2019/20, APC expenditures amounted to $1,751,942 in 2016/17, $7,101,745 in 2017/18, $5,735,689 in 2018/19, and $4,022,097 in 2019/20.

Table 2: Descriptive Statistics for the Non-Discrete Explanatory Variables in the Econometric Analysis of Domestic Pecan Demand Model

	Grower Prices[a]		Real per capita disposable income (2012 dollars)[b]	Consumer Price Index (1982-84=100)[b]	APC domestic promotion expenditures ($)[c]
	Pecans	All tree nuts			
Mean	271.67	188.23	33,184.63	174.63	465,287
Median	247.22	165.71	33,682.00	173.48	0.0
Maximum	544.12	422.39	47,255.00	257.87	7,101,745
Minimum	114.84	94.990	21,775.00	88.883	0.0
Std. Dev.	128.18	78.496	7,063.64	51.274	1,551,834
Skewness	0.6670	0.9965	0.0970	-0.0157	3.3505
Kurtosis	2.4095	3.5273	1.9018	1.7513	13.041
Jarque-Bera	3.5473	7.0839	2.0727	2.6006	242.876
Probability	0.1697	0.0290	0.3547	0.2725	0.0
Observations	40	40	40	40	40

[a] Weighted average, shelled basis, cents/lb. Source: USDA (2020b)
[b] Source: FRED (2020).
[c] Source: American Pecan Council (2020).

The estimated coefficients, standard errors, and p-values associated with the econometric analysis are presented in Table 3. The goodness-of-fit metric (R^2) is 0.70, meaning that our model accounts for 70% of the variability in per capita domestic use of pecans. The level of significance chosen for this analysis is 0.20 given the sparse size of the sample of observations. As such, all estimated coefficients of the model are statistically different from zero. To circumvent any collinearity problems among prices in the domestic demand model, we employ the ratio of the price of pecans relative to the price of all tree nuts. In addition, the dependent variable, the ratio of the price of pecans relative to the price of all tree nuts, and real per capita disposable income are expressed in logarithmic form. Consequently, the estimated coefficients associated the ratio of the price of pecans relative to the price of all tree nuts and real per capita disposable income are elasticities. The own-price elasticity of domestic demand for pecans is -0.148, while the income elasticity is 0.471. Domestic per capita use of pecans is highest for fiscal years 1988/89 and 2010/11 (by roughly 20%), but lowest for fiscal years 1994/95 and 2013/14 (by roughly 20% to 25%). The estimated coefficient with the trend variable is negative, suggesting a slight downward trend in per capita domestic use of pecans, all other factors invariant.

To account for diminishing marginal returns in conjunction with promotion activities, accommodate zero values of the level of promotion over the period 1980/81 to 2015/16, and account for inflation, we employ the square root transformation of the APC demand-enhancing

Table 3: Econometric Analysis of Per Capita Domestic Demand for Pecans, Estimated Coefficients, Standard Errors and p-Values, 1980/81-2019/20

Dependent Variable: LOG(Per Capita Pecan Use, lb) Estimation Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-5.394783	4.645914	-1.161189	0.2547
LOG(Grower pecan price/Grower all tree nut price)	-0.148007	0.043819	-3.377702	0.0020
LOG(Real per capita income)	0.470952	0.463540	1.015990	0.3178
D2010	0.235722	0.074009	3.185024	0.0034
Trend	-0.011474	0.008719	-1.315895	0.1982
D2013	-0.263622	0.077840	-3.386726	0.0020
D1988	0.213968	0.072820	2.938295	0.0063
D1994	-0.189228	0.071532	-2.645344	0.0129
PDL01	7.44E-05	2.60E-05	2.862012	0.0076

R-squared	0.700088	Mean dependent var	-0.766534
Adjusted R-squared	0.620111	S.D. dependent var	0.111898
S.E. of regression	0.068968	Akaike info criterion	-2.311165
Sum of squared residuals	0.142699	Schwarz criterion	-1.927266
Log likelihood	54.06771	Hannan-Quinn criter.	-2.173425
F-statistic	8.753651	Durbin-Watson stat	2.187869
Prob(F-statistic)	0.000004		

Lag Distribution of Square Root of Real APC Promotion Expenditures

	i	Coefficient	Std. Error	t-Statistic
. * |	0	5.0E-05	1.7E-05	2.86201
. * |	1	5.0E-05	1.7E-05	2.86201
	Sum of Lags	9.9E-05	3.5E-05	2.86201

Source: Estimation done with EVIEWS (2020), econometrics software package.

expenditures deflated by the CPI. With this transformation, the APC promotion elasticity not only varies by year but also varies directly with the level of promotion expenditures. The promotion elasticities for the four years of 2016/17 through 2019/20 are 0.0420, 0.0835, 0.0743, and 0.0618.

To account for the carryover effects of promotion as discussed earlier, we employ the Almon polynomial distributed lag (PDL) formulation. Theory provides relatively little guidance as to the structure and length of these dynamic processes. On the basis of model selection criteria, namely the Akaike Information Criterion (AIC), the Schwarz Loss Criterion (SLC) or the Hannan-Quinn Criterion (HQC), we determine that the optimal lag length for APC promotion expenditures is one year. Hence, promotion expenditures not only in the current year but also in the previous year impact per capita domestic use of pecans.

Export Demand for Pecans and Promotion

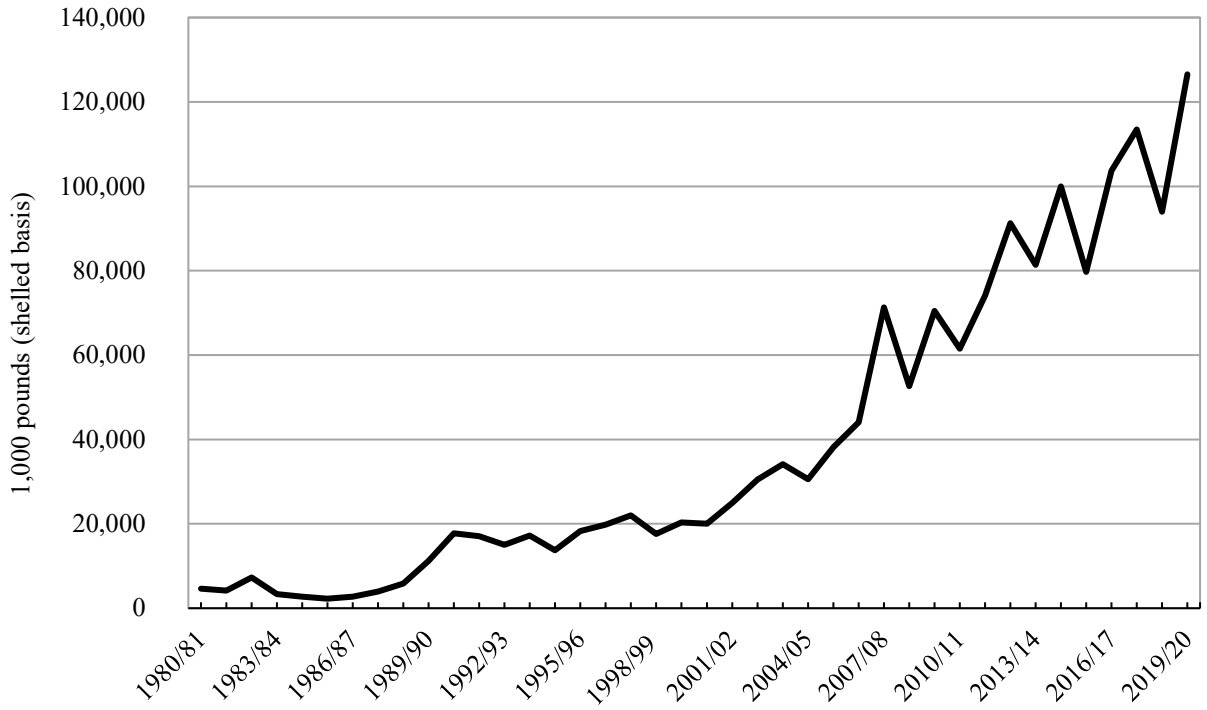
The econometric analysis of export demand for pecans also covers the October/September marketing years of 1980/81 to 2019/20. The dependent variable in this equation is U.S. pecan exports (total shelled, 1,000 pounds). U.S. pecan exports have trended upward since 19080/81 to a high of 126.5 million pounds in 2019/20 (Figure 12).

The set of explanatory factors in this equation include the nominal export unit value (shelled price, cents/pound), world (less USA) real gross domestic product (2010 billion dollars), the tree nut weighted exchange rate index (1980/81-1981/82 =100), the Consumer Price Index (1982-84=100), and nominal APC international program expenditures in dollars. D1982, D1983, D1989, and D2008 represent yearly dummy variables for years 1982/83, 1983/84, 1989/90, and 2008/09. The descriptive statistics for the non-discrete explanatory variables are exhibited in Table 4. On average, world real gross domestic product (not counting the United States) was close to $40 trillion measured in 2010 dollars, ranging from $21.7 trillion to $66.1 trillion. Nominal export unit values were $3.25 per pound on average (shelled basis) over 1980/81 to 2019/20, ranging from $1.54 per pound to $6.07 per pound. The tree nut weighted exchange rate index (1980/81-1981/82=100) varied from 96.1 to 135.0 over the same period.

The estimated coefficients, standard errors, and p-values associated with the econometric analysis of U.S. pecan export demand are presented in Table 5. The goodness-of-fit metric (R^2) is 0.98, meaning that our model accounts for 98% of the variability in U.S. pecan exports. The nominal export unit value variable is deflated by the Consumer Price Index to account for inflation. Subsequently this real measure of export unit value is multiplied by a weighted exchange rate index to account for changes in currency values over time. Further, we account for inertia or stickiness in U.S. exports with the inclusion of a lagged dependent variable.

Again, the level of significance chosen for this analysis is 0.20 given the sparse size of the sample of observations. As such, all estimated parameters of the model, except the coefficient associated with promotion expenditures, are statistically different from zero. The dependent variable, the adjusted export unit value, world real gross domestic product (excluding the United States), and the one-period lag of U.S. exports of pecans are expressed in logarithmic form. The estimated coefficients associated with export unit value and world gross domestic product are elasticities.

Figure 12: U.S. Pecan Exports, 1980/81 to 2019/20



Source: USDA (2020b).

Table 4: Descriptive Statistics for the Non-Discrete Explanatory Variables in the Econometric Analysis of the Export Demand for Pecans, 1980/81-2019/20

	Export Unit Value[a]	World Real Gross Domestic Product (2010 billion dollars)[b]	Tree Nut Weighted Exchange Rate Index (1981-82 =100)[c]	Consumer Price Index (1982-84=100)	APC Export Promotion Expenditures ($)[c]
Mean	324.53	39,983.25	109.71	174.63	1,647,669
Median	285.48	37,545.12	108.71	173.48	1,606,895
Maximum	607.04	66,072.15	135.02	257.87	2,226,817
Minimum	154.11	21,676.32	96.09	88.883	1,150,069
Std. Dev.	135.65	13,343.66	9.08	51.274	488,071
Skewness	0.7623	0.3604	0.7377	-0.0157	0.1828
Kurtosis	2.3752	1.8840	3.1132	1.7512	1.4358
Jarque-Bera	4.5250	2.9420	3.6494	2.6006	0.4200
Probability	0.1041	0.2300	0.1613	0.2724	0.8065
Observations	40	40	40	40	4

[a] Cents/pound, shelled basis. Source USDA (2020c).
[b] Source: USDA (2020e).
[c] Source: USDA (2020d).
[d] Source: FRED (2020).
[e] Source: American Pecan Council (2020).

Table 5: Econometric Analysis of Per Capita Domestic Demand for Pecans, Estimated Coefficients, Standard Errors and p-Values, 1980/81-2019/20

Dependent Variable: LOG(US Pecan Exports) Estimation Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.721138	2.758434	-2.436577	0.0208
LOG(Real U.S. Pecan Export Value)*(Tree Nut Exchange)	-0.724927	0.217673	-3.330343	0.0022
LOG(World Real Gross Domestic Product)	0.908343	0.332870	2.728827	0.0104
LOG(U.S. Pecan Exports(-1))	0.770039	0.085317	9.025606	0.0000
D1982	0.660341	0.190926	3.458630	0.0016
D1983	-0.559633	0.197578	-2.832472	0.0080
D1989	0.511019	0.181921	2.809020	0.0085
D2008	-0.497750	0.190683	-2.610353	0.0138
PDL01	0.000507	0.001386	0.365664	0.7171

R-squared	0.982533	Mean dependent var	10.03036
Adjusted R-squared	0.978025	S.D. dependent var	1.184232
S.E. of regression	0.175550	Akaike info criterion	-0.446676
Sum squared resid	0.955354	Schwarz criterion	-0.066678
Log likelihood	17.93352	Hannan-Quinn criterion	-0.309281
F-statistic	217.9679	Durbin-Watson stat	2.247005
Prob(F-statistic)	0.000000		

Lag Distribution of the Square Root of Real Pecan Export Promotion Expenditures

	i	Coefficient	Std. Error	t-Statistic
. * |	0	0.00034	0.00092	0.36566
. * |	1	0.00034	0.00092	0.36566
Sum of Lags		0.00068	0.00185	0.36566

Source: Estimation done using EVIEWS (2020) econometrics software package.

The export own-price elasticity for pecans is -0.725 while the income elasticity is 0.908. Based on the estimated coefficient of 0.77 associated with the one-year lag of the dependent variable, roughly 23% of the adjustment to long-run equilibrium is made after 1 year. Approximately 96% of the adjustment to long-run equilibrium occurs after 12 years.

To account for diminishing marginal returns in conjunction with promotion activities while accommodating zero values of the level of promotion over the years of 1980/81 to 2019/20 and adjusting for inflation, we employ the square root transformation of deflated APC demand-enhancing expenditures for international marketing. With this transformation, the APC promotion elasticity not only varies by year but also varies directly with the level of promotion expenditures.

The promotion elasticities in 2016/17 through 2019/20 are, respectively, 0.0234, 0.0321, 0.0291, and 0.0246.

As previously discussed, to account for carryover effects, we use the Almon polynomial distributed lag (PDL) formulation. Theory provides relatively little guidance as to the structure and length of these dynamic processes. On the basis of model selection criteria, namely the Akaike Information Criterion (AIC), the Schwarz Loss Criterion (SLC), and the Hannan-Quinn Criterion (HQC), we determined that the optimal lag length for APC promotion expenditures is one year. Hence, promotion expenditures not only in the current year but also in the previous year U.S. exports.

