# IS THE TEXAS PECAN CHECKOFF PROGRAM WORKING?

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Texas Agribusiness Market Research Center (TAMRC) Commodity Market Research Report No. CM-01-08, February 2008 by Mr. Eli D. Moore and Dr. Gary W. Williams.

**ABSTRACT:**
The Texas Pecan Board was established in 1998 to administer the Texas Pecan Checkoff Program and is financed through a one-half cent per pound assessment on grower pecan sales. The Board spends the assessment collections on a variety of advertising campaigns in an attempt to expand demand for Texas pecans, both improved and native varieties, and increase the welfare of Texas pecan growers. This study presents an evaluation of the economic effectiveness of the Texas Pecan Checkoff Program in expanding sales of Texas pecans. First, the effects of Texas Pecan Board promotion on sales of all Texas pecans are determined using the ordinary least squares estimator (OLS) followed by a test for differential effects of Texas Pecan Board promotion on sales of improved and native Texas pecan varieties using the seemingly unrelated regression estimator. The analysis indicates that the Texas Pecan Checkoff Program has effectively increased sales of improved varieties of Texas pecans but has had no statistically measureable impact on sales of native varieties of Texas pecans. A benefit-cost analysis determines that the additional sales revenues generated is relatively large compared to the dollar value invested in promotion indicating that the Texas pecan promotion program has been financially successful.

**ACKNOWLEDGEMENTS:**
This study was conducted under contract with the Texas Pecan Board. Thanks are due to Dr. Oral Capps, Jr., Dr. Leonardo Lombardini, and Dr. Marco Palma for comments and helpful suggestions. Thanks are also due B. Michael Adams, President of the Texas Pecan Board, various other Texas Pecan Board members (current and retired) and pecan growers for their input, comments, and funding. In addition, we are grateful to Cindy Wise, Executive Vice President of the Texas Pecan Growers Association, for her help in pulling together the needed data related to the activities of the Texas Pecan Board.

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# Is the Texas Pecan Checkoff Program Working?

## EXECUTIVE SUMMARY

The Texas Pecan Board (TPB) was established under the Texas Commodity Referendum Law (Texas Agricultural Code Chapter 41) in August of 1998 to administer the Texas Pecan Checkoff Program. The law authorizes TPB to promote pecans in an attempt to increase the welfare of Texas pecan growers. This study statistically analyzes the promotion program and addresses the general question of whether or not the program is working as intended to increase sales of Texas pecans. More specifically, the study focuses on the answers to two key questions:

- What have been the effects of the Texas Pecan Promotion Program on sales of Texas pecans?
- What has been the return on investment made by Texas pecan growers on the promotion of sales of Texas pecans?

The report first provides a review of the literature relevant to the study and briefly reviews the U.S. and Texas pecan industries and the role of the Texas Pecan Checkoff Program as background to the subsequent statistical analysis of the program. The statistical analysis identifies and measures the effects of the main economic drivers of Texas pecan sales and statistically isolates the effects of pecan promotion under the Texas Pecan Checkoff Program. Finally, the results of the statistical analysis are used in an analysis of the returns to Texas pecan growers from their investment in the Texas Pecan Checkoff Program.

The pecan industry functions in a market relatively free of government intervention and supplies a perishable, perennial commodity with a natural tendency for yields to fluctuate widely from year to year. The alternate bearing nature of the pecan creates a pattern of high production in one year followed by low production in the next, often referred to as the “on” and “off” years, respectively. Besides the “on” and “off” year behavior of production which affects annual availability of pecans for sale, many other forces affect the sales of pecans each year, among the most important of which is the price of pecans. Because the pecan market is relatively free of government intervention, the price of pecans is determined primarily by the forces of supply and demand. There are hundreds of pecan varieties throughout the world, classified as either native or improved varieties. Trees that have not been grafted or budded are referred to as native or seedling. On the other hand, improved varieties are those that have been genetically altered through selection and controlled crossing to yield desirable characteristics such as high kernel percentage, low yield variation, and resistance to diseases and insects.

Improved varieties sell at a premium to native varieties. Quality tends to be a major factor in the differentiation of pecan prices and is a function of certain physical characteristics, including meat yield, color, size, minimal foreign material, and shell-out ratio. Research has determined that the shell-out ratio has the most significant impact on pecan prices. Research has also found that growers who achieve higher yields also tend to achieve higher quality in their crop. Thus, because higher quality nuts sell for higher prices, growers with higher yields tend to receive higher prices.

The United States produces more than 80% of the world's supply of pecans. The pecan is grown throughout the southern United States from California to Florida. The volume and value of pecan production has been growing steadily for the past thirty years with improved varieties accounting for the majority of the growth. Although pecans are grown statewide, the principal producing counties in Texas are Comanche, El Paso, and San Saba. Although the Texas harvest begins in mid-September and ends in late January, most of the harvesting activity takes place between mid-October and mid-December.

The "on and off" year behavior of pecan yields which affects what is available for sale tends to be more apparent in native/seedling varieties than is the case for improved pecans. Because Texas has historically produced an above average percentage of native/seedling varieties, the "on" and "off" year phenomenon is more apparent in Texas pecan production and sales data than is the case for many other states. Texas sales of improved varieties have been increasing over the past thirty years just as sales for native/seedling varieties have been on the decline.

The Pecan Promotion and Research Act of 1990 established a national pecan checkoff program that was implemented in 1992. A producer referendum on the continuation of the program in 1994 required by the Act failed and the program was terminated on March 15, 1994. The Texas Pecan Board (TPB) was established in 1998 with its first year of promotion occurring in crop year 1999/2000. Revenues to support the TPB promotion efforts come from a one-half cent per pound assessment on all pecans sold from growers to a first handler. Under the Texas Pecan Checkoff Program, growers with 500 pecan trees or more and at least 15 acres are required to pay the assessment. The assessment is due when the pecans are first processed or shelled. Because the checkoff program is mandatory, the first handler is required by law to collect the assessment from the grower and then report and submit it to the Texas Pecan Board.

Because there is little or no enforcement of the mandatory provision of the checkoff program, only about 44% of the available funds are collected on average each year which effectively limits the potential impact of the Texas Pecan Checkoff Program and suggests that there may be a free rider problem. Assessment revenue has varied between $85,500 and $167,600 per crop year since the program was established. Revenues were at their highest during the 1999/2000 crop year but have been on the decline ever since. Total TPB crop year expenses have varied between $70,100 and $161,600. Expenses on promotional activities have ranged from $58,700 to $145,200 per crop year with an average of $90,600. For analyzing the effectiveness of the pecan promotion program, TPB promotion expenditures were divided into seven categories: (1) the ambassador program, (2) festivals and conferences, (3) clipping service, (4) research, (5) website, (6) media, and (7) other promotion. Media has been the largest expense category accounting for more than 60% of total promotion expenditures.

Because a growing proportion of U.S. pecans are exported (from 2% in 1980/81 to 41% in 2006/07), past research on pecan promotion has focused primarily on export expansion programs rather than on domestic demand expansion efforts. There have not been any previous analyses of the effectiveness of either the national or Texas pecan promotion programs. For this analysis, three statistical models were developed and used to explain the effect of promotion expenditures on: (1) Texas sales of all pecans; (2) Texas sales of only improved varieties of pecans; and (3) Texas sales of only native and seedling varieties of pecans. In essence, the analysis isolates and measures the specific effects of the main factors, including promotion, that influence annual sales of Texas pecans over the 1999/00 through 2006/07 marketing years. Salient results from the statistical analysis include the following:

- *Sales of improved varieties of pecans are sensitive to changes in their price while those of native pecans are not.*

  Price was found to be a statistically significant determinant of the sales of improved varieties of pecans but not sales of native varieties. The own-price elasticity of improved pecan variety sales was estimated to be -0.3231 indicating that a 10% increase in price leads to a 3.2% decline in sales of improved varieties. The statistical insignificance of price as a determinant of native pecans sales does not mean that consumers do not consider price when making their purchasing decisions. Rather, the results suggest that changes in price do not result in large changes in purchases of native pecans because purchases are more sensitive to changes in other variables like the availability of supplies for purchase.

- *TPB promotion expenditures have a statistically significant albeit lagged effect on the sales of Texas pecans measured in the aggregate.*

  The analysis found that TPB promotion affects pecan sales with a one period lag. The promotion elasticity of Texas pecan sales over the period of analysis (that is, the responsiveness of sales to a change in promotion expenditures) was estimated to be 0.03114 meaning that doubling promotion expenditures (a 100% increase) in one year leads to about a 3.1% increase in pecan sales in the next year, a result consistent with the calculated promotion elasticities reported for other commodity promotion programs.

- *Promotion expenditures are a statistically significant determinant of the sales of only improved varieties and not those of native varieties of pecans.*

  When aggregate pecan sales were decomposed into sales of improved varieties and sales of native varieties and analyzed separately, promotion expenditures were found to be a statistically significant determinant of the sales of improved varieties but not of native varieties. The promotion elasticity of improved variety pecan sales (the responsiveness of sales to promotion expenditures) was estimated to be 0.042 meaning that a doubling of expenditures would result in a 4.2% increase in sales of improved pecans in the next period. For native pecans, promotion expenditures were found to have no statistically discernible effect on sales.

- The *availability of pecans for sale each year and the on-going shift in composition of sales from native to improved varieties are major determinants of annual sales of Texas pecans.*

  The availability of pecans for sale each year was found to be a highly significant determinant of the sales of both improved and native varieties of pecans. Perhaps the most important determinant of pecan sales in most years is yield variation which constrains the availability of pecans for sale in some years and allows greater market responsiveness in other years. At the same time, the shift in the composition of sales from native to improved varieties was also found to be statistically significant in explaining the changes in Texas pecan sales over time.

- *Texas pecan sales are not affected by changes in the prices of competing nuts or of consumer income.*

  The statistical analysis found no statistical relationship between changes in sales of Texas pecans and changes in the market prices of almonds or walnuts or changes in consumer income. Again, these results do not mean that buyers are not concerned about changes in these variables as they make their buying decisions but rather that other market forces such as availability are of primary importance in their purchases of Texas pecans.