Counterfactual Simulation Analysis of the APC Pecan Promotion Program

The results of the counterfactual simulation analysis are shown in Table 6. These results are referred to as the "lift" provided by APC pecan promotion over the four years of its operation (2016/17-2019/20) to the U.S. pecan industry. In general, the "lift" achieved by a promotion program is the addition to price, consumption, producer revenue, profit or other industry measures as a result of promotion, that is, how much higher price, consumption, or other industry measures were over time than they would have been if the promotion had not been conducted.

The salient result from this analysis is that the APC pecan promotion program has worked to support pecan prices and, thus producer revenue and profit, at higher levels than would have been the case without the promotion. That is, the APC promotion has created a positive lift for pecan producer prices and revenue. Given the inability of improved pecan producers in particular to expand production to meet the increased demand created by APC promotion activities within the short period of the last four years during which APC promotion occurred (2016/17 through 2019/20), the primary result of the APC domestic and export promotion has been a 24¢/lb (11%) lift in the U.S. average producer pecan price over the period (last column of Table 6). Thus, even though market prices of pecans have declined over the last four years, the analysis clearly shows that prices would have been even lower without the promotion program. Given that pecan prices were higher than would have happened without promotion, pecan producer net profit also was a total of about $275.4 million (12%) higher over the same four years (2016/17 to 2019/20) than would have been the case without the promotion.

Table 6: U.S. Pecan Industry Lift from APC Pecan Promotion, 2016/17-2019/20[1]

	Changes from Domestic Promotion		Changes from Export Promotion		Total Change from Promotion	
	change	% change	change	% change	change	% change
U.S. Pecan Supply (mil. lb)						
Utilized Production (shelled)						
Native/Seedling	0.4	0.5	0.8	0.9	1.2	1.4
Improved Varieties	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.4	0.0	0.8	0.1	1.2	0.0
Imports (shelled)	14.7	2.7	5.9	1.1	20.6	3.8
U.S. Pecan Use (shelled) (mil. lb)						
Domestic Use	33.6	5.6	-3.2	-0.5	30.4	4.8
Exports	-18.0	-4.0	9.5	2.2	-8.5	-1.9
Change in Stocks	-0.6	-1.7	-0.4	-1.1	0.0	0.1
U.S. Pecan Prices (cents/lb) (annual average change)						
Producer Prices (in-shell)						
Native/Seedling	11.7	9.0	4.9	3.5	16.6	11.8
Improved Varieties	17.2	8.5	7.2	3.3	24.4	11.1
U.S. average	16.5	8.5	7.4	3.5	23.9	11.2
Export Price (shelled)	29.8	5.8	12.3	2.3	42.1	7.8
Import Price (shelled)	17.1	3.9	7.0	1.5	24.1	5.3
Revenue/Profit ($ millions)						
Retail Revenue[2]	241.0	9.1	103.3	3.6	344.2	11.9
Export Revenue	38.1	1.6	104.2	4.4	142.3	6.0
Producer Revenue (Profit)	192.8	9.1	82.6	3.6	275.4	11.9

Note: "Lift" is the addition to pecan production, use, revenues, and producer profit as a result of promotion.
[1] Totals may not add due to rounding.
[2] Assumes a 25% price markup from the producer level to the retail level.

The results in Table 6 also indicate that the APC domestic and export promotion of pecans created about a 5% lift in domestic pecan consumption over the same four-year period of about 30 million pounds (shelled basis). About 30% of the consumption lift (8.5 million pounds, shelled basis) was from a re-direction of pecans from exports into the domestic market due to the promotion while nearly two-thirds was the result of a nearly 5% lift in pecan imports (20.6 million pounds, shelled basis) over that period. Only about 1.2 million pounds (shelled basis) of the consumption lift was from an increase in domestic consumption of native pecans. These results are consistent with an earlier discussion regarding the conflicts from simultaneously promoting domestic demand and exports in connection with Figure 6.

Table 6 also decomposes the APC promotion program effects into those resulting from promotion activities in the domestic market and those resulting from export promotion[5]. The level of lift to the pecan industry from APC promotion in each category is largely related to the fact that the APC spent over four times more funds ($18.6 million) on domestic market promotion than on export promotion ($4.3 million) over the 2016/17 through 2019/20 period. They worked together to lift the domestic producer price of pecans by nearly 24 ¢/lb. (11.2%), 16.5 ¢/lb. from domestic promotion and another 7.4 ¢/lb. from export promotion.

At the same time, however, domestic market promotion and export market promotion conflicted to some extent in their market effects. Domestic promotion provided a 33.6-million-pound lift (shelled basis) (5.6%) to U.S. pecan consumption partly by redirecting 18 million pounds (shelled basis) (4.0%) from exports since few additional pecan supplies were available from domestic production as a result of the promotion. The domestic and export promotion programs also drew in additional pecan imports of 14.7 million pounds (2.7%) and 5.9 million pounds (1.1%), respectively. On the other hand, APC export promotion provided a 2.2% pecan export lift of 9.5 million pounds (shelled basis) partly by re-directing 3.2 million pounds (shelled basis) (0.5%) from the domestic market to exports. On net, the more generously funded APC domestic promotion program prevailed resulting in a net lift in U.S. pecan consumption of 30.4 million pounds (shelled basis) (4.8%) and a net negative lift in exports of 8.5 million pounds (-1.9%). Together, the two programs provided a lift to pecan producer profit over the four-year period of 2016/17 to 2019/20 of $275.4 million (11.9%), including a $192.8 million lift from APC domestic promotion and another $82.6 million from APC export promotion.

Benefit-Cost Analysis of the APC Pecan Promotion Program

Clearly, based on the simulation analysis results summarized in Table 6, the APC pecan promotion program has effectively boosted pecan prices and pecan producer profit over its four years of existence. A critical concern, of course, is whether the lift (gains) in producer profit induced by the APC domestic and export promotion programs have been substantial enough over that period

[5] See the earlier discussion of APC activities categorized as domestic promotion and those categorized as export promotion.

to more than cover the cost of the promotion to producers who pay for the promotion. If not, then the conclusion would be that APC promotion programs should be discontinued because the cost of the promotion is greater than the return to producers. On the other hand, if the producer profit generated by the promotion more than cover the costs, the promotion program would be deemed a successful investment opportunity for pecan producers. This section, then, provides a benefit-cost analysis of the APC domestic and export promotion programs to answer these questions based on the simulation results from Table 6.

Using equation (4) from the methodology section, we calculated the net revenue (profit) benefit-cost ratio (SBCR) for the APC domestic, export, and overall promotion programs over the period of 2016/17 through 2019/20. Recall that a BCR that is greater than 1 is interpreted as meaning that the program has more than paid for itself. Otherwise, the program has created an economic loss for pecan producers because the benefit generated is less than the program cost.

With the lift in producer profit (net of the promotion cost) from domestic promotion of $174.2 million and of $76.0 million from export promotion, the total profit earned by pecan producers as a result of APC promotion over 2016/17 through 2019/20 amounts to $250.2 million (Table 7). Given that APC promotion expenditures (including MAP funds but excluding administrative expenditures) over that same period totaled $25.2 million, the BCR to the overall APC pecan promotion program is 9.9. In other words, every dollar of expenditure by the APC to promote pecans over 2016/17 through 2019/20 returned an average of $9.9. This BCR is well within the range of those reported for other generic commodity promotion programs and above the weighted average across many generic commodity promotion programs of 6.9 reported by Williams, Capps, and Hanselka (2018) (see Table 1 and supporting discussion). They also report, however, that the BCRs of the newer, less well funded programs are generally above the average, ranging from about 10.0 to 28.0, while the BCRs of the better-funded and more well-established programs are generally below the average BCR. They conclude that as the level of expenditures by a commodity checkoff organization increases, the promotion BCR is expected to drop to some extent because the increase in producer profit generated for every additional dollar spent declines as promotion expenditures increase, a phenomenon known as the *law of diminishing returns*.

Table 7: Benefit-Cost Analysis of the APC Pecan Promotion Program

	Domestic Promotion	Export Promotion	Total[1]
APC Pecan Promotion Expenditures ($ million)	18.6	6.6	25.2
Additional Producer Revenue (Profit) Earned ($ million)			
Gross Revenue (Profit)	192.8	82.6	275.4
Net Revenue (Profit) [2]	174.2	76.0	250.2
Producer Net Benefit-Cost Ratio (BCR)[3]	**9.4**	**11.5**	**9.9**

[1] Totals may not add due to rounding
[2] Gross Revenue net of promotion expenditures as a cost to producers.
[3] Ratio of Net Revenue to APC promotion expenditures.

Thus, over time, if pecan promotion expenditures increase, the pecan promotion BCR would be expected to decline to some extent. The relatively high pecan promotion BCR also means that the pecan promotion program is underfunded. Note that for every dollar in additional assessment NOT paid by pecan producers and invested in promotion by the APC, pecan producers lose an average of $9.9 in additional profit. Further increases in the assessment might also lead to some reduction in the BCR because of the law of diminishing returns. However, with such a high estimated BCR, pecan producers could authorize a substantial increase in the assessment rate and still expect to generate a quite reasonable rate of return and substantially higher profits.

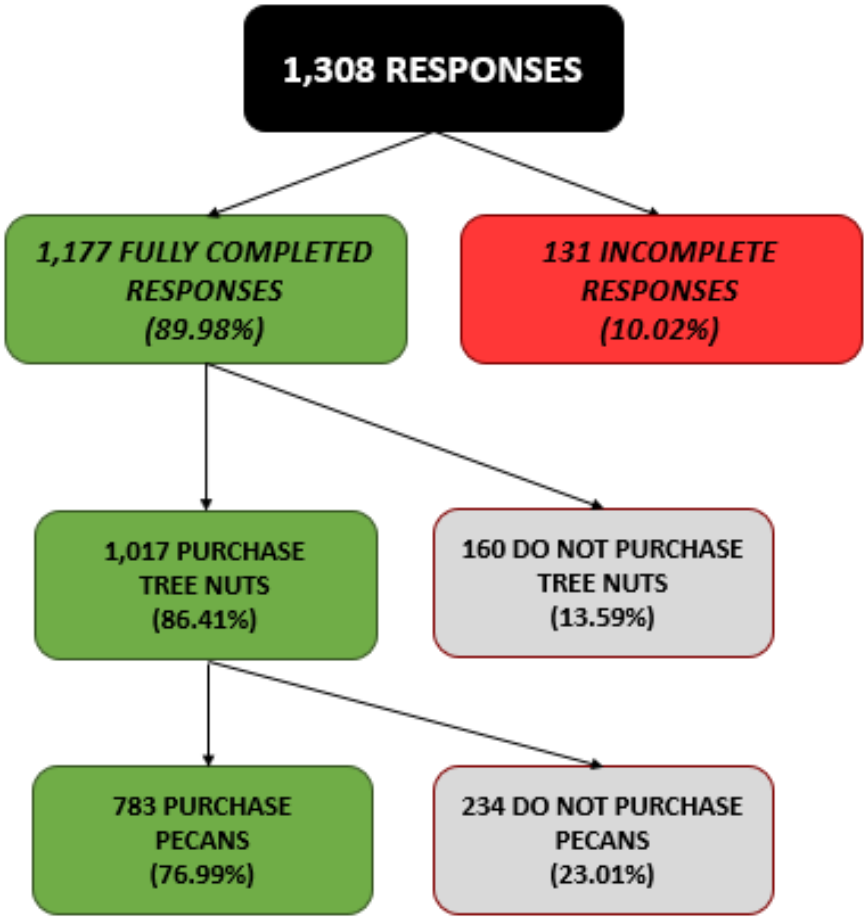
Interestingly, despite the lower level of producer profit generated by the APC export promotion program ($76.0 million) compared to the APC domestic promotion program ($174.2 million) as shown in Table 7, the BCR to the export promotion program of 11.5 is actually higher than the BCR for the domestic promotion program of 9.4. Obviously, the higher BCR for the export promotion program does not mean that export promotion has been more profitable for pecan producers than domestic promotion since domestic promotion has generated over twice as much in profit for pecan producers than export promotion. What then, does the higher BCR for export promotion mean? Mostly the higher BCR just means that less was spent to promote exports than to promote domestic use of pecans, an illustration of the law of diminishing returns in pecan promotion.

Analysis of the Survey of Tree Nut Consumers Regarding Pecans

The number of survey responses initially collected via Survey Monkey was 1,308 (Figure 13). Owing to 131 incomplete responses, however, the number of useable responses for analysis was 1,177 (90% of the respondents). Out of the 1,177 respondents, 160 did not purchase tree nuts, leaving 1,017 respondents who purchased tree nuts. Consequently, the market penetration for tree nuts is slightly more than 86%. More succinctly, close to 9 out of 10 panelists purchase tree nuts. Of those respondents who purchased tree nuts, 234 respondents did not purchase pecans. Out of 1,177 respondents then, 394 did not purchase any type of tree nut or just not pecans. Hence, the market penetration for pecans is roughly 67%. In other words, our sample reveals that two out of three panelists purchase pecans.

To demonstrate the representativeness of our sample to the U.S. population, we compared the socio-demographic characteristics of our sample with population statistics provided by the Current Population Survey (CPS) (U.S. Census Bureau, 2020) and by Statista (2020). The respective socio-demographic characteristics include: (1) gender (CPS); (2) race (CPS); (3) household size (CPS); (4) age (CPS); (5) region (CPS); (6) household income (Statista, 2020); (7) ethnicity (CPS); (8) education level (CPS); and (9) presence/absence of children (Statista, 2020). As exhibited in Table 8, the Survey Monkey sample matches very well the distribution of households by household size, region, and household income. However, the sample from Survey Monkey slightly underestimates the percentage of males and slightly over estimates the percentage of females in the U.S. population. The sample overestimates the percentage of white households and other households and underestimates the percentage of black and Asian households. The other category for race includes Native Americans as well as Latino/Mexican Americans and mixed races. Further, the sample underestimates the distribution by age for the category 18-24 and overestimates the distribution by age for the 35-44 category and the 65+ category. Otherwise, the sample distribution by age for categories 25-34, 45-54, and 55-64 matches well the distribution of the age of the population. As well, the percentage of Hispanic households (6.88%) was lower in our sample compared to the percentage of Hispanic households in the U.S. population (18.45%). Moreover, in our sample, the percentage of households whose heads received at least some college education or technical school training was 88.27%, compared to 61.10% from the U.S. population. As such,

Figure 13: Schematic of Survey Responses



our sample consists of higher-educated respondents relative to the U.S. population. Finally, the Survey Monkey sample understates the distribution of U.S. households with children under age 18 (24.30% compared to 39.99%) and thereby overstates the distribution of U.S. households without children under age 18 (75.70% compared to 60.01%). Bottom line, aside from modest differences by gender, race, ethnicity, education, and absence/presence of children, the sample from Survey Monkey can be considered representative of the U.S. population.

In subsequent sections, we summarize the response of the 1,177 qualified respondents on a question-by-question basis. Initially we present the findings concerning tree nuts, and subsequently we present the findings regarding pecans.

Table 8: Representativeness of the Survey Monkey Sample Data to the U.S. Population

Socio-Demographic Characteristic	2019/2020 Data[1]	Survey Monkey Sample Data
	%	%
MALE	49.3	44.2
FEMALE	50.8	55.1
WHITE	79.0	84.4
BLACK	13.5	6.0
ASIAN	6.0	3.7
OTHER	1.5	5.9
HOUSEHOLD SIZE--1	28.4	23.3
HOUSEHOLD SIZE--2	34.5	41.3
HOUSEHOLD SIZE--3	15.1	16.3
HOUSEHOLD SIZE--4	12.8	9.9
HOUSEHOLD SIZE--5	5.8	5.1
HOUSEHOLD SIZE--6	2.3	2.6
HOUSEHOLD SIZE--7 OR MORE	1.2	1.5
18-24 YEARS OLD	9.2	5.0
25-34 YEARS OLD	14.0	13.3
35-44 YEARS OLD	12.7	24.0
45-54 YEARS OLD	12.5	13.9
55-64 YEARS OLD	12.9	17.9
65+ YEARS OLD	16.5	25.9
EAST NORTH CENTRAL REGION	14.3	15.6
EAST SOUTH CENTRAL REGION	5.8	3.7
MID-ATLANTIC REGION	12.5	14.4
MOUNTAIN REGION	7.6	8.7
NEW ENGLAND REGION	4.5	6.1
PACIFIC REGION	16.3	18.7
SOUTH ATLANTIC REGION	20.0	17.8
WEST NORTH CENTRAL REGION	6.5	6.7
WEST SOUTH CENTRAL REGION	12.4	8.3
LESS THAN $25,000	17.1	13.3
BETWEEN $25,000 AND $50,000	20.0	18.9
BETWEEN $50,000 AND $75,000	16.5	17.9
BETWEEN $75,000 AND $100,000	12.3	16.6
BETWEEN $100,000 AND $150,000	15.5	14.9
BETWEEN $150,000 AND $200,000	8.3	9.0
GREATER THAN $200,000	10.3	9.4
HISPANIC	18.4	6.9
NOT HISPANIC	81.6	93.1
LESS THAN HIGH SCHOOL EDUCATION	10.6	1.9
HIGH SCHOOL GRADUATE	28.3	9.9
SOME COLLEGE	23.6	20.2
COLLEGE GRADUATE	21.3	35.3
POST COLLEGE	12.1	28.0
TECHNICAL SCHOOL	4.1	4.8
ABSENCE OF CHILDREN	60.0	75.7
PRESENCE OF CHILDREN	40.0	24.3

[1] Source: U.S. Census Bureau (2020) and Statista (2020)

Survey Responses Concerning Tree Nuts in General

Q: What tree nuts have you purchased in the past year? (Check all that apply.)

The most frequently purchased tree nuts in the past year were almonds, cashews, pistachios, walnuts, and pecans in that order. Roughly 68% of respondents purchased almonds in the past year, 62% purchased cashews, 49% purchased pistachios, 48% purchased walnuts, 48% purchased pecans, 19% purchased macadamia nuts, and 15% purchased hazelnuts (Figure 14). Candied nuts (12%) and Brazil nuts (12%) also were among the various tree nuts purchased in the past year.

Q: If you did NOT purchase tree nuts in the past year, what is (are) your reason(s)? (Check all that apply.)

Of the respondents who did not purchase tree nuts, 43% simply did not like tree nuts. Close to 14% had cost/budgetary restrictions, 10% were allergic to tree nuts, and slightly more than 8% had dietary restrictions (see Figure 15).

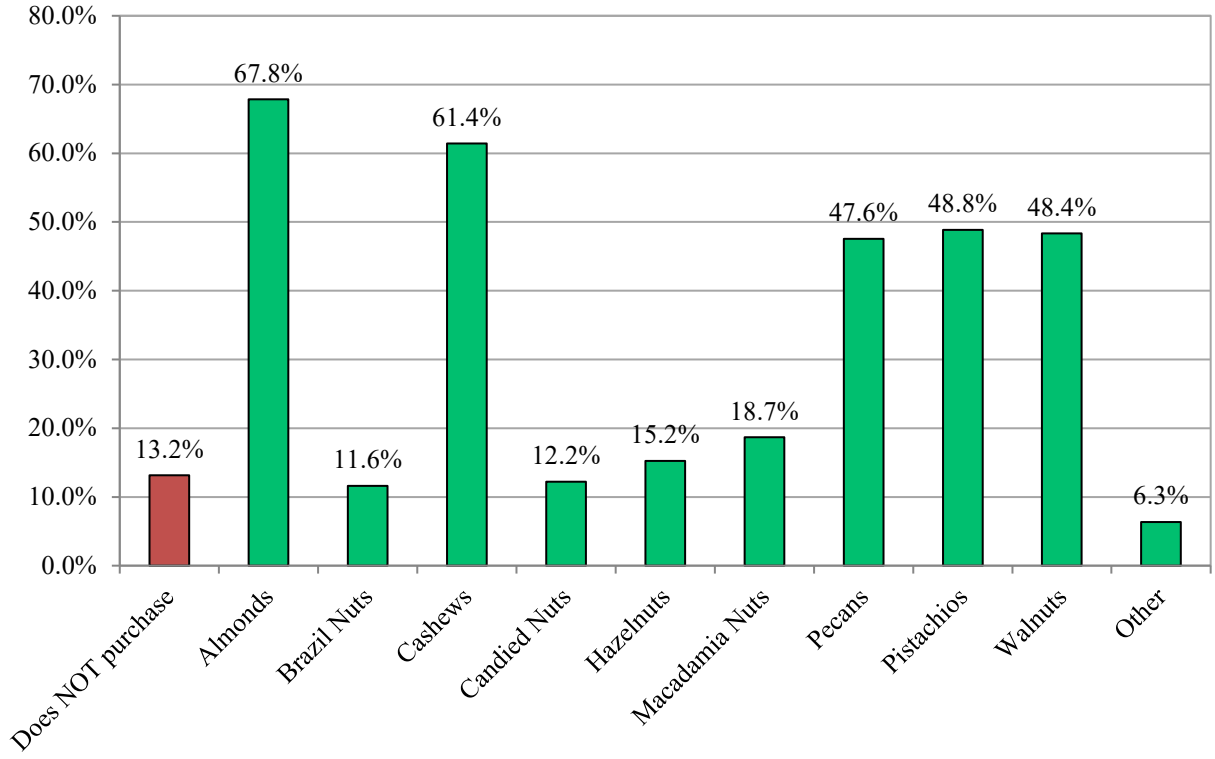
Q: What are your favorite tree nuts?

As depicted in Figure 16, roughly 32% of the respondents listed cashews as their favorite tree nut, followed by almonds (22%), pistachios (15%), pecans (12%), macadamia nuts (6%), and walnuts (6%). About 2% of the respondents did not indicate a favorite tree nut. Second favorite tree nuts were cashews (21%), almonds (19%), pistachios (18%), pecans (14%), walnuts (10%), and macadamia nuts (8%). Third favorite tree nuts were pistachios (18%), almonds (18%), walnuts (16%), pecans (15%), cashews (12%), and macadamia nuts (9%). Of importance to the American Pecan Council, pecans ranked fourth in regard to favorite, second favorite or third favorite tree nut.

Q: What is (are) your main source(s) of information about tree nuts? (Check all that apply.)

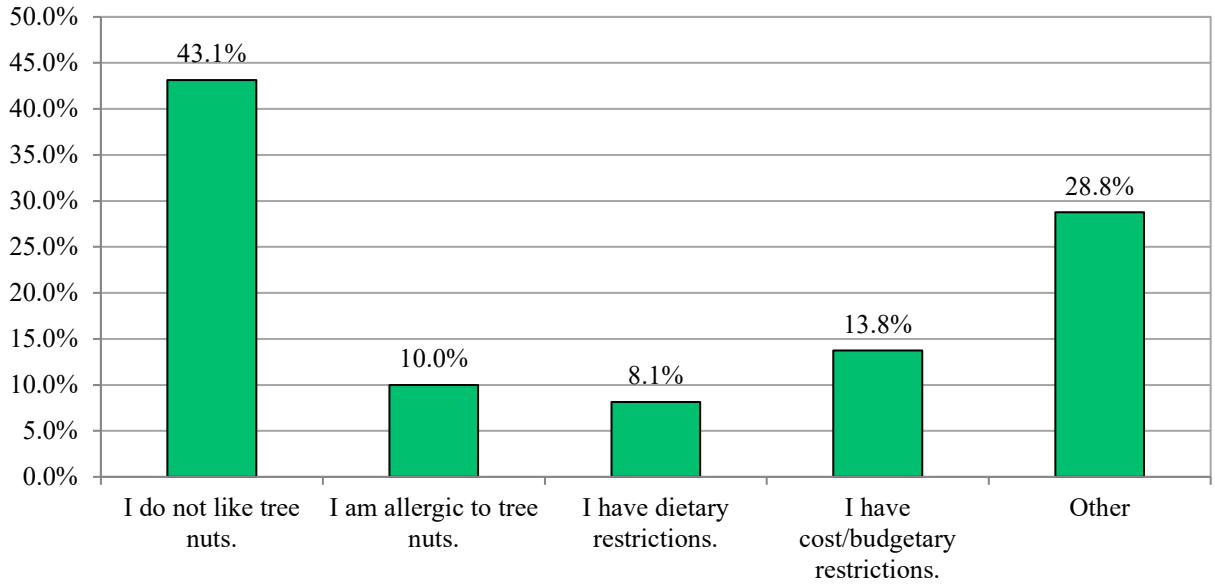
By far, the main source of information about tree nuts is past experience (61%) followed by package labels (38%), recipes (32%), and friends and family (25%). Magazines (11%), television (10%), and radio (3%) are additional sources of information about tree nuts (Table 9). However, Facebook (4%) and Twitter (0.5%) are not primary sources of information about tree nuts. The other category (10.3%) includes Pinterest, Google, Yahoo, YouTube, and medical and nutritional websites as principal sources of information about tree nuts.

Figure 14: Tree Nuts Purchased in the Past Year*



*Note: Other category responses include: mixed nuts, peanuts, chestnuts, pine nuts, pumpkin seeds, sunflower seeds, Japanese nuts, etc.

Figure 15: Reasons Behind NOT Purchasing Tree Nuts*



*Note: Other category responses include: not the main shopper, painful to eat nuts, no interest, no reason, etc.

Figure 16: Top Three Favorite Tree Nuts

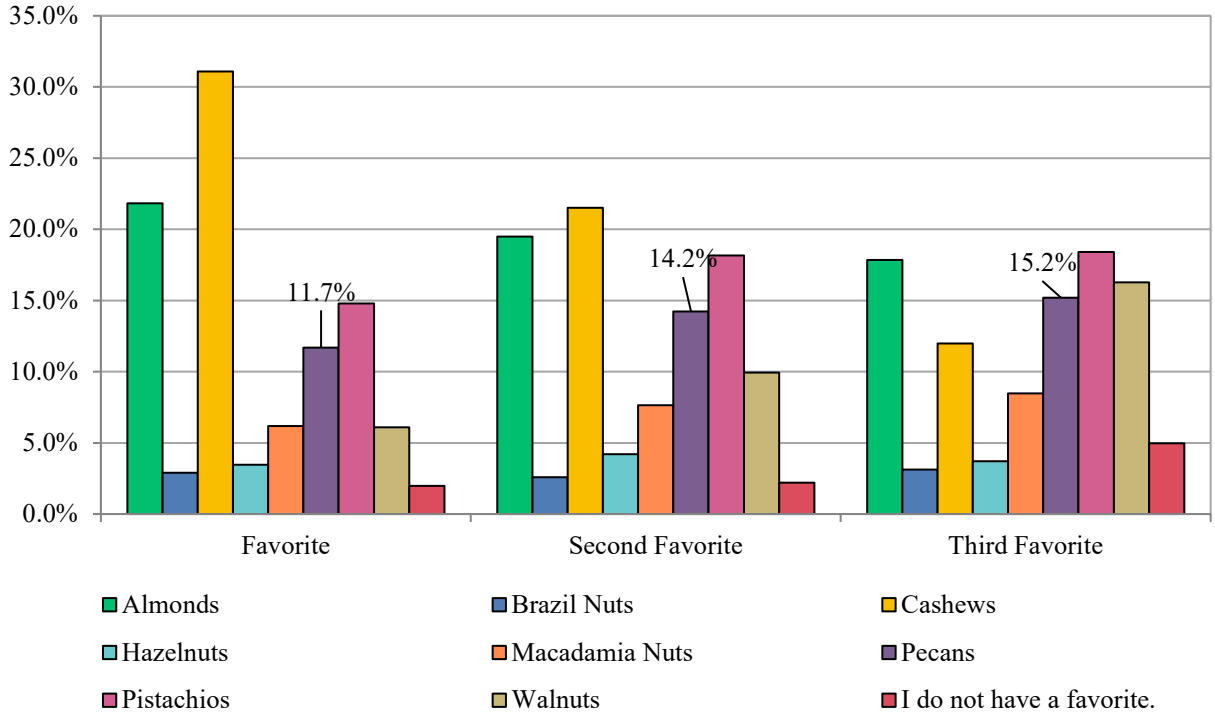


Table 9: Main Sources of Information Regarding Tree Nuts

Source	Percentage
Facebook	4.1%
Twitter	0.5%
Television	10.6%
Radio	2.7%
Magazines	11.1%
Friends and family	25.0%
Recipes	32.1%
Past experience	60.8%
Package labels	37.4%
Other Social Media/Websites*	10.3%

*Note: Other category responses include: Pinterest, Google, Yahoo, YouTube, and medical and nutritional websites.