The results of the statistical analysis were used to determine answers to the two key questions that are the specific focus of this study. The analysis of the first question focused on whether the expenditures of pecan checkoff assessment revenues by the TPB to promote Texas pecan sales have effectively and consistently increased the sales of Texas pecans over the eight-year period of 1999/00 to 2006/07. A benefit-cost approach was used to analyze the second question regarding the return to Texas pecan promotion activities. In general, the study concludes that pecan promotion and advertising expenditures by the Texas Pecan Board and funded by the Texas Pecan Checkoff Program since its inception in 1998 have been effective in augmenting Texas pecan sales. More specifically, the study finds the following:

- *The TPB promotion program has effectively "moved the needle" for pecan sales.*

  Promotion expenditures since the inception of the Texas Pecan Checkoff Program have added an average of nearly 2.7 million lbs annually to Texas pecan sales for a total of 21.5 million lbs (4.9% of actual sales) from 1999/00 through 2006/07 that would have not been sold without the promotion program. In terms of industry revenue, the promotion program added an average of nearly $3.7 million annually for a total of over $29.4 million in additional sales of pecans over the period that would not have occurred without the promotion program.

- *Sales of improved pecan varieties have been the main beneficiary of the promotion program.*

  The promotion-led increase in sales experienced by the Texas pecan industry has been composed primarily of improved variety pecans rather than native pecans. Since its inception, the Texas Pecan Board has focused on increasing the visibility of pecans for home consumption and, by doing so, may have unintentionally promoted sales of improved varieties of pecans rather than sales of native pecans since improved varieties tend to be used for home consumption while native pecans tend to be used for food and candy production.

- *TPB pecan promotion program has generated a net industry revenue of $36 for every pecan checkoff dollar spent on promotion or $30.5 on a discounted, present value basis.*

- *In terms of sales, the TPB promotion program has generated 26.4 lbs in additional sales of improved varieties of pecans per dollar spent on promotion.*

The analysis presented in this study also provides some important insights for management of the pecan promotion program:

- *The Texas Pecan Promotion Program is greatly under-funded.*

  The BCR calculated for the Texas Pecan Promotion Program seems high relative to those generally reported for the larger commodity promotion programs. Given the low level of promotion expenditures for Texas pecans compared to those of the major checkoff commodities like cotton, soybeans, beef, and pork, however, the somewhat higher BCR found for Texas pecans is not unreasonable. The higher BCR implies that while Texas pecan promotion efforts have been successful, the promotion activities also are greatly under-funded. Both experience and the theory of advertising suggest strongly that a substantial increase in funding over time would likely reduce the Texas pecan BCR to levels more in line with those of the better-funded commodity promotion programs.

- *Free riders are limiting the funds available for promotion and industry revenues.*

  Less than half of the required assessment revenues are actually paid and remitted to TPB each year which effectively limits the potential impact of the Texas Pecan Checkoff Program. The consequence is that a large portion of the additional industry revenues generated by the pecan promotion program is being earned by those who have chosen not to contribute to the cost of the promotion. The current assessment rate is too low to fund promotion programs and, at the same time, pay the necessary cost of a collections program. The result is that free riders are allowed to enjoy the benefits of the program without being required to pay the cost.

- *A high BCR does not imply a large impact of the program on sales.*

  The high estimated BCR should not be mistaken to imply large absolute impacts of the pecan checkoff program on Texas pecan sales. A BCR of 36:1 results by dividing a $36 billion industry profit benefit by a $1 billion checkoff investment or by dividing a $36 benefit by a $1 investment. In fact, the high BCR found for the pecan promotion program is the result of dividing a small increase in industry revenue from the promotion program by an even smaller expenditure on promotion. The high estimated BCR means that the Board has accomplished a lot with very little funds. In an effort to encourage compliance with the assessment requirement or to sell the program during a referendum, however, the temptation is for the Board to imply that the high BCR found for the promotion program means that the program has been a major factor influencing Texas pecan sales. This misinterpretation of the BCR is a common occurrence among commodity checkoff programs and leads contributors to expect large impacts on their sales and revenues. When such impacts do not occur, support for the program among contributors begins to wane. A more prudent message to contributors is that the per unit return is large but on a very few dollars available for investment implying the need for more investment to achieve more meaningful returns. The promotion program could be better sold to contributors as a *producer controlled tool* that pays more than it costs to help reduce downside pressure on sales in bad years and contribute to sales in good years rather than as a panacea to the financial problems they may face.

- *Not all contributors receive the same benefits.*

  The positive BCR calculated for the pecan promotion program indicates that contributors gain “on average” from the program. Research has shown, however, that the benefits of a checkoff program may not be evenly distributed among contributors with some gaining more than others. The research suggests that more of the benefits accrue to larger producers although smaller producers benefit more in terms of the net revenues accrued *per unit of assessed checkoff*. If the smaller producers tend to be the higher cost producers and the large producers tend to be the lower cost producers, then the high cost producers benefit the most and the low cost producers benefit the least. That is, those that pay the most receive the least per dollar that they pay in checkoff assessment. Thus, a checkoff program works as a mechanism to redistribute income from large, low cost producers to small, high cost producers. If this is the case and the differences in benefits are substantial, larger producers may begin to feel somewhat disenfranchised over time and to be less supportive of the checkoff program. Several checkoff programs (for example, beef and cotton) have experienced such problems which has led to protracted court cases related to the mandatory nature of the program.

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# IS THE TEXAS PECAN CHECKOFF PROGRAM WORKING?

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This report addresses the general question of whether or not the Texas Pecan Checkoff Program is working as intended to increase sales of Texas pecans. More specifically, the study focuses on the answers to two key questions:

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## Previous Studies of Pecan Promotion and Related Research

Onunkwo and Epperson (2000) report that the United States produces more than 80% of the world's supply of pecans. At the same time, USDA (2007) estimates that the proportion of U.S. pecans that are exported has grown steadily from 2% in 1980/81 to 41% in 2006/07. Thus, past research on pecan promotion has focused primarily on efforts to expand exports rather than domestic demand. Regardless, the available literature provides a firm foundation and background on the pecan industry, as well as insights on the promotion of pecans that proved useful in this study of domestic pecan promotion. This section provides a critical review of the literature relevant to the evaluation of pecan promotion programs as well as related research.

## *Studies of Pecan Promotion*

Onunkwo and Epperson (2000) analyzed U.S. pecan export demand promotion. Although Onunkwo and Epperson did not analyze state-level or even domestic U.S. promotion of pecans, they provided valuable information and examples relevant to an analysis of domestic pecan promotion. They analyzed the effects of various pecan export promotion programs, including those funded under the USDA Foreign Market Development Program and Targeted Export Assistance promotion program which annually spend an average of approximately $30.5 million and $98 million, respectively, on export promotion. Onunkwo and Epperson (2000) postulated that the export demand for U.S. pecans was a function of income, U.S. promotion expenditures for pecans as well as walnuts and almonds, and prices of pecans, almonds, and walnuts. The prices of almonds and walnuts were included in their study to account for the effects on pecan export demand from changes in the prices of substitutes. They concluded that pecan promotion expenditures were statistically significant at the 0.01 level of significance in expanding demand for pecans in export markets. They calculated that the benefit-cost ratios for federal export promotion were 6.45 to 1 and 6.75 to 1 for Asia and the European Union, respectively (Onunkwo and Epperson 2000). They also calculated promotion elasticities for Asia and the European Union to be 0.98 and 0.06, respectively.

According to Wood, Payne, and Grauke (1994), the pecan industry experienced considerable growth during the twentieth century that could have continued if the industry had not failed to develop and expand markets. Florkowski and Park (2001) discussed strategies for demand expansion including advertising and marketing campaigns. They concluded that demand expansion programs can have a statistically significant, positive effect on consumption when the promotion targets pecan uses, pecan visibility, and the health benefits of pecans such as its effect on decreasing LDL cholesterol levels (Rajaram et al. 2001). These three factors have been the primary targets of Texas Pecan Board promotion expenditures, specifically pecan visibility.

## *Related Research*

Florkowski, Purcell, and Hubbard (1992) studied promotion programs for other tree nuts and concluded that those programs have decreased the market share of pecans and have adversely affected the pecan market. The success of other tree nut promotion programs suggests that pecan promotion programs may be an important factor affecting the demand for pecans.

There has been more research reported on almond promotion programs, primarily for California almonds, than on pecan promotion programs. Based on earlier research by Bushnell and King (1986) and Alston et al. (1995), Crespi and Sexton (2001) analyzed the economic impacts of promotion expenditures by the Almond Board of California on the U.S. demand for almonds over the crop years of 1962/63 through 1997/98. They report a benefit-cost ratio for that program of between 1.53 to 1 and 7.60 to 1 (95% confidence interval) assuming a supply elasticity of 1.50.

Halliburton and Henneberry (1995) evaluated the effectiveness of U.S. export promotion programs (the Foreign Market Development Program and the Market Promotion Program) with application to almonds. Their study is similar to the Onunkwo and Epperson study except that they considered almond exports rather than pecan exports. In their model, they lagged promotion expenditures to account for the typical delayed consumer response to advertising. Although this study provides useful insight into model specification and analysis of a promotion program, neither the techniques used nor conclusions reached were strictly applicable to Texas pecans.