Q: Within the past year, do you recall seeing or hearing any advertising for any type of tree nut?
Nearly 50% of those surveyed recall seeing or hearing advertising for some type of tree nut (Figure 17). Close to 30%. However, do not recall seeing or hearing any advertising for any tree nuts and slightly over 20% do not recall seeing or hearing any advertising for any tree nuts.

Q: How often do you purchase tree nuts?
Close to 60% of the respondents purchase tree nuts on a monthly basis (Figure 18). Slightly less than 25% purchase tree nuts annually, while slightly more than 10% purchase tree nuts on a weekly basis. About 8% of the respondents purchase tree nuts only during holidays.

Q: In what form do you purchase tree nuts?
The most common form of purchases of tree nuts is roasted, salted (73%) followed by raw, shelled (58%), and in the shell (43%) (Figure 19.). Flavored (21%) and candied (18%) forms of purchases also were evident.

Q: In what type of packaging do you purchase tree nuts? (Check all that apply.)
The most predominant type of packaging of purchases of tree nuts is in bags (83%) (Figure 20). The next most common type of packaging is in cans (48%) followed by snack size (29%) and in bulk (24%).

Q: Where do you purchase tree nuts? (Check all that apply.)

Roughly five out of six respondents purchase tree nuts at grocery stores, and nearly three out of five respondents purchase tree nuts at supercenters such as Walmart, Sam's Club, or Target (Table 10). Additional places of purchases of purchases of tree nuts are convenience stores (18%), farmers' markets (12%), specialty stores (11%), Amazon (9%), roadside stands (6%), other online sources (4%), and mall kiosks (1%). Costco and pharmacies also are notable places where tree nuts are purchased.

Survey Responses Concerning Pecans Specifically

Q: How often do you purchase pecans?
About 23% of respondents who purchase tree nuts do not purchase pecans. The most common frequency of purchase of pecans is annually (Figure 21). The second most common purchase

Figure 17: Recollection of Tree Nut Advertising

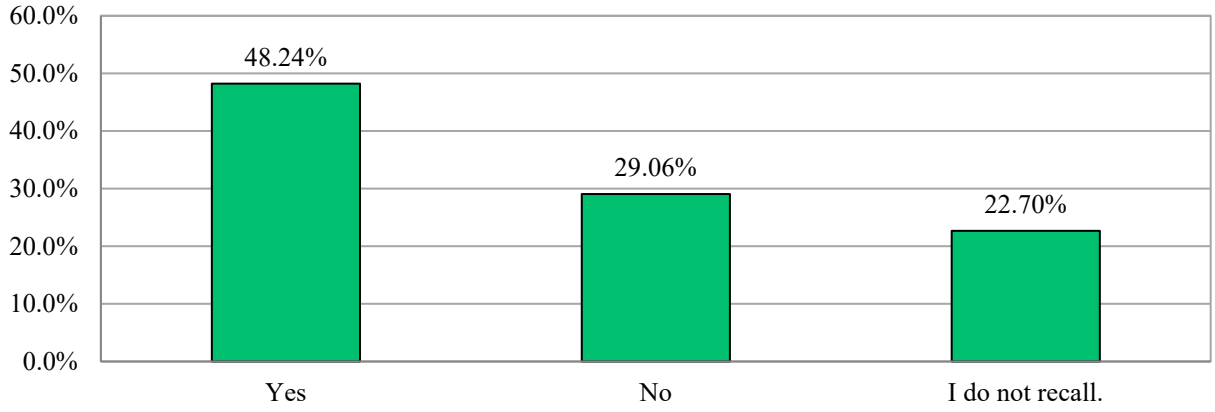


Figure 18: Frequency of Tree Nuts Purchases

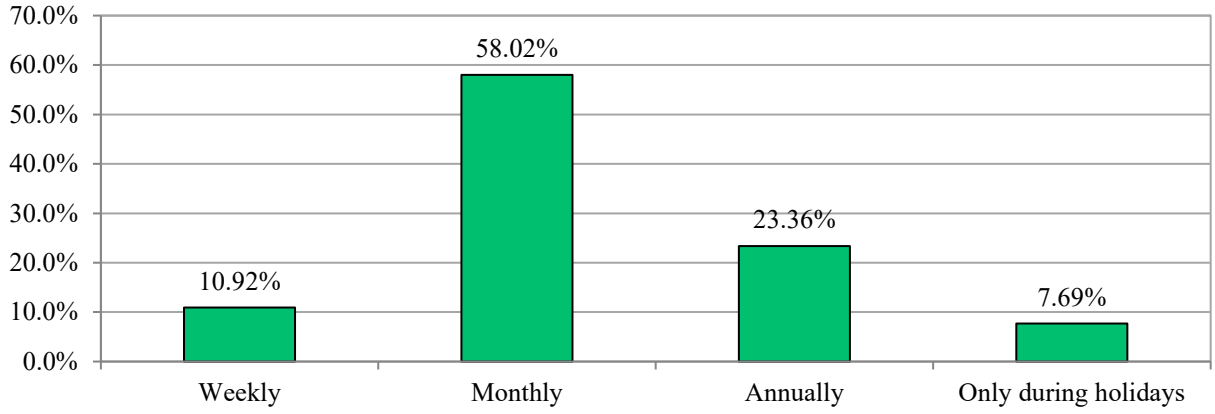
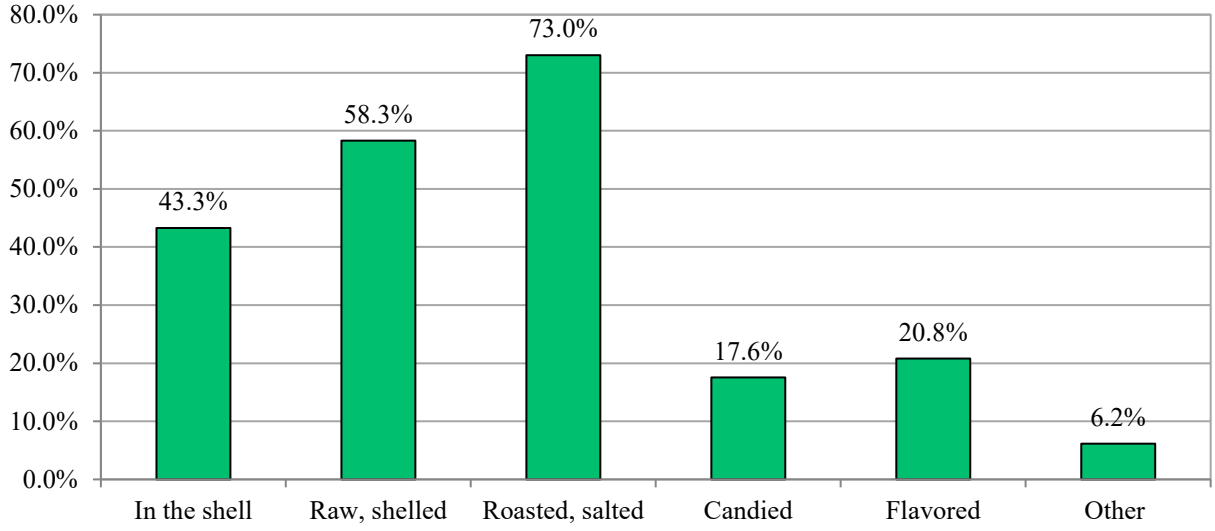


Figure 19: Form of Tree Nuts Purchases*



* Note: Other category responses include: Nut spread; nut milk; roasted, unsalted; and honey roasted.

Figure 20: Packaging Type of Purchased Tree Nuts

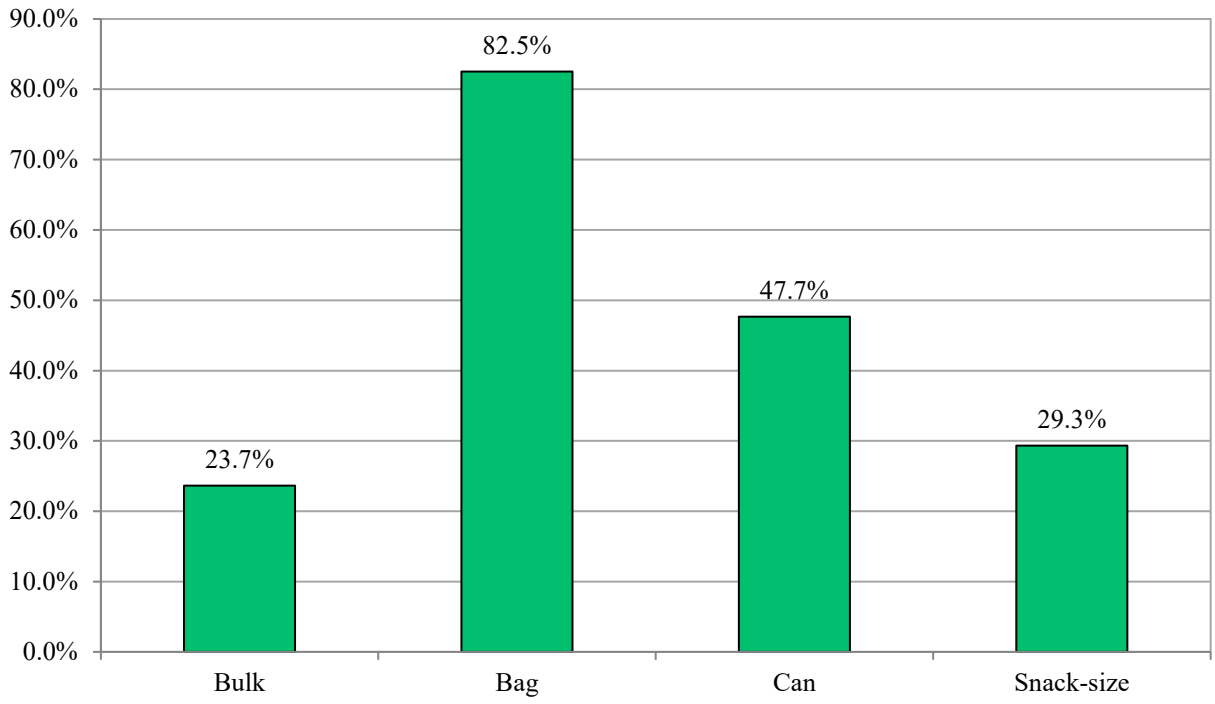
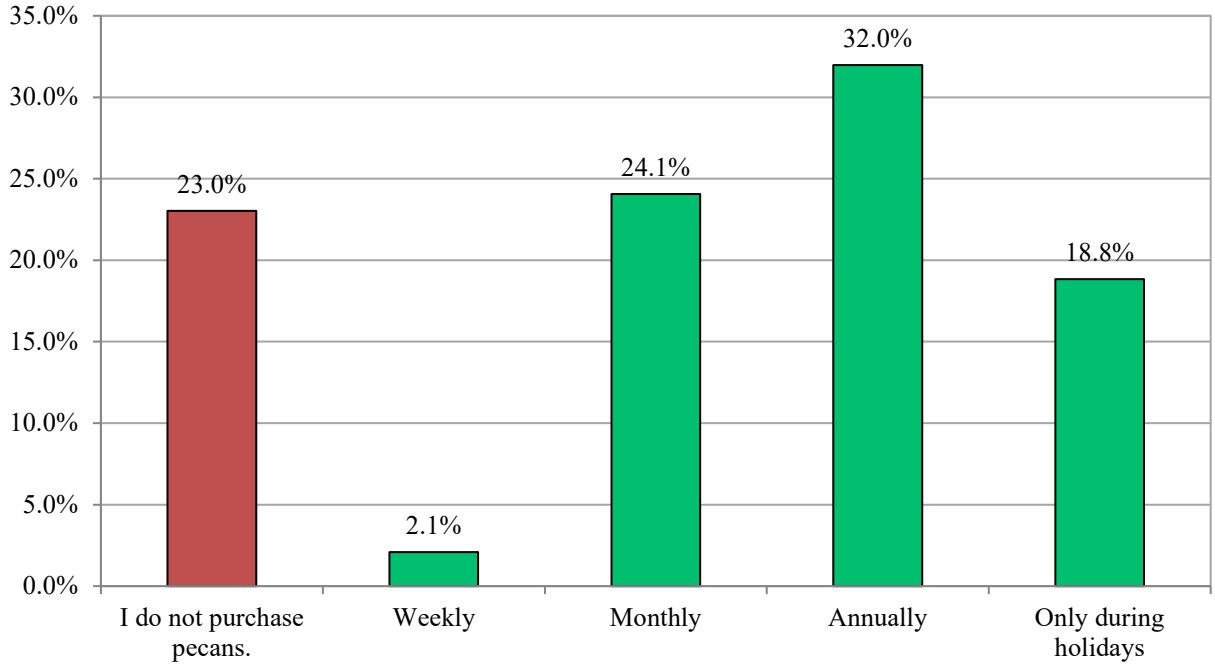


Table 10: Where Tree Nuts Are Purchased

Location Description	Percentage
Grocery stores (e.g., HEB, Kroger, Whole Foods)	83.1%
Supercenters (e.g., Walmart, Sam's Club, Target)	55.8%
Roadside stands	5.8%
Farmers market	11.6%
Convenience stores	17.4%
Specialty stores	10.4%
Mall kiosk	1.3%
Amazon	8.7%
Other online sources	4.1%
Other (Costco, Trader Joe's, CVS, Walgreens, family/friends)	6.6%

Figure 21: Frequency of Pecan Purchases



frequency is monthly. A notable number of respondents also purchase pecans during the holidays. Relatively few respondents purchase pecans on a weekly basis. The frequency purchase of pecans differs considerably from the frequency purchase pattern of tree nuts in general.

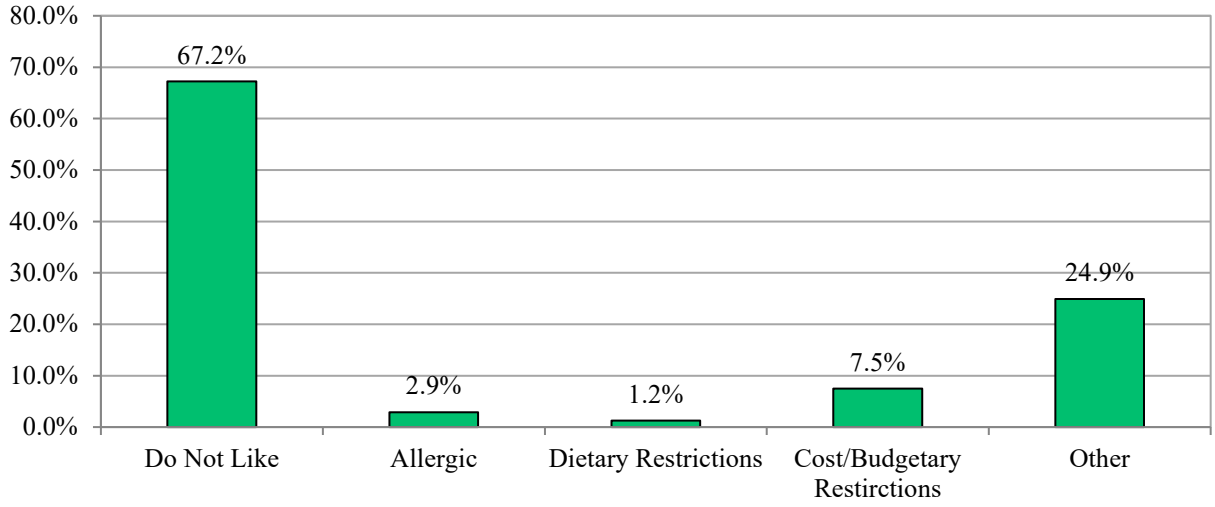
Q: If you did NOT purchase pecans in the past year, what is (are) your reason(s)? (Check all that apply.)

The primary reason for non-purchases of pecans is that respondents simply do not like pecans (Figure 22). Cost/budgetary restrictions are a secondary reason for not purchasing pecans as well as dietary restrictions and allergies to pecans. Other category responses primarily include no need; prefer other tree nuts; and prefer to purchase in pies.

Q: In what form do you purchase pecans? (Check all that apply.)

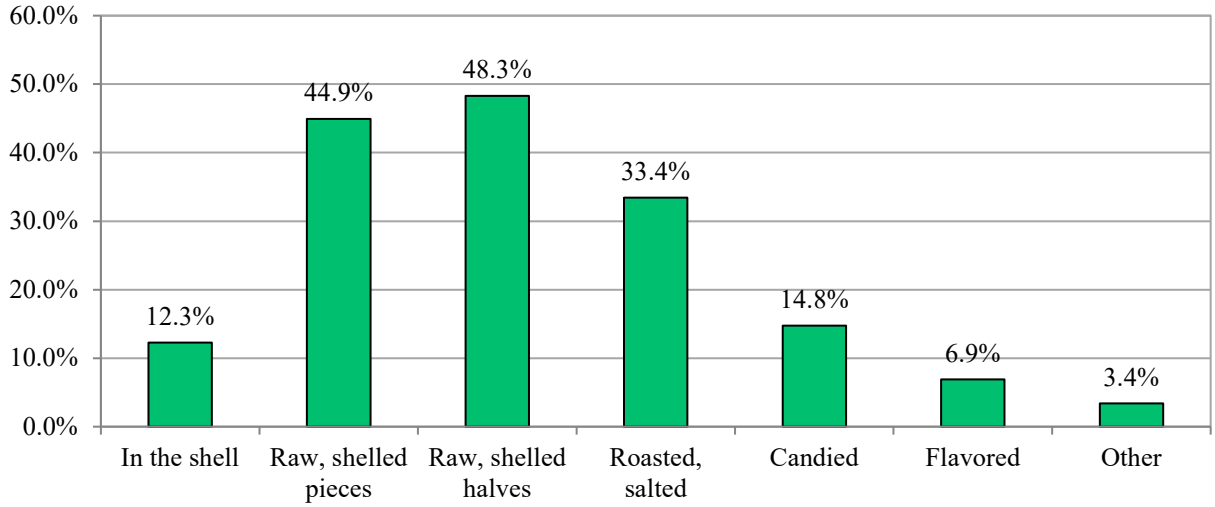
As exhibited in Figure 23, the most common form of purchases of pecans is raw, shelled halves (48%) and raw, shelled pieces (45%) followed by roasted, salted (34%), candied (15%), in the shell (12%), and flavored (7%). The form of purchases of pecans differs markedly from the form of purchases of tree nuts in general. Other category responses include chopped; pecan pie; roasted and unsalted; mixed nuts, etc.

Figure 22: Reasons Associated with NOT Purchasing Pecans*



*Note: Other category responses include: no need, prefer other tree nuts, prefer to purchase in pies, etc.

Figure 23: Form of Pecan Purchases*

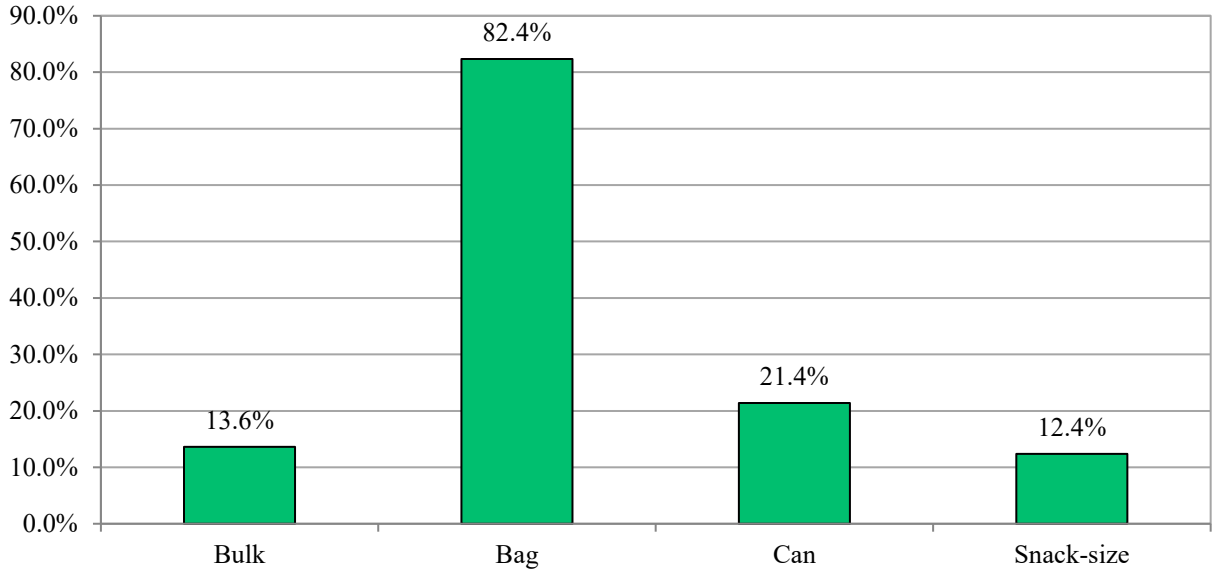


*Note: Other category responses include: chopped, pecan pie, roasted and unsalted, mixed nuts, etc.

Q: In what type of packaging do you purchase pecans? (Check all that apply.)

The most predominant type of packaging of purchases of pecans is in bags (82%) (Figure 24). The next most type of packaging is in cans (21%) followed by in bulk (14%) and snack size (12%). Opportunities may exist for stakeholders in the pecan industry to purse packaging in cans or for snack sizes.

Figure 24: Packaging Type of Pecans Purchased



Q: Where do you purchase pecans? (Check all that apply.)

Roughly four of five respondents purchase pecans at grocery stores, and nearly half of the respondents purchase pecans at supercenters such as Walmart, Sam's Club, or Target (Table 11). This finding is very similar to places of purchases of tree nuts. Additional places of purchases of purchases of pecans are specialty stores (8%), farmers' markets (8%), convenience stores (7%), roadside stands (4%), Amazon (4%), other online sources (3%), and mall kiosks (2%). Additionally, pecans are purchased at Costco and pharmacies such as CVS and Walgreen's.

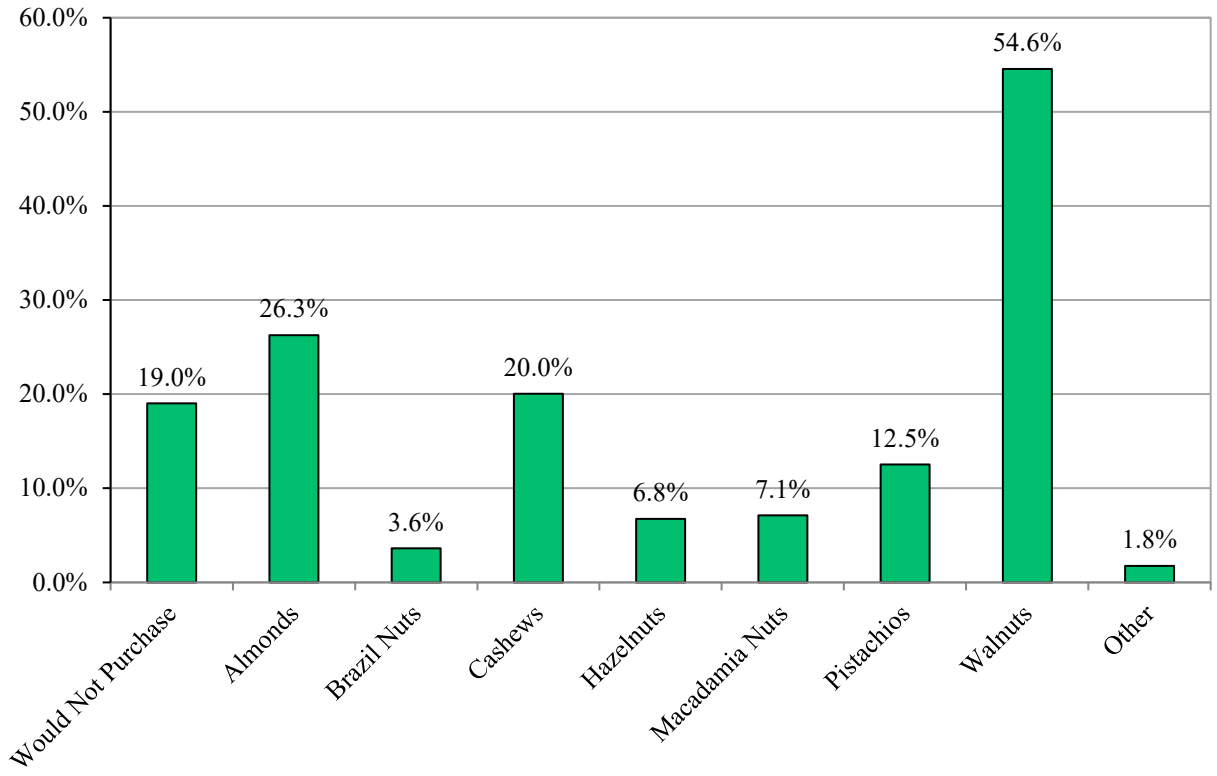
Q: If pecans were not available for their intended use, which of the following would serve as a substitute for that purpose? (Check all that apply.)

Walnuts by far are the most popular substitute for pecans according to survey respondents (Figure 25). About 55% of respondents revealed that walnuts would serve a substitute for pecans. Interestingly, almonds came in second as a substitute for pecans with 26% of respondents selecting almonds as a substitute for pecans. Other notable potential substitutes for pecans are cashews (20%) and pistachios (12%). Macadamia nuts (7%), hazelnuts (7%), and Brazil nuts (4%) also are potential substitutes for pecans but not as likely as the previously mentioned tree nuts. Of particular importance is the finding that nearly 20% would not purchase a substitute if pecans were not available for their intended use.

Table 11: Where Pecans Are Purchased

Description	Responses
Grocery stores (e.g., HEB, Kroger, Whole Foods)	77.8%
Supercenters (e.g., Walmart, Sam's Club, Target)	48.0%
Roadside stands	4.3%
Farmers' markets	7.5%
Convenience stores	7.3%
Specialty stores	7.8%
Mall kiosks	1.8%
Amazon	4.1%
Other online sources	2.9%
Other (Costco, Trader Joe's, CVS, Walgreens, family/friends)	5.6%

Figure 25: Substitutes for Pecans



Q: What comes to mind when you think about pecans? (Check all that apply.)

A number of things come to consumers' minds when thinking about pecans, including ingredient for cooking or pies (56%), delicious desserts (35%), and family/holiday gatherings (31%) (Table 12). Additional images of pecans are wholesome (26%), heart-healthy (25%), and expensive (22%) followed by packed with multiple health-promoting nutrients (18%), heart-smart food (16%), nutrition powerhouse (14%), high caloric content (10%), and homegrown (9%). For close to 11% of those surveyed, pecan images include family memories, Texas, snack, delicious/tasty, pecan pies, Southern states, and squirrels. About 2% to 3% of survey respondents mentioned that pecans are America's only major native tree nut, a decreased risk of mortality, and the original super nut. For about one in six respondents, nothing comes to mind when thinking about pecans.

Q: Where specifically do you recall seeing or hearing messages that would encourage you to purchase pecans? (Check all that apply.)

Slightly more than 60% of respondents do not recall seeing or hearing messages that would encourage them to purchase pecans (Table 13). The predominant source of messaging comes from recipes (22%). Additional sources of messaging include friends and family (11%), television (10%), and magazines/newspapers (7%). Social media such as Facebook and Twitter are not sources from which respondents recall seeing or hearing messages that would encourage them to purchase pecans.

Q: What specifically would make you more likely to purchase more pecans? (Check all that apply.)

Slightly more than 40% of respondents revealed that lowering the price would make them more likely to purchase more pecans (Table 14). Roughly 28% placed emphasis on health and nutrition considerations to make them more likely to purchase more pecans. Additional suggestions to improve the likelihood of purchasing more pecans include: (1) recipes featuring pecans (25%); (2) promotional specials (coupons, etc.) (18%); (3) more variety in available pecans (roasted, salted, spiced, candied, etc.) (14%); (4) more information in general about pecans (11%); (5) wider availability (9%); and (6) advertising and promotion about pecans (8%). Roughly 20% of respondents did not know what would make them more likely to purchase more pecans. Moreover, close to 8% of those surveyed said nothing would make them more likely to purchase more pecans.