## The U.S. and Texas Pecan Industries

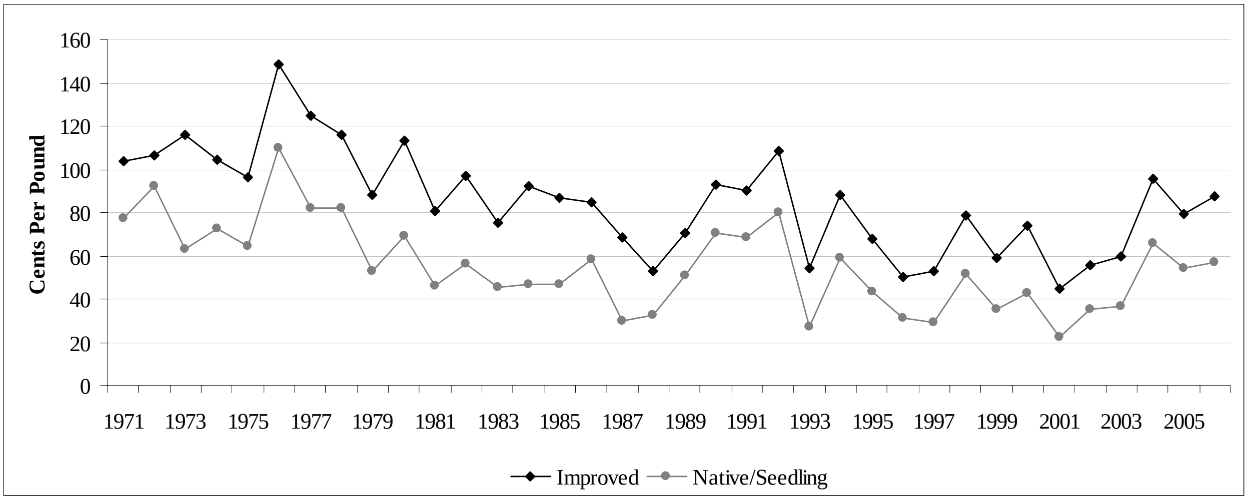
The pecan [*Carya illinoinensis* (Wangenh.) C. Koch] industry is unique, functioning in a market relatively free of government intervention and supplying a perishable, perennial commodity with a natural tendency for yields to fluctuate widely from year to year. The alternate bearing nature of the pecan tends to create a pattern of high production in one year followed by low production in the next, often referred to as the “on” and “off” years, respectively.

Besides the “on” and “off” year behavior of production which affects annual availability of pecans for sale, many other forces affect the sales of pecans each year, among the most important of which is the price of pecans. Because the pecan market is relatively free of government intervention, the price of pecans is determined primarily by the forces of supply and demand. Consequently, low supplies in the “off” years often result in higher prices than in the “on” years. Pecans cannot be stored without refrigeration for long periods of time in anticipation of future prices due to their susceptibility to oxidation (Florkowski and Wu 1990). Moreover, pecan growers cannot easily substitute production resources to produce alternative crops. Consequently, pecan prices are sensitive to changes in supply and demand each season (Shafer 1996). Onunkwo and Epperson (2000) concluded that the demand for U.S. pecans by Asia and the European Union is fairly responsive to price changes with own-price elasticities of -0.72 and -0.73, respectively.

There are hundreds of pecan varieties throughout the world, classified as either native or improved varieties (Thompson and Young 1985). Trees that have not been grafted or budded are referred to as native or seedling. On the other hand, improved varieties are those that have been genetically altered through selection and controlled crossing in order to yield desirable characteristics such as high kernel percentage (high meat content), low yield variations, and resistance to diseases and insects (Worley 1994).

Improved varieties sell at a premium to native varieties (Figure 1). Quality tends to be a major factor in the differentiation of pecan prices as discussed by Florkowski and Park (1999). According to Wood, Payne, and Grauke (1994), quality has been one of the major factors in the growth of the pecan market. The quality of pecans is a function of certain physical characteristics. However, different segments of the industry emphasize different characteristics (Erickson 1994). Erickson (1994) concluded that the characteristics of pecans that are often associated with quality are meat yield, color, size, minimal foreign material, and shell-out ratio (meat to shell weight ratio). However, the shell-out ratio, calculated as the weight of the kernel or meat divided by the weight of the entire nut, has empirically proven to have the most significant impact on pecan prices (Florkowski and Hubbard 1994).

**Figure 1: Inflation-Adjusted Prices Received by Texas Growers by Classification, Crop Years 1971- 2006**




Source: USDA (2006).

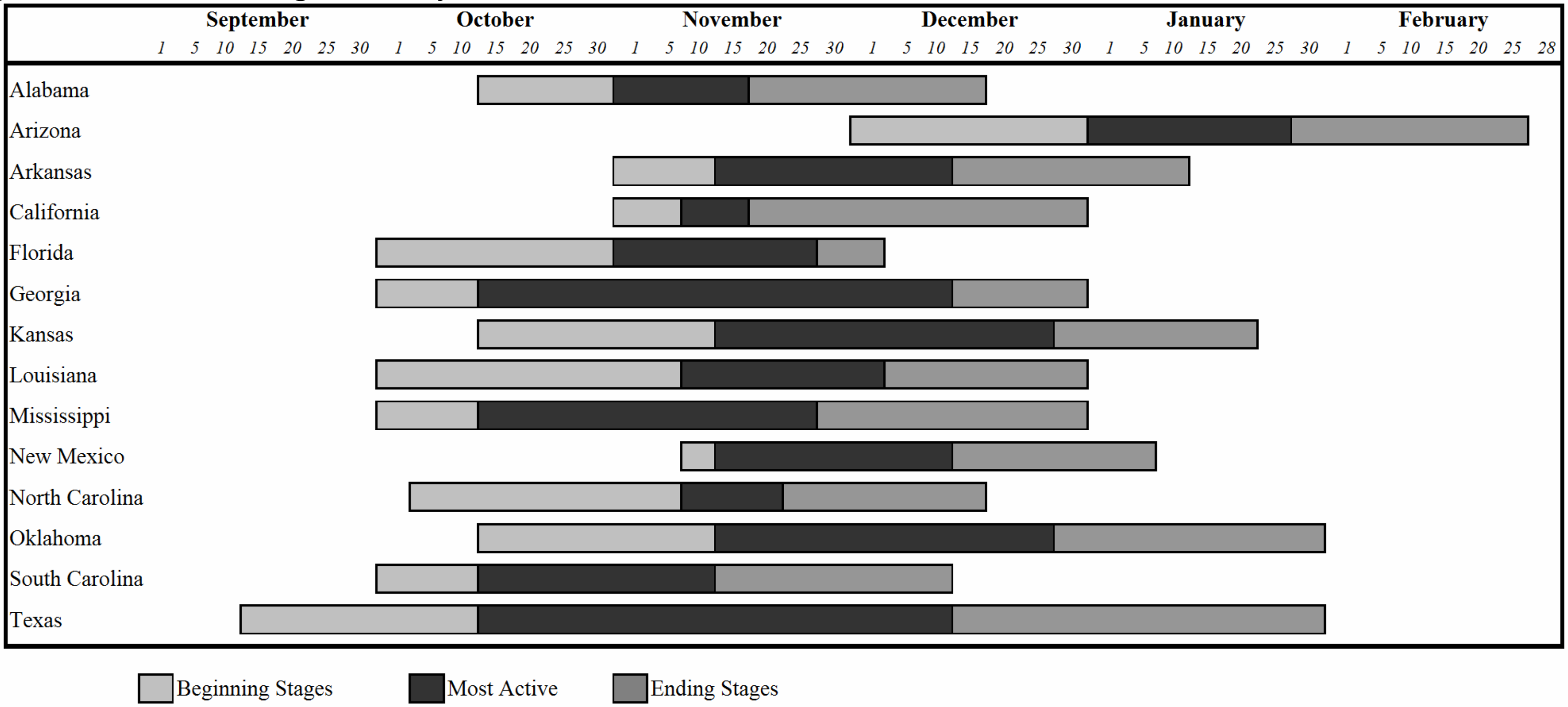
A decline in domestic supply has increased the prices for high quality nuts substantially (Santerre 1994). According to Tomek and Robinson (1972), differentiated nut quality across the market creates multiple prices for each quality which are determined by their own supply and demand functions. However, Okunade and Cochran (1991) found that different varieties of pecans tend to be of different qualities. Thus, they may be priced differently which is especially true for the improved varieties that are genetically designed for producing high quality nuts.

Even so, Florkowski and Sarmiento (2005) found that quality impacts the differentiation of prices received by growers for different varieties of pecans and that the causes of quality differences may help explain aggregate changes in the prices of pecans. Florkowski and Sarmiento (2005) also found that growers who achieve higher yields also tend to achieve higher quality in their crop. Thus, because higher quality nuts sell for higher prices, growers with higher yields tend to receive higher prices. While quality differences in pecans primarily affect their relative prices and substitutability, quality problems caused by factors such as diseases, insects, or abiotic stresses (drought, hail, excessive rain, etc.) affect all varieties of pecans and impact their market availability.

*The U.S. Pecan Industry*

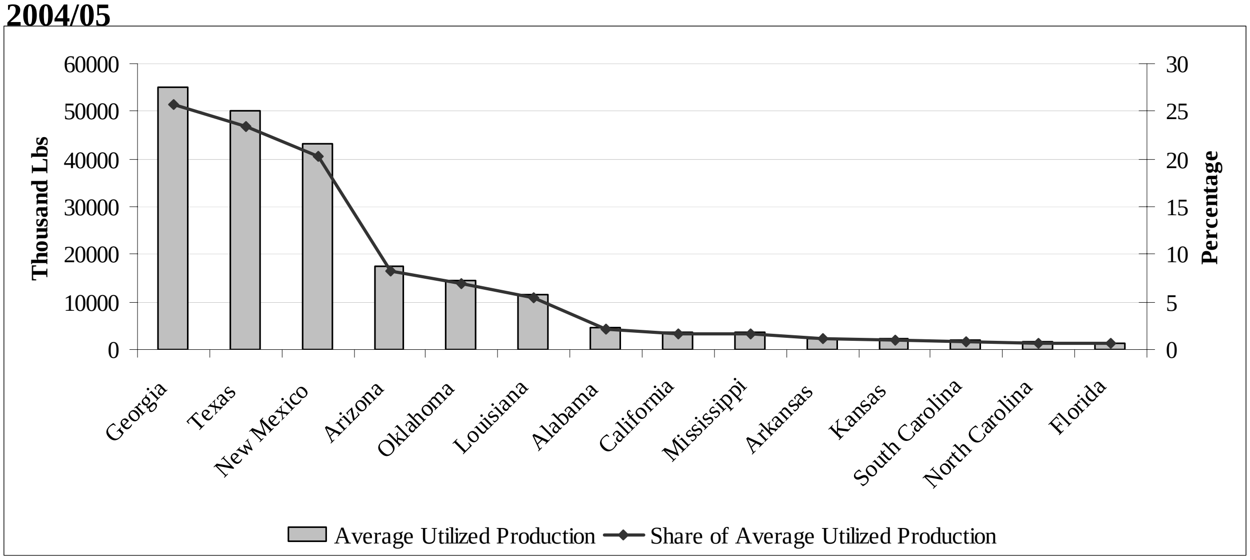
Onunkwo and Epperson (2000) estimate that the United States produces more than 80% of the world's supply of pecans. The pecan is grown throughout the southern United States from California to Florida. Marketing and harvesting seasons vary widely throughout the United States (Figure 2). Texas harvests pecans earlier than anywhere in the country and has the longest marketing season. Arizona is the last to harvest its pecans. California has the shortest harvesting season. The top three producing states in 2002/03-2004/05 included Georgia accounting for roughly 25% of annual utilized production, followed by Texas (23%), and New Mexico (20%) (Figure 3). However, in 2005/2006, New Mexico was the leading producer accounting for

**Figure 2: Pecan Harvesting Seasons by State**




Source: USDA (2006)

**Figure 3: Average Utilized Production and Share of Utilized Production by State, 2002/03-2004/05**




Source: USDA (2006)

30.4% of utilized production (sales)[1]. That same year, Georgia accounted for 23.8% of U.S. utilized production and Texas followed with 21.8%. The value of U.S. pecan production has been growing steadily for the past thirty years with improved varieties accounting for the majority of the growth (Figure 4).