Table 12: What Comes to Mind When the Respondents Think About Pecans

Description	Percentage
Nothing comes to mind	15.9%
Wholesome	25.7%
Homegrown	9.4%
Heart-healthy	24.6%
High caloric content	9.9%
Packed with multiple health-promoting nutrients	17.7%
Nutrition powerhouse	14.2%
The original super nut	1.9%
Heart-smart food	16.4%
Expensive	22.3%
Linked to a decreased risk of mortality	2.2%
America's only major native tree nut	2.8%
Ingredient for cooking or pies	56.2%
Family/holiday gatherings	30.6%
Delicious desserts	34.5%
Other (family memories, Texas, snack, delicious/tasty, squirrels)	10.8%

Table 13: Main Sources of Information Regarding Tree Nuts

Description	Responses
I do not recall.	63.8%
Facebook	1.7%
Twitter	0.7%
Television	9.9%
Radio	1.5%
Magazines/Newspaper	7.3%
Friends and family	10.7%
Recipes	22.0%
Billboards	0.9%
Other, including but not limited to websites, other social media platforms, etc.	5.0%

Table 14: What Would Make Respondents More Likely to Purchase Pecans?

Description	Percentage
Health and nutrition considerations	27.9%
Wider availability	9.0%
More variety in available pecans (roasted, salted, spiced, candied, etc.)	13.8%
More information in general about pecans	10.9%
Lower price	43.3%
Promotional specials (coupons, etc.)	18.2%
Advertising and promotion about pecans	8.2%
Recipes featuring pecans	24.5%
I do not know	20.3%
Other (predominantly nothing)	7.8%

Q: Are you aware of the existence of the American Pecan Council, comprised of grower and shellers, founded in 2016?

Slightly more than 5% of the respondents were aware of the existence of the American Pecan Council (Figure 26). Another 5% of respondents did not recall awareness of the existence of the American Pecan Council. The remaining 90% of respondents indicated no awareness of the existence of the American Pecan Council.

Q: Have you ever visited the website of the American Pecan Council (www.americanpecan.com)?

Only 1.4% of the respondents indicated that they had visited the website of the American Pecan Council (Figure 27). Another 1.5% could not recall ever having visited the website. The remaining 97% of the respondents indicated they had never visited the American Pecan Council website.

Q: If you have visited the American Pecan Council website, what were you looking for? (Check all that apply.)

Of those respondents that had visited the American Pecan Council website, about 53% indicated that they were looking for recipes, 40% for general information regarding pecans, and 20% for health and nutrition information and benefits (Figure 28).

Figure 26: Respondents' Awareness of the American Pecan Council

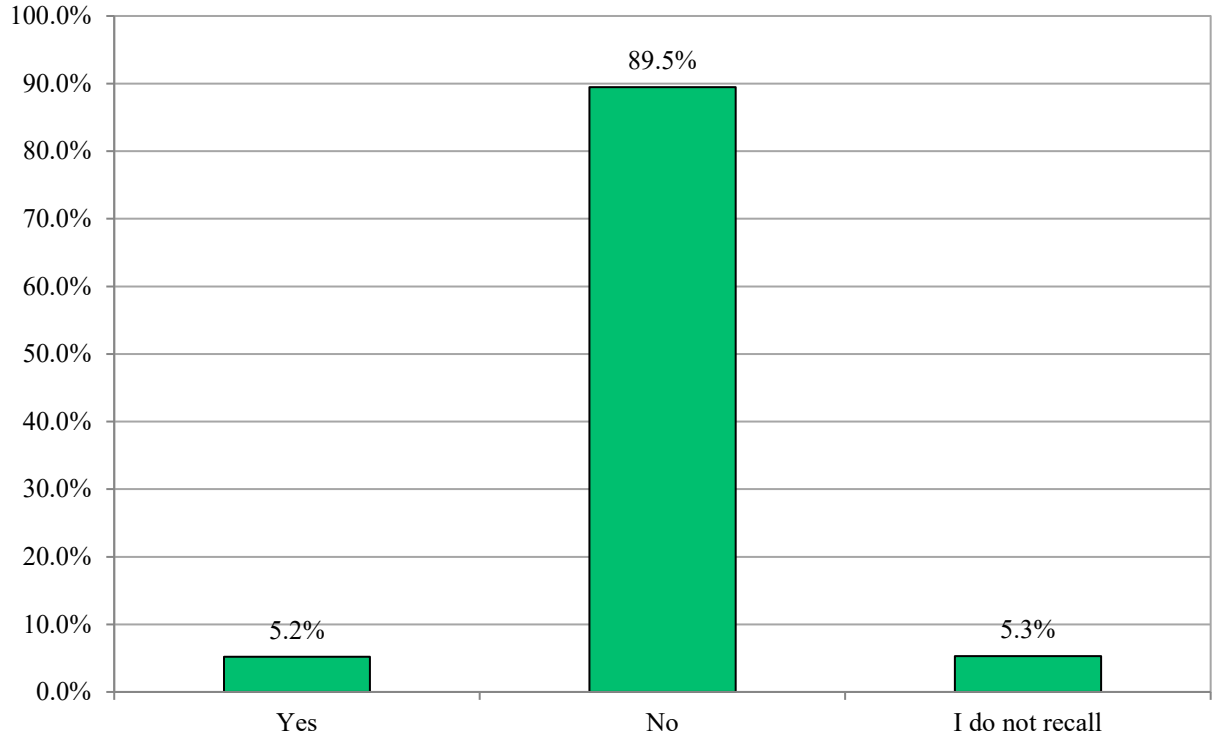


Figure 27: Have Respondents Visited the American Pecan Council Website?

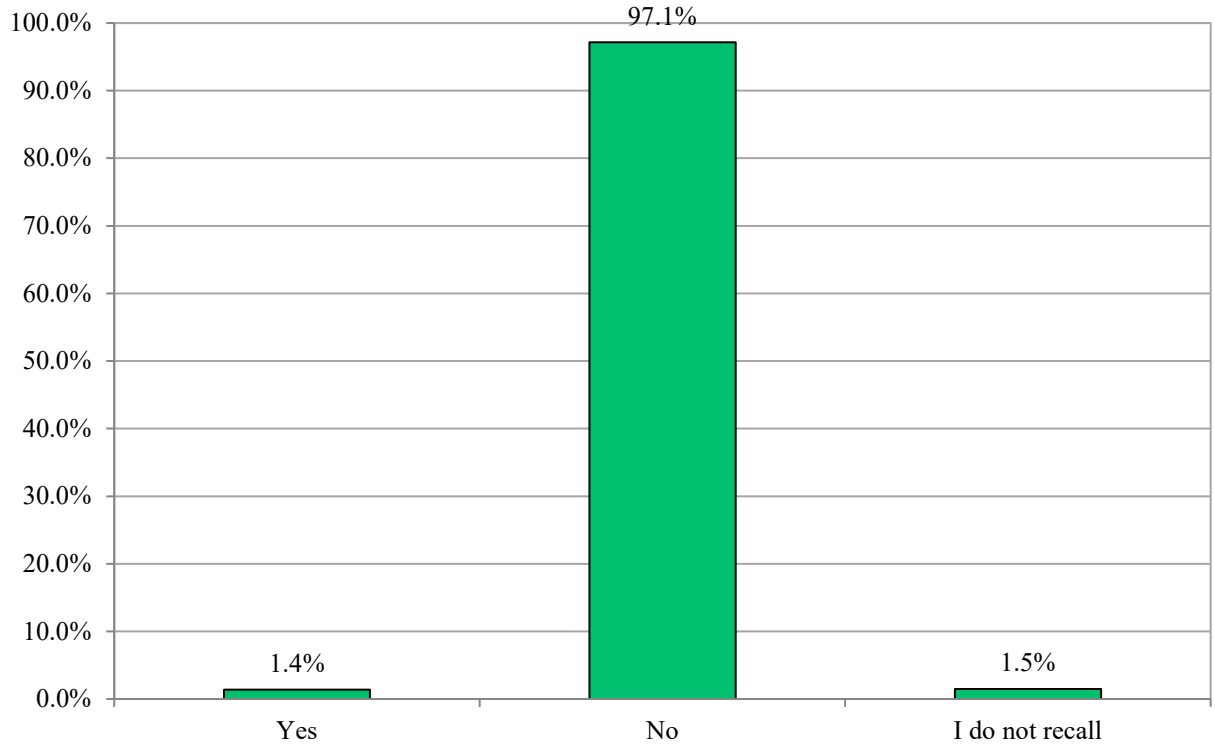
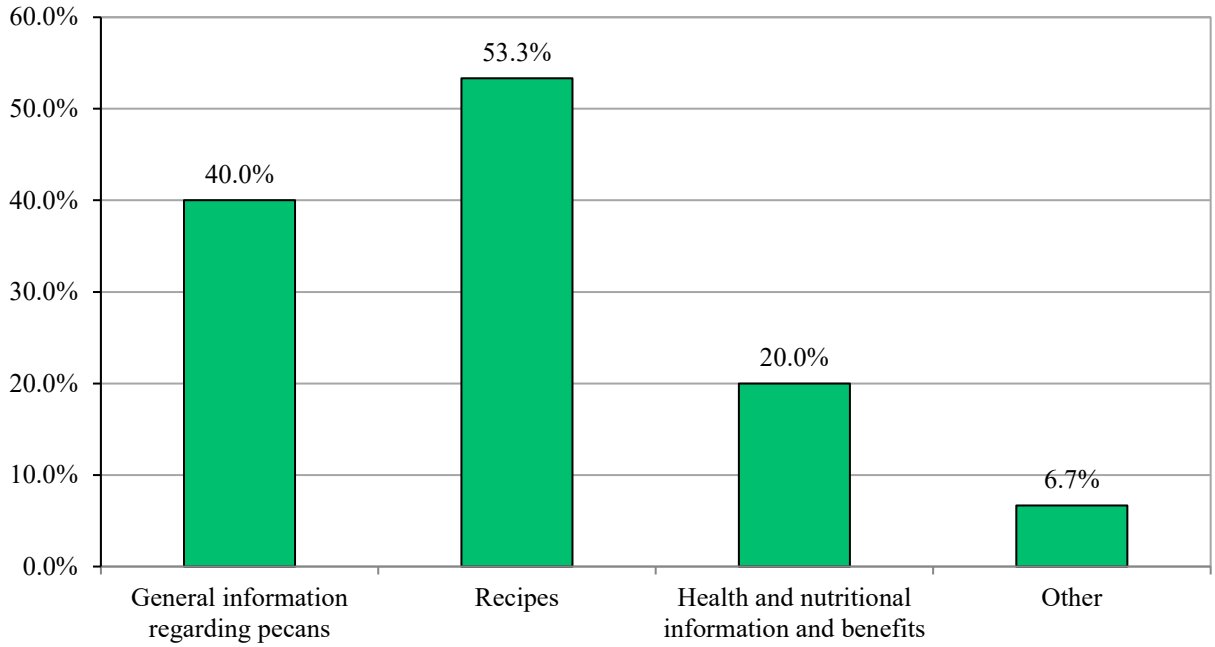


Figure 28: What Respondents Looked for on the APC Website



Econometric Analysis of the Consumer Decision to Purchase Pecans

To delve deeper into the decision by consumers to purchase pecans or not, we conducted an econometric analysis using a probit regression model based on the survey results. The use of probit models is commonplace in economic analyses of the food industry (Byrne et al., 1996; Alviola and Capps, 2010; Capps, Ahad, and Murano, 2017). The probit regression model in this analysis is a binary choice model, where the dependent variable takes on two values – zero for non-purchases of pecans, and one for purchases of pecans by reference person *i*. The reference person in the household is the household head who completed the survey.

The use of the probit/logit analysis, particularly of binary choices, is well established in the economic literature (Maddala, 1983; McFadden, 1984; Pindyck and Rubinfeld, 1998). Capps and Kramer (1985) demonstrated the probit and logit models yield similar results in the case of binary choice models. Additionally, since the logistic density function closely resembles the t-distribution with seven degrees of freedom (Hanushek and Jackson, 1977), the logit and probit formulations are quite similar. The only difference is that the logistic density has a slightly heavier tail than the standard normal density.

Mathematically, the probit model takes the following form:

(1) $$y_i = \boldsymbol{x}_i'\boldsymbol{\beta} + e_i$$

$y_i = 1$ if purchases of pecans were made by reference person i

$y_i = 0$ if no purchases of pecans were made by reference person i

and

(2) $$\Pr\left(y_i = 1 \mid \boldsymbol{x}_i'\right) = \Phi(\boldsymbol{x}_i'\boldsymbol{\beta}),$$

where $\boldsymbol{\Phi}$ is the cumulative distribution function (CDF) of the standard normal distribution; $\boldsymbol{x}_i'$ is a column vector of explanatory variables, $\boldsymbol{\beta}$ is a vector of parameters associated with the explanatory variables, and e_i is the random error. Operationally, the decision to purchase pecans is denoted by Purchase_Pecans, and is defined in equation (3) as:

(3) $$\text{Purchase\_Pecans}_i = \beta_0 + \beta_1 * \text{Household\_Size}_i + \beta_2 * \text{Number\_Children}_i + \beta_3 * \text{Male}_i + \beta_4 * \text{Black}_i + \beta_5 * \text{Asian}_i + \beta_6 * \text{White}_i + \beta_7 * \text{Hispanic}_i + \beta_8 * \text{College}_i + \beta_9 * \text{Age\_25to34}_i + \beta_{10} * \text{Age\_35to44}_i + \beta_{11} * \text{Age\_45to54}_i + \beta_{12} * \text{Age\_55to64}_i + \beta_{13} * \text{Age\_65Plus}_i + \beta_{14} * \text{Hincome}_i + \beta_{15} * \text{New England}_i + \beta_{16} * \text{Mid\_Atlantic}_i + \beta_{17} * \text{East\_North\_Central}_i + \beta_{18} * \text{West\_North\_Central}_i + \beta_{19} * \text{South\_Atlantic}_i + \beta_{20} * \text{East\_South\_Central}_i + \beta_{21} * \text{West\_South\_Central}_i + \beta_{22} * \text{Mountain}_i + e_i$$

The explanatory variables correspond to socio-demographic factors namely household size, number of children living in the household, gender, race, ethnicity, education, age, household income, and region. Gender, race, ethnicity, education, age, and region are indicator or dummy variables. As such, these variables take on the value of 1 or 0. For example, Male=1 if the respondent is male, and 0 if the respondent is female. The base or reference categories for the respective discrete or dummy variables are as follows: (1) gender: female; (2) race: other; (3) ethnicity: non-Hispanic; (4) education: no college; (5) age: 18 to 24 years of age; and (6) region: Pacific.