The North American Free Trade Agreement (NAFTA) has expanded markets and increased competition in the U.S. pecan industry. Sun, Epperson, and Ames (1996) showed that although U.S. exports have been increasing, U.S. pecan imports from Mexico are larger that exports and have been increasing at a faster rate, leading to increasing U.S. net imports of pecans (Figure 5). They also argued that the U.S. pecan producer surplus (a measure of producer welfare) has decreased by nearly 44% as a result of NAFTA. Eliminating barriers to U.S. imports of Mexican pecans as a result of NAFTA has increased the competition facing U.S. pecan producers. Even so, U.S. per capita consumption of pecans has remained relatively constant implying that imports are growing just fast enough to replace domestic production (Figure 6).

Competition among substitutable nuts is also increasing (Florkowski and Park 2001). Pecan, almond, and walnut prices tend to follow similar patterns as would be expected of highly substitutable products (Figure 7). Although almonds tend to be more expensive than pecans, the reverse has often been the case. Walnuts are almost always the cheapest of the three nuts.

The U.S. pecan industry has not experienced the same level of growth as the almond industry since the mid-1960s. Between 1965-1974 and 1996-2005, the marketable production of pecans increased 30% and disappearance increased 52%. Over the same period, the marketable production of almonds experienced a 500% increase while almond disappearance increased by

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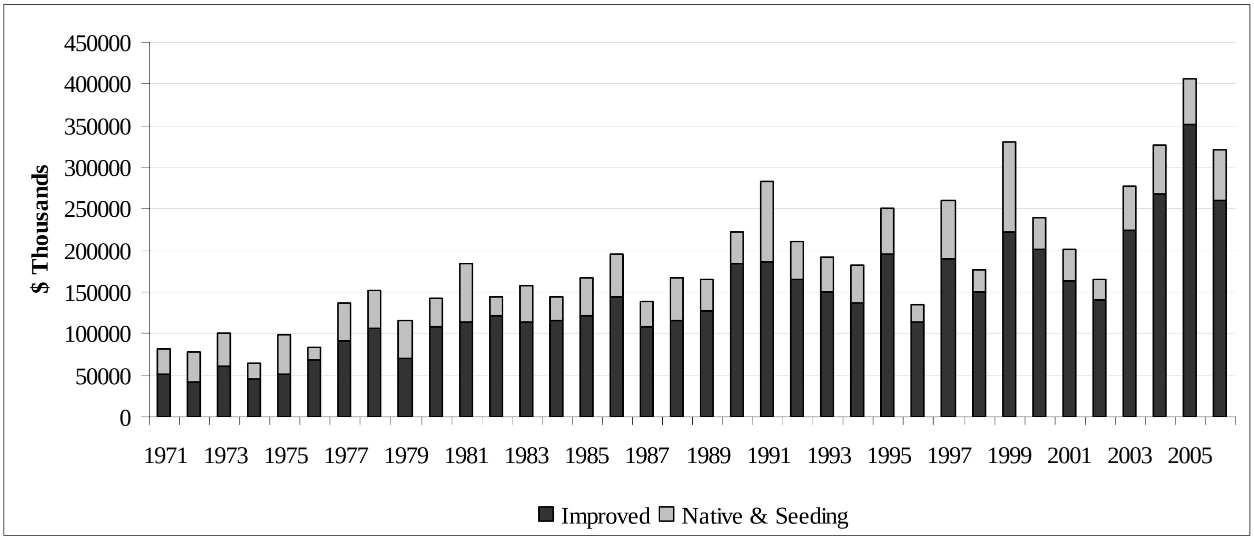
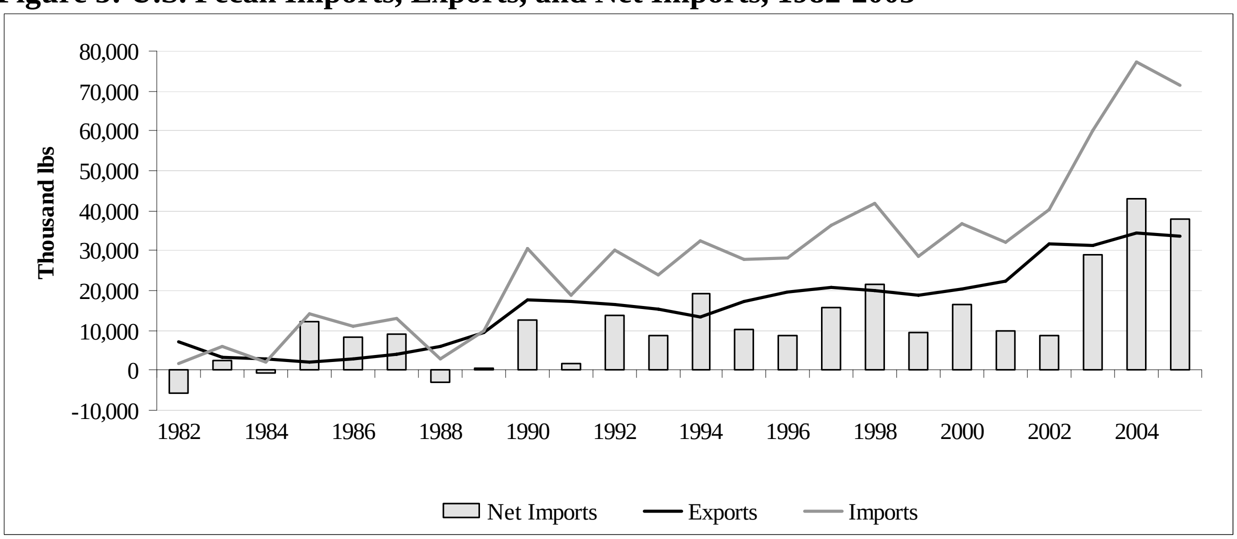
[1] Utilized production is defined by the USDA (2006) as “the amount sold plus the quantities used at home or held in storage” and is considered equivalent to sales according to USDA definitions.

**Figure 4: Value of U.S. Pecan Production by Variety, Crop Years 1971-2006**



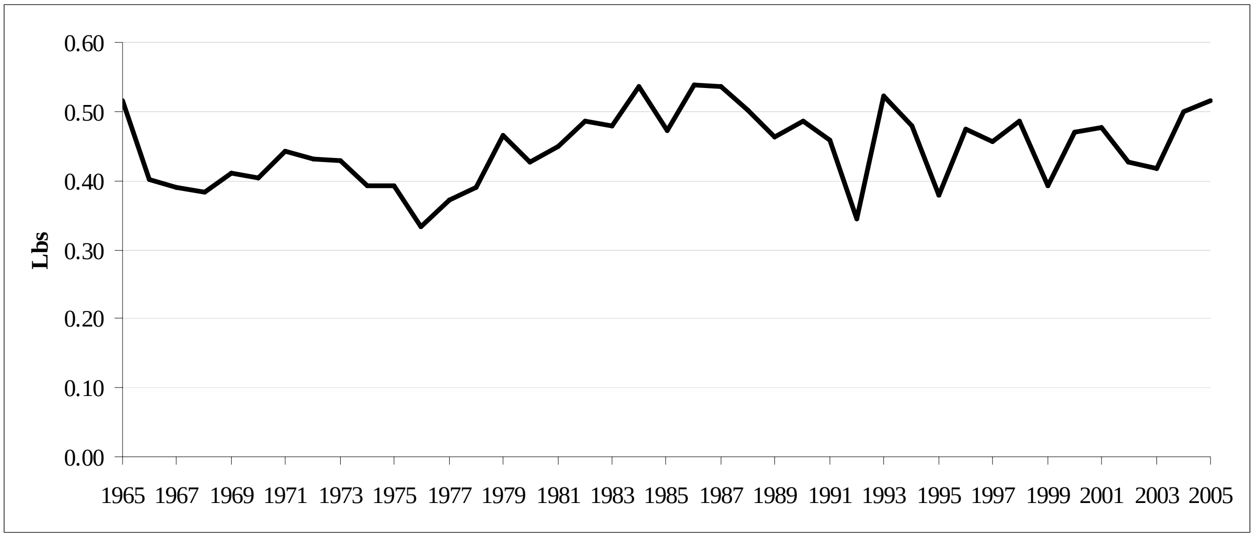

Source: USDA (2006)

**Figure 5: U.S. Pecan Imports, Exports, and Net Imports, 1982-2005**



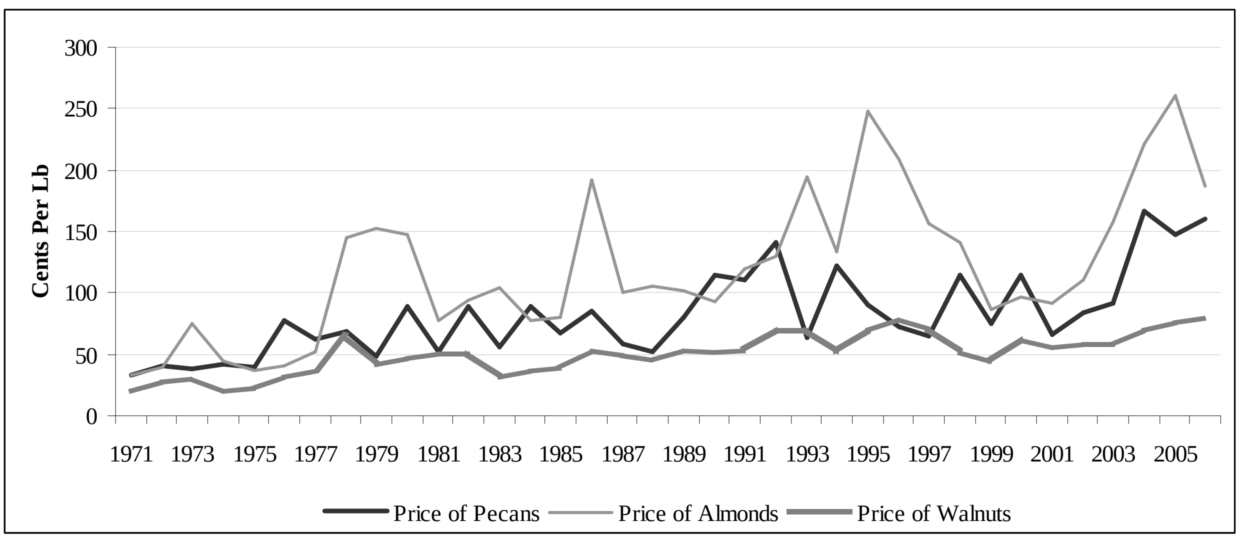

Source: USDA (2006)

**Figure 6: U.S. Per Capita Consumption of Pecans, 1965-2005**




Source: USDA (2006)

**Figure 7: National Pecan, Walnut, and Almond Prices Received by Growers, Crop Years1971-2006**




Source: USDA (2006)

250%. Research suggests that the growth of the almond industry was result of aggressive promotion tactics to expand both domestic and foreign market demand (Santerre 1994).

### *The Texas Pecan Industry*

Texas has been successful in producing pecans because of the numerous east Texas rivers that have provided transportation and irrigation for pecan growers (Wood, Payne, and Grauke, 1994). Although pecans are now grown statewide in Texas, the principal producing counties according to the USDA (2006) are Comanche, El Paso, and San Saba (Figure 8). The primary improved varieties grown in Texas are the Cheyenne, Desirable, Pawnee, Western, and Wichita (USDA 2006). The usual date of full bloom in Texas is during the month of April. Although harvest begins in mid-September and ends in late January, most of the harvesting activity takes place between mid-October and mid-December (see Figure 2).

The “on and off” year behavior of pecan yields which affects what is available for sale tends to be more apparent in native/seedling varieties than is the case for improved pecans. Because Texas has historically produced an above average percentage of native/seedling varieties (Figure 9), the “on” and “off” year phenomenon is more apparent in Texas pecan production and sales data than is the case for many other states.

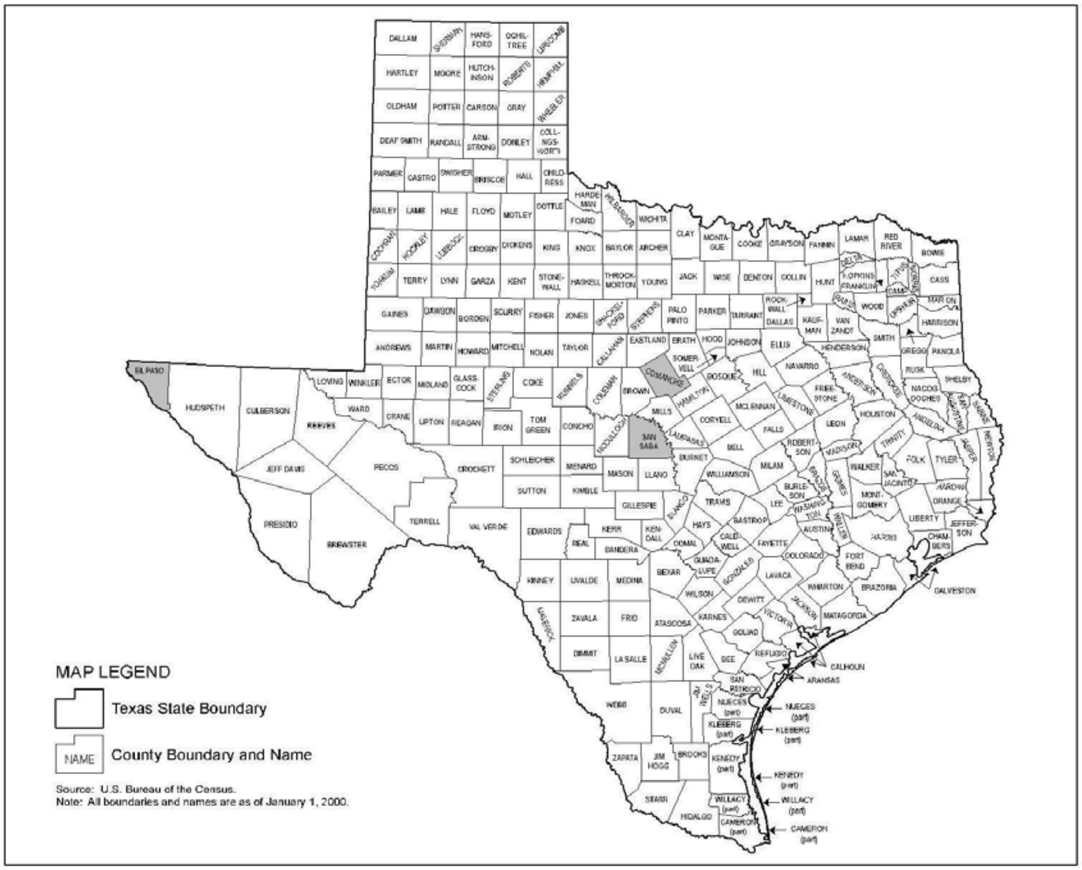
Producers of native varieties are more responsive to price which also contributes to the observed volatility of native pecan sales (Adams et. al. 2007). When native prices are low due to quality or weather, producers may not even harvest their crop likely because they typically do not spend as much on inputs as do producers of improved variety pecans, and, therefore, do not have as much overhead to cover. In some cases, the only costs they may need to recoup are harvesting expenses associated with actually harvesting the crop. This only adds to the problem of what is available for sale.

On the other hand, producers of improved varieties always harvest and tend to hold their crop until prices become more desirable. These producer behaviors limit consumer purchases by constraining what is available for sale, especially in the case of native pecan sales because of their already higher than improved yield fluctuations.

Sales of native pecans, although affected by price, are reportedly more determined by availability for sale. According to one producer and member of the Texas Pecan Board, the harvest of native pecans is determined primarily by the magnitude of the crop (Adams et. al. 2007), meaning that even though sales of native pecans are influenced by price, sales are driven primarily by the availability of the supply for sale.

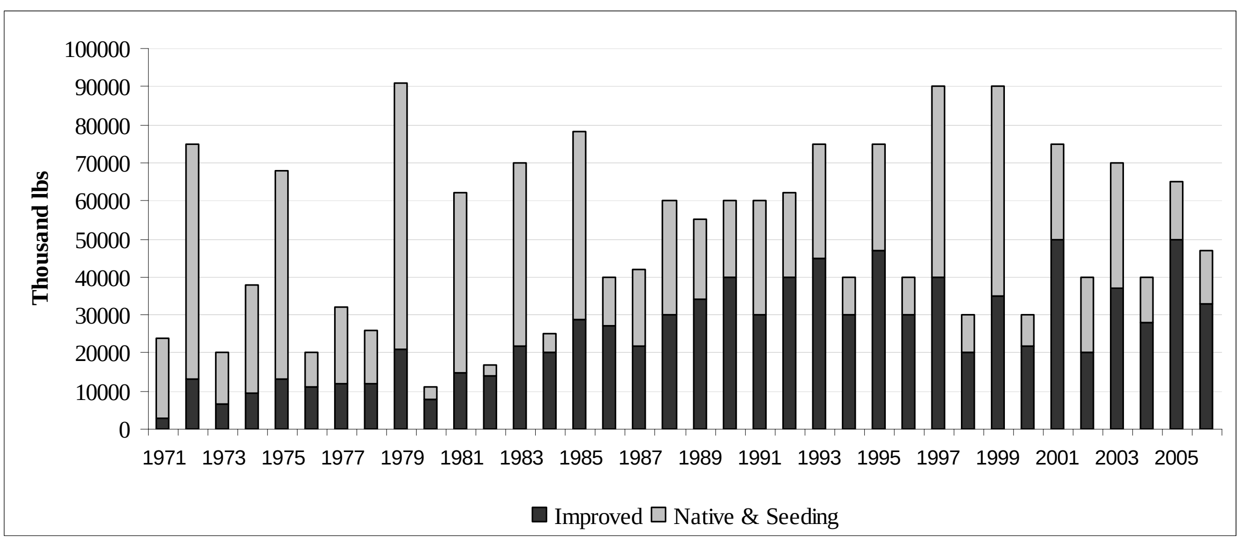
The value of Texas pecan production has been increasing over the past thirty years (Figure 10) with the majority of the growth attributed to the development and implementation of improved varieties. Prices for improved varieties tend to be higher than those of native/seedling varieties because of higher meat content and greater quality in the nuts (see Figure 1).