Hill and Lynchehaun (2002) and Dharmasena and Capps (2014) identified various cultural and socio-economic factors influencing consumer preferences including age, ethnicity, income, education, gender, presence of children, region, and race. Hence, we hypothesize that these factors also are determinants of the decision to purchase pecans. Further, because education level often is positively associated with health consciousness (Alviola and Capps, 2010), we hypothesize that this socio-demographic factor is positively related to the decision to purchase pecans. Moreover,

given that pecans are produced predominantly in Alabama, Arkansas, Arizona, California, Florida, Georgia, Kansas, Louisiana, Missouri, Mississippi, North Carolina, New Mexico, Oklahoma, South Carolina, and Texas, we expect that respondents located in the South Atlantic, the East South Central, and the West South-Central regions are more likely to purchase pecans than respondents located in other regions.

Data

As mentioned previously, the survey response data for this analysis came from a national panel of U.S. residents via SurveyMonkey (www.surveymonkey.com/). The survey was administered in December 2020. The data set used in this analysis consists of 944 observations. Each observation corresponds to a unique respondent *i*. Thus, the data set is equivalent to a cross-sectional representation of U.S. households. Prior to data cleaning, the original sample size was 1,308 observations. We dropped households who failed to complete the survey as well as households who failed to report gender, household income, and region.

About 67% of the sample purchased pecans (Table 15). Concerning age, 4% of the sample was 18 to 24 years; 14% was 25 to 34 years; 26% was 35 to 44 years; 14 % was 45 to 54 years, 18% was 55 to 64 years; and 25% was 65 years and over. Household size was about 2.5, and the average income was roughly $80,000. About 83% of the sample had at least some college education (college), slightly less than 45% of the sample were male, and slightly more than 55% were female. As well, about 7% were of Hispanic ethnicity, while 93% were not Hispanic. Further, roughly 85% of the sample were white, 6% were Black, and about 3% were Asian. About 6% of the sample were located in the New England region (Connecticut, Maine. Massachusetts, New Hampshire, Rhode Island, and Vermont), 14% in the Mid-Atlantic (New Jersey, New York, and Pennsylvania), 15% in the East North Central region (Indiana, Illinois, Michigan, Ohio, and Wisconsin), 6% in the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota), 18% in the South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia), 4% in the East South Central region (Alabama, Kentucky, Mississippi, and Tennessee), 8% in the West South Central region (Arkansas, Louisiana, Oklahoma, and Texas), 9% in the Mountain region (Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, and Wyoming), and 19% in the Pacific region (Alaska, California, Hawaii, Oregon, and Washington).

Table 15: Descriptive Statistics of the Variables in the Probit Analysis

Variable Name	Mean
Purchase Pecans	
(Dependent Variable in the Probit Model)	
Yes	0.668008
No	0.331992
Race	
White	0.848089
Black	0.064386
Asian	0.033199
Other *(Reference/Base Category)*	0.054326
Region	
New England	0.058350
Mid-Atlantic	0.136821
East North Central	0.151911
West North Central	0.064386
South Atlantic	0.178068
East South Central	0.042254
West South Central	0.082495
Mountain	0.094567
Pacific *(Reference/Base Category)*	0.191147
Household Income	
Hincome	$80,636
Household Size	
Household_Size	2.46
Education	
College	0.829980
No College *(Reference/Base Category)*	0.170020
Gender	
Male	0.449698
Female *(Reference/Base Category)*	0.550302
Ethnicity	
Hispanic	0.071429
Non-Hispanic *(Reference/Base Category)*	0.928571
Age	
Age_18to24 *(Reference/Base Category)*	0.040241
Age_25to34	0.138833
Age_35to44	0.255533
Age_45to54	0.140845
Age_55to64	0.177062
Age_65plus	0.247485
Number of Children	
Number_Children	0.480885

Source: Calculations by authors using EVIEWS (2020) econometrics software package.

Probit Model Empirical Results

The estimation of the probit model was done using a maximum likelihood procedure with the EVIEWS (2020) econometrics software package. The parameter estimates, standard errors, and associated p-values of the respective explanatory variables in the probit model are exhibited in Table 16. The goodness-of-fit statistic, McFadden's R^2, is 0.0676. The overall significance of the probit regression model was examined using a likelihood ratio test. Specifically, we tested the null hypothesis that all estimated coefficients, except the intercept coefficient, are jointly equal to zero. The p-value associated with the likelihood ratio test (Table 16) suggests the null hypothesis is rejected, and therefore, at least one of the estimated coefficients is statistically different from zero. Variance inflation factors, condition indices and variance proportions were used to examine potential collinearity issues in the probit model (Belsley, Kuh, and Welsch, 1980). No degrading collinearity issues were evident from this examination.

The level of statistical significance chosen for this analysis is 0.15. All variables with estimated coefficients that are statistically different from zero are in bold in Table 16. The key drivers associated with the decision to purchase pecans are: (1) household size; (2) number of children; (3) education; (4) region; (5) age; (6) household income. Neither race, gender nor ethnicity are factors which significantly affect the decision to purchase pecans.

Household size is positively related to the likelihood of purchasing pecans, but the number of children living in the household is negatively related to the likelihood of purchasing pecans. College-educated respondents and households with higher income levels are more likely to purchase pecans relative to non-college-educated respondents and households with lower income levels. Older respondents aged 45 to 54, 55 to 64, and 65 and over are more likely to purchase pecans relative to younger respondents. Finally, respondents located in the West North Central, South Atlantic, and West South-Central regions are more likely to purchase pecans than respondents located in the New England, Mid-Atlantic, East North Central, East South Central, and Pacific regions of the United States.

Marginal effects provide insight as to how changes in the right-hand side variables affect the probability of purchasing pecans. In order to calculate the marginal effect for any explanatory variable, the estimated coefficient associated with that variable is multiplied by the standard

Table 16: Econometric Results from the Probit Analysis of the Purchase of Pecans

Dependent Variable: PURCHASE_PECANS
Method: ML - Binary Probit (Newton-Raphson / Marquardt steps)
Convergence achieved after 4 iterations

Variable*	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.447977	0.342141	-1.309333	0.1904
HOUSEHOLD_SIZE	**0.070104**	**0.048189**	**1.454774**	**0.1457**
NUMBER_CHILDREN	**-0.127616**	**0.066742**	**-1.912068**	**0.0559**
MALE	-0.069298	0.088232	-0.785413	0.4322
BLACK	-0.091099	0.265121	-0.343612	0.7311
ASIAN	**-0.504544**	**0.301846**	**-1.671528**	**0.0946**
WHITE	-0.146914	0.209645	-0.700774	0.4834
HISPANIC	0.057583	0.183774	0.313334	0.7540
COLLEGE	**0.338943**	**0.115866**	**2.925287**	**0.0034**
AGE_25TO34	0.129348	0.234428	0.551761	0.5811
AGE_35TO44	0.220005	0.223542	0.984175	0.3250
AGE_45TO54	**0.539921**	**0.237460**	**2.273729**	**0.0230**
AGE_55TO64	**0.775317**	**0.236003**	**3.285202**	**0.0010**
AGE_65PLUS	**0.701177**	**0.231882**	**3.023850**	**0.0025**
HINCOME	**1.22E-06**	**8.47E-07**	**1.440699**	**0.1497**
NEW_ENGLAND	0.098937	0.199949	0.494813	0.6207
MID_ATLANTIC	-0.109875	0.149372	-0.735579	0.4620
EAST_NORTH_CENTRAL	0.139175	0.150281	0.926096	0.3544
WEST_NORTH_CENTRAL	**0.362924**	**0.201249**	**1.803358**	**0.0713**
SOUTH_ATLANTIC	**0.256756**	**0.142816**	**1.797813**	**0.0722**
EAST_SOUTH_CENTRAL	0.287503	0.235628	1.220154	0.2224
WEST_SOUTH_CENTRAL	**0.402511**	**0.184654**	**2.179806**	**0.0293**
MOUNTAIN	0.107935	0.166859	0.646863	0.5177

McFadden R-squared	**0.067599**		
LR statistic	**85.41348**		
Prob(LR statistic)	**0.000000**		
Observations with Dep=0	330	Total observations	994
Observations with Dep=1	664		

Reference Category for Gender: Female
Reference Category for Race: Other (F-statistic 1.05; p-value 0.3678)
Reference Category for Ethnicity: Non-Hispanic
Reference Category for Age: Age 18 to 24 (F-statistic 6.48; p-value 0.0000)
Reference Category for Region: Pacific (F-statistic 1.63; p-value 0.1131)

* Variables with statistically significant coefficients are marked in **bold**.
Source: Estimation of the Probit model done using EVIEWS (2020) econometrics software package.

normal density function $f(\boldsymbol{x}_i'\boldsymbol{\beta})$. The marginal effects in Table 17 are calculated at the sample means for each of the explanatory variables in the probit model.

The marginal effects Table 17 indicate that for every unit change in household size, the probability of purchasing pecans changes by 2.5% in the same direction. But for every unit change in the number of children living in the household, the likelihood of purchasing pecans changes by 4.6% in the opposite direction. For college-educated household heads, the probability of purchasing pecans is higher by 12.1% relative to non-college educated individuals. For household heads of Hispanic ethnicity, the probability of purchasing pecans is higher by 2.1% relative to individuals of non-Hispanic ethnicity. Males are less likely to purchase pecans by 2.5 basis points relative to females. The probability of purchasing pecans is lower by 3.3% for Black households, 18.1% for Asian households, and 5.3% for white households compared to households of other races. Relative to household heads who are between 18 and 24 years of age, the likelihood of purchasing pecans is higher by 4.6% for those in the 25 to 34 age bracket; 7.9% higher for those in the 35 to 44 age bracket; 19.3% higher for those in the 45 to 54 age bracket; 27.7% higher for those in the 55 to 64 age bracket; and 25.1% higher for those 65 years of age and over. Relative to respondents located in the Pacific region, the probability of purchasing pecans is higher by 3.5% for those located in the New England region; lower by 3.9% for those located in the Mid-Atlantic region; higher by nearly 5% for those located in the East North Central region; higher by almost 13% for those located in the West North Central region; 9.2% higher for those located in the South Atlantic region; 10.3% higher for those located in the East South Central region; 14.4% higher for those located in the West South Central region; and 3.9% higher for those located in the Mountain region.

We also provide the elasticity or the percentage change in the probability of purchasing pecans attributed to a 1% change in household size, number of children in the household, and household income in Table 17. The elasticity is the product of the marginal effect times the ratio of the relevant continuous explanatory variable to the dependent variable. In this analysis, the appropriate value of the dependent variable is the probability that a purchase of pecans will be made. This probability, calculated at the sample means, is equal to 0.67. Thus, if household income were to change by 1%, the probability of purchasing pecans would increase by 0.05%. In the same way, if household size or number of children were to change by 1%, the probability of purchasing pecans would increase by 0.09% and -0.03%, respectively.

Table 17: Marginal Effects and Elasticities Associated with the Probit Analysis Calculated at the Sample Means of the Data

Variable	Marginal Effects	Elasticities
HOUSEHOLD_SIZE	0.025091	0.090770
NUMBER_CHILDREN	-0.045674	-0.032330
MALE	-0.024802	
BLACK	-0.032605	
ASIAN	-0.180578	
WHITE	-0.052581	
HISPANIC	0.020609	
COLLEGE	0.121309	
AGE_25TO34	0.046294	
AGE_35TO44	0.078741	
AGE_45TO54	0.193240	
AGE_55TO64	0.277489	
AGE_65PLUS	0.250954	
HINCOME	0.00000044	0.051826
NEW_ENGLAND	0.035410	
MID_ATLANTIC	-0.039325	
EAST_NORTH_CENTRAL	0.049811	
WEST_NORTH_CENTRAL	0.129892	
SOUTH_ATLANTIC	0.091894	
EAST_SOUTH_CENTRAL	0.102899	
WEST_SOUTH_CENTRAL	0.144060	
MOUNTAIN	0.038630	

Source: Calculations by the authors

About 67% of the survey respondents purchased pecans (624 out of 994 respondents). Hence, in the derivation of the prediction-success (Table 18), the cutoff probability for classification purposes is 0.668008. That is, we predict that the *ith* reference person will purchase pecans if the probability of doing so exceeds 0.668008, and we predict that the *ith* reference person will not purchase pecans if the probability of doing so is less than 0.668008. In agreement with Greene (2012, p. 658), "in general any prediction rule will make two types of errors; it will incorrectly classify zeros as ones and ones as zeros." Within sample, the probit model correctly classifies the decision to not make purchases of pecans with 59.7% accuracy (197 out of 330). Within sample, the probit model correctly classifies the decision to make purchases of pecans with 63.4% accuracy (421 out of 664). Overall, within the sample, the model correctly classifies all decisions 618 out of 994 times, with 62.2% accuracy. For binary choice models, to the best of our knowledge, no benchmark exists regarding correct classifications. The probit model comprised of socio-demographic factors is able to discern the decision to purchase as well as not to purchase pecans. Overall, the model is correct three out of five times.

CONCLUSIONS AND IMPLICATIONS

The primary conclusions from the economic effectiveness analysis is that, despite its relatively recent launch, the American Pecan Council has effectively enhanced domestic and export demand for U.S. pecans over 2016/17 through 2019/20 through its generic promotion activities and generated a high rate of return to pecan producers who have paid for the promotion over that period. In addition, main conclusions from the consumer survey are: (1) close to 9 out of 10 households purchase tree nuts; (2) two out of three households purchase pecans; (3) pecans ranked fourth in regard to favorite, second favorite or third favorite tree nut; (4) almost a quarter of respondents who purchase tree nuts do not purchase pecans; (5) the most common frequency of pecan purchase is annually; (6) the primary reason for non-purchases of pecans is non-preference for pecans, but cost/budgetary restrictions, dietary restrictions and allergies to pecans are also frequently cited as reasons for non-purchases; (7) roughly four out of five respondents purchase pecans at grocery stores, and nearly half purchase pecans at supercenters; (8) walnuts by far are the most popular substitute for pecans; (9) principal pecan images that come to mind include ingredient for cooking or pies, delicious/tasty desserts, family/holiday gatherings and memories, wholesome, snacks, heart-healthy/heart-smart, expensive, nutrition powerhouse,

Table 18: Expectation-Prediction Evaluation of the Probit Model Within Sample*

	Dep=0	Dep=1	Total
P(Dep=1)<=C	197	243	440
P(Dep=1)>C	133	421	554
Total	330	664	994
Correct	197	421	618
% Correct	59.7	63.4	62.2

*Success cutoff: C = 0.668008.
Dep=0 indicates non-purchase of pecans; Dep=1 indicates purchase of pecans
Source: Calculations by the authors.

high caloric content, homegrown, and Texas/Southern states; (10) slightly more than 60% of respondents do not recall seeing or hearing messages that would encourage them to purchase pecans; (11) the predominant source of messaging concerning pecans comes from recipes; (12) slightly more than 40% of respondents revealed that lowering the price would make them more likely to purchase more pecans, while roughly nearly 30% placed emphasis on health and nutrition considerations; (13) close to 8% said nothing would make them more likely to purchase more pecans, and about 20% did not know what would make them more likely to purchase more pecans; and finally, (14) slightly more than 5% of the respondents were aware of the existence of the American Pecan Council, and (15) less than 2% have visited the website.