**Figure 8: Primary Pecan Producing Counties, State of Texas, Shaded in Gray**




Source: U.S. Bureau of the Census (2000)

**Figure 9: Texas Utilized Production by Variety, Crop Years 1971-2006**




Source: USDA (2006)

Sales of improved varieties have been increasing over the past thirty years just as sales for native/seedling varieties have been on the decline. The transition being made by Texas pecan growers from native to improved pecans due to changes in consumer demand can be seen in Figure 11. The average sales of Texas pecans over the last decade were approximately 57 million pounds higher than sales in the decade of the 1970s, an increase of 17.2 million pounds (42%). The 17 million pound growth in total pecan sales over that period, however, was the result of a 22.6 million pound (207%) increase in improved variety sales with a 5.4 million pound decline in native/seedling variety sales.

The sales of native pecans have also been much more volatile than those of improved variety pecans (see Figure 11). To empirically compare the difference in sales volatility between native and improved pecans, the coefficients of determination ($c_v$) for each can be calculated as:

$$c_v = \frac{\sigma}{\mu} \quad (1)$$

where $\sigma$ is the standard deviation and $\mu$ is the mean. Using equation (1), the coefficients of determination for improved and native pecans over the 1971-2006 period were calculated to be 0.50 and 0.69, respectively, indicating that native pecan sales have been more volatile than improved pecan sales over time. Although improved varieties typically do not experience the volatility in production that native varieties experience, the change in production of improved varieties from 2001/02 to 2002/03 was the largest nominal variation from an “on” year to an “off” year. According to USDA (2001 and 2002), early season growing conditions were excellent during 2001 including above average rainfall which, combined with the alternate bearing cycle (“on” year), contributed to the high availability of pecans for sale in 2001/02. However in 2002/03, unseasonable rains and wind due to tropical storms during October and November delayed and reduced the pecan harvest and negatively affected quality through increased diseases (USDA 2002). These weather factors combined with the alternate bearing cycle (“off” year) produced a record low crop of improved varieties in the 2002/03 season.

### *Pecan Promotion*

The Pecan Promotion and Research Act of 1990 established a national pecan checkoff program that was implemented in 1992. A producer referendum on the continuation of the program in 1994 required by the Act failed and the program was terminated on March 15, 1994 (Sterns 1999). Since 1994, pecan promotion at the national level has primarily been export promotion programs operated by the Foreign Agriculture Service of the U.S. Department of Agriculture.[2]

The National Pecan Shellers Association also promotes pecan sales through efforts to inform consumers about the variety of uses and health benefits of pecans. The Nutrition Research and Education Foundation of the International Tree Nut Council also operates a similar promotion effort focused on the health benefits of tree nuts (including pecans) and educating consumers about nuts.

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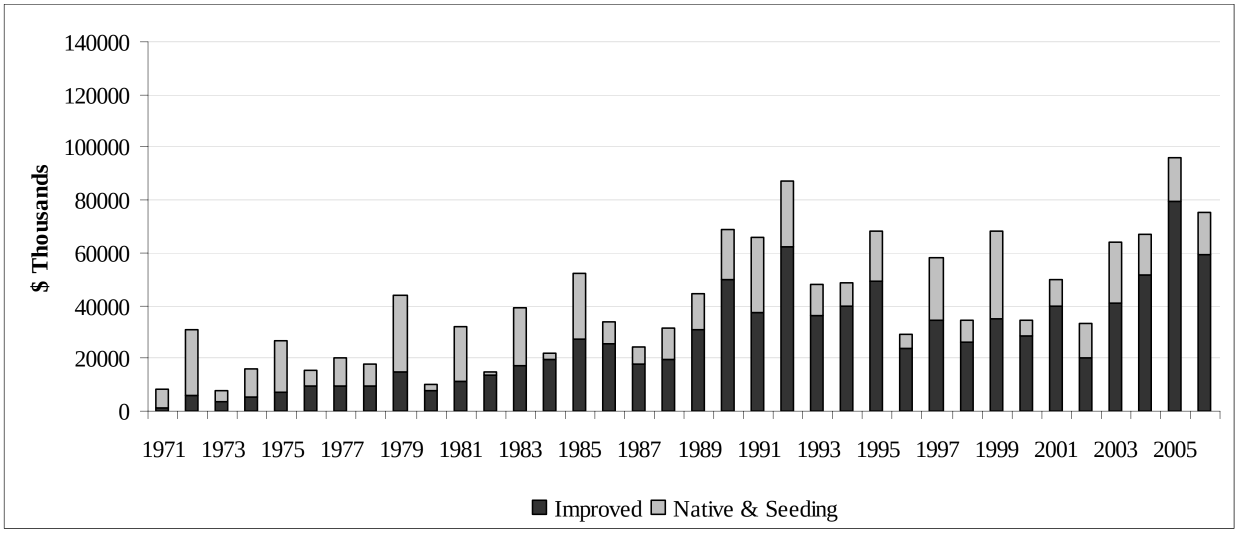
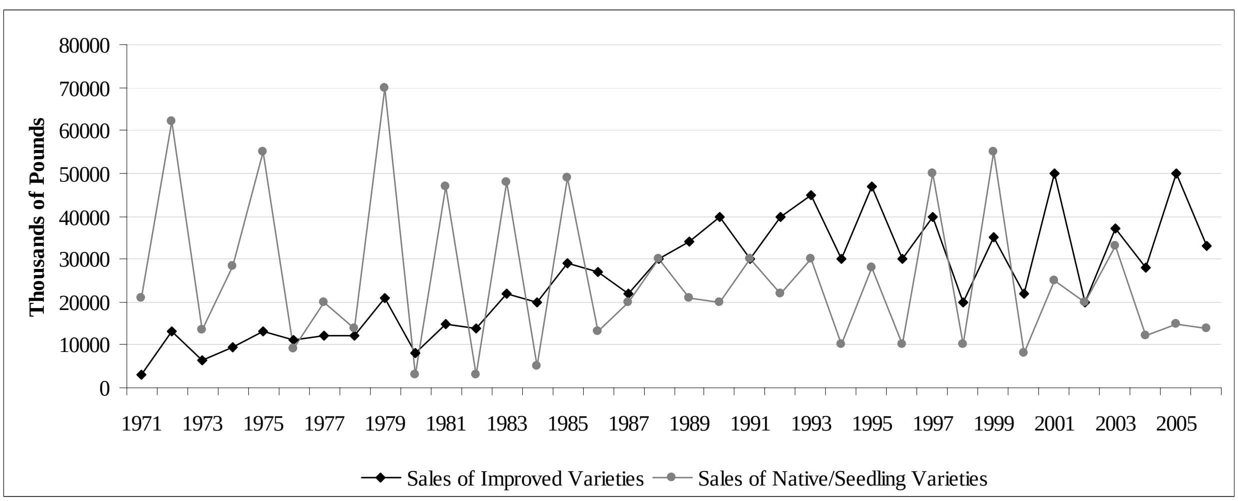
[2] Pecan export promotion programs have included the Foreign Market Development Program (FMDP), the Market Access Program (MAP), and the Market Promotion Program (MPP) (Onunkwo and Epperson 2000).

**Figure 10: Texas Value of Pecan Production by Variety, Crop Years 1971-2006**




Source: USDA (2006)

**Figure 11: Sales of Improved and Native Varieties, Crop Years 1971-2006**




Source: USDA (2006)

The Texas Pecan Board (TPB) was established in 1998 with its first year of promotion occurring in crop year 1999/2000. Revenues to support the TPB promotion efforts come from a one-half cent per pound assessment on all pecans sold from growers to a first handler. However, there is little to no enforcement of the mandatory checkoff collection due to a lack of funds and manpower at the Texas Department of Agriculture. Consequently, only about 44% of the available funds are collected on average each year which effectively limits the potential impact of the Texas Pecan Checkoff Program and suggests that there may be a free rider problem (Adams 2007).

Pecan checkoff revenue has varied between $85,500 and $167,600 per crop year (Figure 12). Expenses in crop year 1998/1999, which were solely administrative costs, were $65,200. Since then, total expenses have varied between $70,100 and $161,600. Revenues from the assessment fees were at their highest during the 1999/2000 crop year but have been on the decline ever since.

Of total TPB expenses, annual expenditures on promotional activities have ranged from $58,700 to $145,200 with an average of $90,600. For the purpose of analyzing the effectiveness of the TPB pecan promotion program, TPB promotion expenditures were divided into seven categories: (1) the ambassador program, (2) festivals and conferences, (3) clipping service, (4) research, (5) website, (6) media, and (7) other promotion (Figure 13). The Texas Pecan Board has hired three separate entities to manage their promotion efforts over the years, including Oldfield Davis Inc. in the early years and subsequently two other private marketing agents.

Unfortunately, little information is now available regarding the specific promotion expenditures made by Oldfield Davis, Inc. from 1999 through 2002. The invoices and records available provide little or no description of what the funds provided to Oldfield Davis were used for. Consequently, administrative costs incurred by Oldfield Davis, inc. could not be separated out from the expenses related specifically to promotional activities. Also, the Oldfield Davis expenditure data could not be broken down into subcategories of expenditure. Based on what records are available and the recollection of the TPB bookkeeper, all funds provided to Oldfield Davis were categorized as "media." Because administrative costs could not be separated out from Oldfield Davis invoices, advertising fees to the other advertising agents used after 2002 were also included in the media category to maintain uniformity in the data.

Expenses under the *ambassador program* category include covered travel, conference fees, and a small stipend for a representative who promotes pecans and the TPB. The *festivals and conferences* category includes expenses associated with the annual State Fair and Pecan Festival such as prize money for pecan cook-offs, posters and radio advertisements for the fair, fair fees, and other miscellaneous fair and festival expenses. The *clipping service* expenses occurred between 2002 and 2003 and paid for the collection of articles and stories from media outlets (including television, newspapers, and the internet) regarding pecan promotion in the state of Texas. The *research* category includes expenses for health benefit studies, promotion evaluation research, and a benchmark study. The *website* category includes expenses for hosting, maintaining, and registering the TPB website which hosts a variety of promotion literature including recipes and health benefits of pecans. The *media* category is the largest expense category and includes expenses for radio advertisements, a promotional video, magazine articles

**Figure 12: Texas Pecan Board Crop Year Assessment Revenue and Expenditures, 1998/99 – 2006/07**

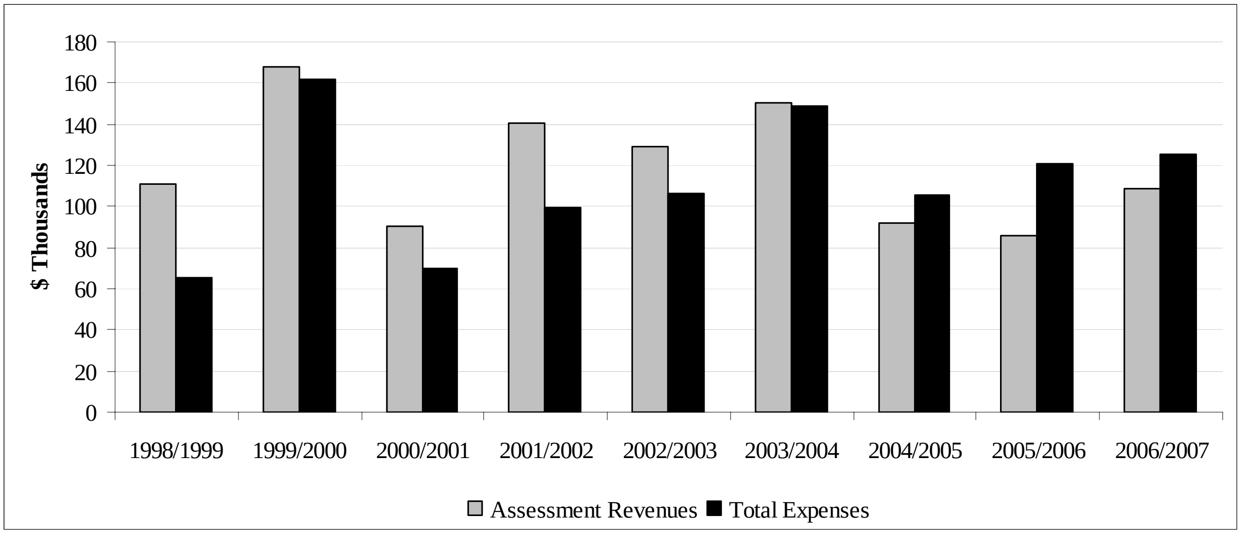
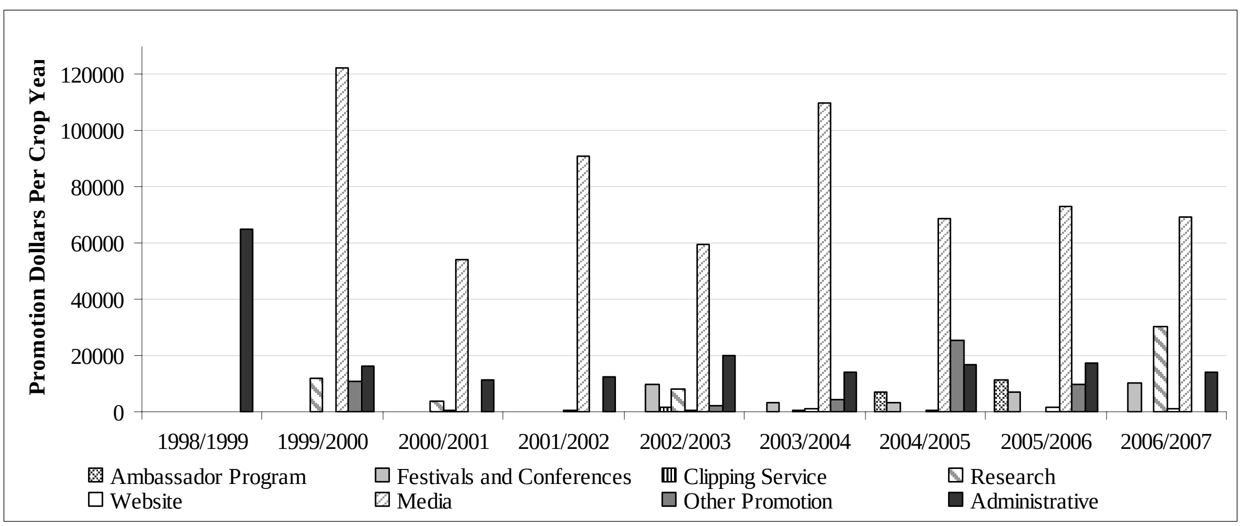



**Figure 13: Texas Pecan Board Expenditures by Category, 1998/99 – 2006/07**



and advertisements, recipe booklets, posters, other publications, and fees paid to advertising agents. The *other promotion* category includes expenses not included in one of the previous six categories and either ambiguous promotion expenses such as payments with no detailed description, one time projects, or miscellaneous promotion expenses such as grower packets, contributions to other pecan research, t-shirts and hats, presentations, and booth fees for special events. The largest expense categories over the life of the Texas Pecan Board are media, administrative, research, and other promotion (Figure 14). Promotion categorized as *media* represents more than 60% of total promotion expenditures. Expenditures on the smaller promotion categories are detailed in Figure 15.

## Methodology

Measuring the effects of promotion on the sales of Texas pecans is simple in concept. Promotion is intended to increase the demand for Texas pecans as illustrated in Figure 16. If successful, the consequence is a shift in the demand for Texas pecans to the right and an increase in quantity of pecan sales ($Q_0$ to $Q_N$ in Figure 16). All that the analyst needs to do, then, is measure the increase in sales as a result of the promotion. However, actually measuring the magnitude of any shift in the demand for Texas pecans that can reliably be attributed specifically to the promotional efforts funded by the Texas Pecan Checkoff Program is a good deal more complicated.

Early efforts to measure the demand effects of promotion programs relied largely on anecdotal evidence and simple comparisons of gross investments in promotion and gross changes in sales. During periods of rapidly expanding markets and rising prices, this approach tends to yield some persuasive stories and even more impressive upward-sloping graphical relationships between promotion expenditures and sales. The problem with this approach, however, is that various factors other than the promotion program affect the volume and value of commodity sales, such as relative price changes, agricultural policies, changes in incomes, population growth, competition from other products, and consumer health concerns and demographics, just to name a few. The problem becomes all too apparent in years when markets turn down and prices drop. Program managers find that taking credit for rising demand and prices in good years forces them to take the blame for declining demand and prices in bad years.

Over the years, increasingly sophisticated statistical methods have been developed to isolate and measure the unique contribution of promotion programs to the performance of the sales of the commodity being promoted. Most common has been the use of econometric regression techniques and models to statistically disentangle the effects of promotion program activities on commodity sales and demand from those of other market forces. The process usually requires a large amount of historical data on not only the sales of the product and advertising expenditures over time but also the many other relevant market forces that might have affected sales over the same period. The application of the statistical technique to the data allows for the measurement of the unique contribution of each market force considered, including promotion, to the change in sales observed over the years.