The principal accomplishment of the APC domestic and export promotion program has been to support the annual average producer price of pecans about 24¢/lb (11%) above the level to which it might have fallen over the period of 2016/17 through 2019/20 if the promotion had not been done. The APC promotion activities generated demand for U.S. pecans but because the lag between price changes and production adjustments is lengthy (more than 8 years or more), the demand enhancement primarily helped moderate the price declines experienced in recent years. Thus, with higher prices than would have occurred without the promotion on about the same level of production, pecan producer profit was also higher than it might otherwise have been without the promotion by a total of about $275.4 million (12%) over the same four years (2016/17 to 2019/20). Given APC promotion expenditures (including MAP funds but excluding administrative costs), the benefit-cost ratio for the APC promotion program for 2016/17 through 2019/20 is

calculated at 9.9, meaning that the promotion returned $9.9 in profit to pecan producers for every dollar spent on promotion.

The analysis leads to a number of important implications for the management of APC pecan promotion program. First, the highly positive BCR for the APC pecan promotion program in this study, which is actually much in excess of the BCRs calculated for larger and more mature programs like soybeans, cotton, beef, and pork, does not indicate that the APC program is much more effective than those other checkoff programs. Rather, the higher BCR primarily reflects the small size of the APC promotion program compared to those of other major commodities, many of which spend in excess of $100 million per year on promotion. Not only is the average of $6.65 million spent by the APC promotion program each year small in comparison to that of larger generic commodity promotion programs, the pecan promotion intensity, that is, the ratio of APC pecan promotion expenditures to the value of production, was only 1.1% on average over the 2016/17 through 2019/20 period, compared to generally about 2% for the larger programs. In other words, stakeholders in the larger generic commodity promotion programs pay more and contribute a generally higher share of their industry revenues to their respective commodity promotion programs than do pecan producers.

Second, an implication that follows from the previous point is that the pecan promotion program is vastly underfunded imposing a huge opportunity cost on pecan producers of potentially millions of dollars. The results indicate that for every dollar in additional assessment NOT paid by pecan producers and, thus, not spent on pecan promotion, producers lose an average of $9.9 in additional profit. Of course, as indicated above, increases in checkoff assessment rates and total spending on promotion are usually accompanied by a reduction in the corresponding BCR. But with such a high estimated BCR, producers could profitably afford to increase the assessment rate substantially beyond current levels and still expect to generate a quite reasonable rate of return comparable to the $2 to $6 per dollar of promotion earned by the beef, pork, cotton, soybeans, and other of the larger commodity promotion programs.

Third, the high BCR calculated for the APC pecan promotion program is not indicative of the level of impact of the program on the U.S. pecan industry. The small amount of pecan promotion funds expended in each year generated a positive but rather small lift for the industry. The small positive

benefit divided by an even smaller promotion expenditure resulted in a relatively large BCR. Commodity promotion groups sometimes interpret large estimated BCRs as implying large absolute impacts of their program on the market. Nothing could be further from the truth. A BCR of 9.9:1, for example, results by dividing a $9.9 billion industry profit benefit by a $1 billion promotion investment or by dividing a $9.9 benefit by a $1 investment. Thus, the BCR indicates only the return generated from the investment and not the level of impact the program has on pecan demand or price. Research has shown that as the level of promotion expenditures grows, the marginal impact of each additional dollar spent declines. Thus, for a huge checkoff program like soybeans or dairy, the marginal effectiveness of each dollar is much lower than for pecans which implies a lower BCR (average return to each dollar invested) under those programs. But with millions more being spent each year by those programs, the absolute impact of their promotion programs on their markets is also much greater.

Fourth, because the BCR as a measure of effectiveness is often misunderstood, perhaps the best metric is the impact of the promotion on key industry measures. In the case of pecans, this study determined that the APC promotion program can take credit for supporting the producer price of pecans by about 11% and saving producers $275.4 million (about 12%) in profit that would have been lost without the promotion, a remarkable achievement with rather modest promotion funds over a short period of time.

Using data extracted in December 2020 from a survey instrument using Survey Monkey, a probit model was estimated incorporating socio-demographic variables. The key drivers associated with the decision to purchase pecans are: (1) household size; (2) number of children; (3) education; (4) region; (5) age; (6) household income. Neither race, gender nor ethnicity are factors which significantly affect the decision to purchase pecans. Household size is positively related to the likelihood of purchasing pecans, but the number of children living in the household is negatively related to the likelihood of purchasing pecans. College-educated respondents and households with higher income levels are more likely to purchase pecans relative to non-college-educated respondents and households with lower income levels. Older respondents aged 45 to 54, 55 to 64, and 65 and over are more likely to purchase pecans relative to younger respondents. Finally, respondents located in the West North Central, South Atlantic, and West South Central regions are

more likely to purchase pecans than respondents located in the New England, Mid-Atlantic, East North Central, East South Central, and Pacific regions of the United States.

Bottom line, on the basis of the nationally representative survey, the primary target for American Pecan Council promotion appears to be older and relatively more wealthy households who are college-educated and reside in the West North Central, South Atlantic, and West South Central regions of the United States. These results should help stakeholders in the pecan industry to increase sales by targeting households who are more likely to purchase pecans. This research provides a benchmark for future studies concerning the decision to purchase pecans. We have answered a question that has not been addressed previously, namely what socio-demographic factors affect the decision to purchase pecans in the United States.

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APPENDIX

Tree Nut and Pecan Survey Questions

Tree Nuts Survey

Welcome to My Survey

This survey is designed to obtain insights into selected issues associated with tree nuts and pecans. It should take no more than 5-10 minutes to complete. The questions deal with various topics. Your feedback is very important so that we may learn more about the principal performance and economic issues associated with tree nuts and pecans.

We look forward to receiving your feedback and thank you in advance for your valuable time in completing our survey. Your opinions will be kept in strict confidence, and your responses will be reported only in aggregate with others.

Tree Nuts Survey

Demographics

* 1. What is your gender?

- ◯ Male
- ◯ Female

* 2. Are you White, Black or African American, Asian, Native American, or some other race?

- ◯ White (Caucasian)
- ◯ Black or African American
- ◯ Asian
- ◯ Native American
- ◯ Other (please specify)

* 3. What is your ethnicity?

- ◯ Hispanic
- ◯ Non-Hispanic

* 4. What is the highest level of schooling you have completed or the highest degree you have received?

- ◯ Less than high school
- ◯ High school graduate
- ◯ Technical school
- ◯ Some college
- ◯ College graduate
- ◯ Post-college graduate

* 5. How much ***total annual household income*** did all members of your household earn over the past year?

* 6. Indicate the number of members living in your household, including yourself.

* 7. How many children under the age of 18 are living with you in your household?

* 8. Indicate your age.

* 9. Indicate your ***zip code*** and the ***state*** in which you currently reside.

Zip code

State

Tree Nuts Survey

Purchasing Tree Nuts

* 10. What tree nuts have you purchased in the past year? (Check all that apply.)

- [ ] I do not purchase tree nuts.
- [ ] Almonds
- [ ] Pecans
- [ ] Walnuts
- [ ] Macadamia Nuts
- [ ] Cashews
- [ ] Pistachios
- [ ] Hazelnuts
- [ ] Brazil Nuts
- [ ] Candied Nuts
- [ ] Other (please specify)

Tree Nuts Survey

Purchasing Tree Nuts

* 11. If you did **NOT purchase tree nuts** in the past year, what is (are) your reason(s)? (Check all that apply.)

- [ ] I do not like tree nuts.
- [ ] I am allergic to tree nuts.
- [ ] I have dietary restrictions.
- [ ] I have cost/budgetary restrictions.
- [ ] Other (please specify)

Tree Nuts Survey

Purchasing Specific to Tree Nuts

* 12. What are your ***three favorite tree nuts***? Please rank your favorites below.

	Tree Nuts
Favorite:	
Second Favorite:	
Third Favorite:	

* 13. What is (are) your main source(s) of information about ***tree nuts***? (Check all that apply.)

- [ ] Facebook
- [ ] Twitter
- [ ] Television
- [ ] Radio
- [ ] Magazines
- [ ] Friends and family
- [ ] Recipes
- [ ] Past experience
- [ ] Package labels
- [ ] Other Social Media or Websites (please specify)

* 14. Within the past year, do you recall seeing or hearing any advertising for any type of ***tree nuts***?

- ◯ Yes
- ◯ No
- ◯ I do not recall.

* 15. How often do you purchase ***tree nuts***?

- ◯ Weekly
- ◯ Monthly
- ◯ Annually
- ◯ Only during holidays

* 16. In what form do you purchase ***tree nuts***? (Check all that apply.)

- ☐ In the shell
- ☐ Raw, shelled
- ☐ Roasted, salted
- ☐ Candied
- ☐ Flavored
- ☐ Other (please specify)

* 17. In what type of packaging do you purchase ***tree nuts***? (Check all that apply.)

- ☐ Bulk
- ☐ Bag
- ☐ Can
- ☐ Snack-size

* 18. Where do you purchase ***tree nuts***? (Check all that apply.)

- ☐ Grocery stores (e.g. HEB, Kroger, Whole Foods)
- ☐ Supercenters (e.g. Walmart, Sam's Club, Target)
- ☐ Roadside stands
- ☐ Farmers market
- ☐ Convenience stores
- ☐ Specialty stores
- ☐ Mall kiosk
- ☐ Amazon
- ☐ Other online sources
- ☐ Other (please specify)

Tree Nuts Survey

Purchasing Specific to Pecans

* 19. How often do you purchase ***pecans***?

- ◯ I do not purchase pecans.
- ◯ Weekly
- ◯ Monthly
- ◯ Annually
- ◯ Only during holidays

* 20. If you did **NOT** purchase ***pecans*** in the past year, what is (are) your reason(s)? (Check all that apply.)

- ☐ I do not like pecans.
- ☐ I am allergic to pecans.
- ☐ I have dietary restrictions.
- ☐ I have cost/budgetary restrictions.
- ☐ Other (please specify)

Tree Nuts Survey

Purchasing Specific to Pecans

* 21. In what form do you purchase ***pecans***? (Check all that apply.)

- [ ] In the shell
- [ ] Raw, shelled pieces
- [ ] Raw, shelled halves
- [ ] Roasted, salted
- [ ] Candied
- [ ] Flavored
- [ ] Other (please specify)

* 22. In what type of packaging do you purchase ***pecans***? (Check all that apply.)

- [ ] Bulk
- [ ] Bag
- [ ] Can
- [ ] Snack-size

* 23. Where do you purchase ***pecans***? (Check all that apply.)

- [ ] Grocery stores (e.g. HEB, Kroger, Whole Foods)
- [ ] Supercenters (e.g. Walmart, Sam's Club, Target)
- [ ] Roadside stands
- [ ] Farmers market
- [ ] Convenience stores
- [ ] Specialty stores
- [ ] Mall kiosk
- [ ] Amazon
- [ ] Other online sources
- [ ] Other (please specify)

* 24. If pecans were not available for their intended use, which of the following would serve as a substitute for that purpose? (Check all that apply.)

- [ ] I would not purchase a substitute.
- [ ] Almonds
- [ ] Brazil Nuts
- [ ] Cashews
- [ ] Hazelnuts
- [ ] Macadamia Nuts
- [ ] Pistachios
- [ ] Walnuts
- [ ] Other (please specify)

* 25. What comes to mind when you think about ***pecans***? (Check all that apply.)

- [ ] Nothing comes to mind
- [ ] Wholesome
- [ ] Homegrown
- [ ] Heart-healthy
- [ ] High caloric content
- [ ] Packed with multiple health-promoting nutrients
- [ ] Nutrition powerhouse
- [ ] The original super nut
- [ ] Other (please specify)
- [ ] Heart-smart food
- [ ] Expensive
- [ ] Linked to a decreased risk of mortality
- [ ] America's only major native tree nut
- [ ] Ingredient for cooking or pies
- [ ] Family/holiday gatherings
- [ ] Delicious desserts

* 26. Where specifically do you recall seeing or hearing messages that would encourage you to purchase ***pecans***? (Check all that apply.)

- [ ] I do not recall.
- [ ] Facebook
- [ ] Twitter
- [ ] Television
- [ ] Radio
- [ ] Magazines/Newspaper
- [ ] Friends and family
- [ ] Recipes
- [ ] Billboards
- [ ] Other, including but not limited to websites, other social media platforms, etc. (please specify)

* 27. What specifically would make you more likely to purchase more ***pecans***? (Check all that apply.)

- [ ] Health and nutrition considerations
- [ ] Wider availability
- [ ] More variety in available pecans (roasted, salted, spiced, candied, etc.)
- [ ] More information in general about pecans
- [ ] Lower price
- [ ] Promotional specials (coupons, etc.)
- [ ] Advertising and promotion about pecans
- [ ] Recipes featuring pecans
- [ ] I do not know
- [ ] Other (please specify)

* 28. Are you aware of the existence of the American Pecan Council, comprised of growers and shellers, founded in 2016?

- ◯ Yes
- ◯ No
- ◯ I do not recall

* 29. Have you ever visited the website of the American Pecan Council (www.americanpecan.com)?

- ◯ Yes
- ◯ No
- ◯ I do not recall

* 30. If you ***have*** visited the American Pecan Council website, what were you looking for? (Check all that apply.)

- ☐ General information regarding pecans
- ☐ Recipes
- ☐ Health and nutrition information and benefits
- ☐ Other (please specify)