**Figure 14: Major Promotion Expenditure Category Shares of Total Expenditures, 1998/1999-2006/2007**

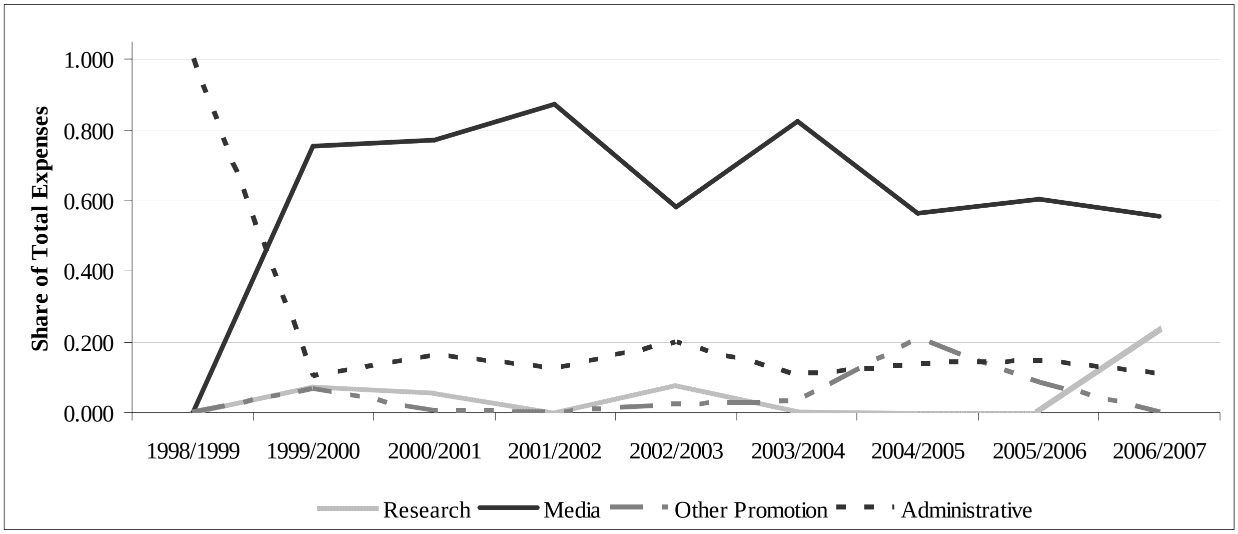



**Figure 15: Texas Pecan Board Promotion Expenditures Excluding Media, 1998/1999-2006/2007**

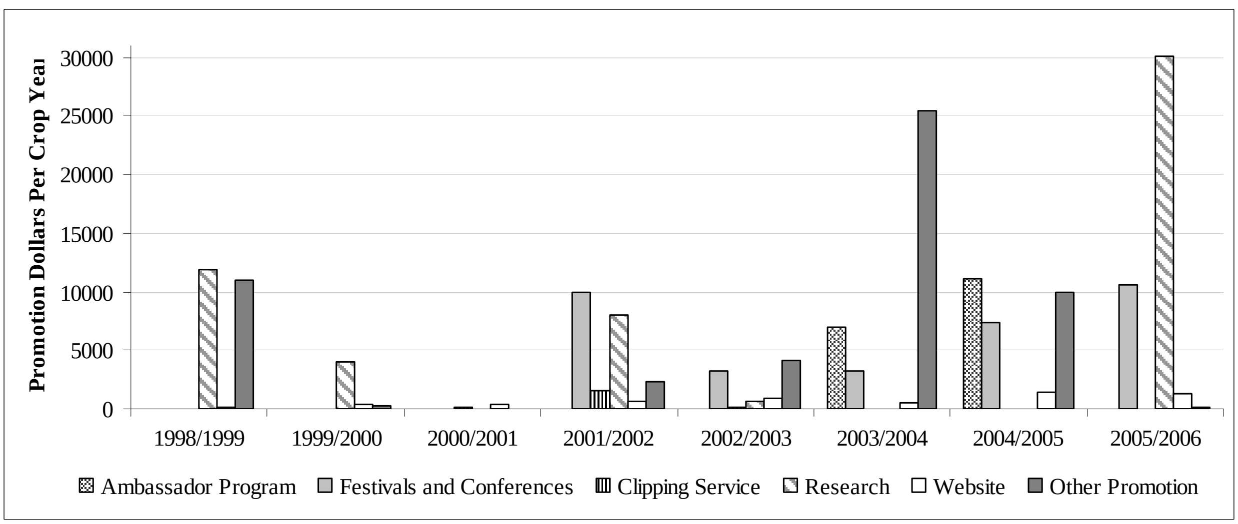
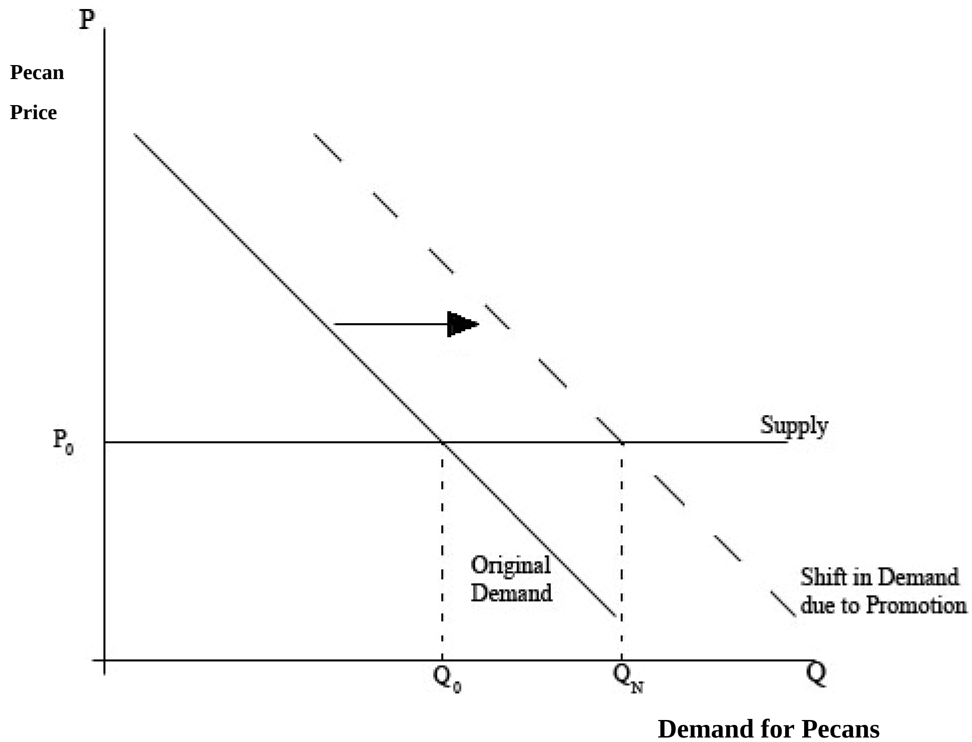


**Figure 16: Illustration of the Shift in Demand for Texas Pecans Due to Promotion**




Even if the statistical analysis indicates that a promotion program has had a positive and statistically significant effect on market sales, however, the question remains as to whether the increase has been large enough to cover the cost of the program. For that reason, the next step in the measurement process is to use the statistical results to calculate some aggregate measure of the effectiveness of the promotion expenditures. The most commonly reported measure is the benefit-cost ratio (BCR).

Because this is the first such analysis of the effectiveness of the Texas Pecan Checkoff Program, there is no previous research that evaluates the program on which to build or with which to compare. However, the evaluation of national pecan promotion efforts and those of other state-level checkoff programs such the grapefruit and orange promotion program operated by the Texas citrus industry (Williams, Capps, and Palma, 2007) and California commodity promotion programs (Alston et al. 2006) provide guidance on appropriate methodologies and procedures to successfully analyze the Texas Pecan Checkoff Program.

*Conceptual Models of Texas Pecan Sales and Promotion*

The purpose of this analysis is to evaluate the effectiveness of the Texas Pecan Checkoff Program in enhancing sales of Texas pecans. Based on previous related research and the qualitative analysis of the U.S. and Texas pecan industries in the previous chapter, three econometric models (Table 1) were tested to explain the effect of Texas Pecan Board promotion expenditures on: (1) Texas sales of improved and native varieties combined (Model 1); (2) Texas sales of improved varieties of pecans (Model 2); and (3) Texas sales of native and seedling varieties of pecans (Model 3).

**Model 1: Sales of All Texas Pecans**

Model 1 in Table 1 is the combined or aggregate model for all sales of Texas pecans. The equation hypothesizes that annual sales of all Texas pecans ($Y^P$) are determined by TPB inflation-adjusted promotion expenditures (PROMR), the inflation-adjusted or real price of all pecans ($PR^P$), the inflation-adjusted or real price of almonds ($PR^A$), the inflation-adjusted or real price of walnuts ($PR^W$), the availability of pecans for sale (AV), inflation-adjusted consumer disposable income (DIR), and an indicator variable representing a structural change in consumer preference from native to improved pecans (STRUCT) (see Table1).

The real price of pecans ($PR^P$) is included as a potential demand determinant consistent with well-accepted demand theory. As discussed earlier, almonds and walnuts are the closest substitutes for pecans and provide an alternative for consumer purchases. If the price of almonds or walnuts increases, theory suggests that the demand for pecans will increase, whereas the consumption of pecans will decrease if the price of almonds or walnuts decreases. Furthermore, because consumer purchasing decisions are subject to a budget constraint, consumers' ability to purchase pecans is limited by their disposable income. Consequently, real U.S. per capita disposable income (DIR) was included to account for this constraint.

As also discussed earlier, the availability of pecans for sale (AV) provides an additional constraint on consumer purchases. The availability of pecans is affected by the alternate-bearing nature of the pecan tree which limits the quantity of pecans produced and ready for sale in various years despite what the demand may be. Annual average Texas pecan yield is used as a proxy for "availability" because it provides a measure of the annual variation of production per bearing acre. Availability likely has a greater effect on native pecan sales than improved pecan sales because improved varieties have been genetically altered through selection and crossing so as to minimize the effects of the alternate-bearing nature of the pecan.

Inflation-adjusted TPB promotion expenditures (PROMR) are included as a potential driver in Model 1 to measure the effects of promotion on Texas pecan sales. Because the effect of expenditures on promotion in a given period may affect consumer decisions over a longer period of time (referred to as the "carryover effect" of advertising), the promotion data is introduced into the model using a lag structure. Two common lag structures are the polynomial distributed lag (PDL) and the geometric lag. The PDL allows the lag weights to be specified by a continuous function which, in turn, can be approximated by evaluating a polynomial function. Furthermore, the PDL is flexible in the shape of the lag formation allowing for humped-shaped or monotonically decreasing lag weight distributions. To determine the length and polynomial degree of the distribution, a number of regression estimations are run with varying degrees and lags (Almon 1965). The appropriate lag length, degree of polynomial, and endpoint restrictions

**Table 1: Conceptual Pecan Models and Variable Definitions**

**Model 1: All Pecan Sales**

$Y^p = f(PR^p, PR^A, PR^W, PROMR, AV, DIR, STRUC)$

**Model 2: Improved Variety Pecan Sales**

$Y^i = f(PR^i, PR^A, PR^W, PROMR, AV, DIR, STRUC, Y^i_{t-1}, AD)$

**Model 3: Native Variety Pecan Sales**

$Y^n = f(PR^n, PR^A, PR^W, PROMR, AV, DIR, Y^i_{t-1})$

Variable Definitions

| | |
|---|---|
| *AD* | Binary variable representing a drastic change in availability from 2001-2002 |
| *AV* | Availability of pecans using the proxy yield, pounds per acre |
| *DIR* | Real U.S. Disposable personal income, billion dollars |
| $PR^A$ | Real almond price received by growers, cents/lb |
| $PR^i$ | Real Texas improved pecan price received by growers, cents/lb |
| $PR^n$ | Real Texas native/seedling pecan price received by growers, cents/lb |
| $PR^p$ | Real Texas pecan price received by growers, cents/lb |
| $PR^w$ | Real walnut price received by growers, cents/lb |
| *PROMR* | Real Texas Pecan Board promotion and advertising expenditures, dollars |
| *STRUC* | Binary variable representing the structural change from 1977-2006 |
| $Y^i$ | Texas sales of improved pecan varieties, thousand lbs |
| $Y^n$ | Texas sales of native pecan varieties, thousand lbs |
| $Y^p$ | Texas sales for both improved and native pecan varieties, thousand lbs |

required can be determined using the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC).

The geometric lag is more straight-forward in concept and application in that only weights have to be specified instead of estimating a polynomial which provides some advantages over the PDL by allowing easier specification of the desired lag weights. The use of a geometric lag structure assumes that the lag effects decline geometrically over a long period of time (Pindyck and Rubinfeld 1991). Given that the Texas pecan sales data are on a crop year basis, however, a lag of more than two or three periods in the effects of promotion is unlikely. More complex lag structures such as rational distributed lags could be used but provide few advantages over the simpler geometric and PDL models. Both the geometric and the PDL lag structures for promotion expenditures will be tested using the AIC and SIC statistics to determine which process better explains the carryover effects Texas pecan promotion on Texas pecan sales.

Not all variables or events that affect demand can be easily quantified. One such event that has affected the behavior Texas pecan sales over the years has been the on-going transition in consumer preferences from native to improved pecans. As discussed earlier, the composition of Texas pecan sales has been switching from native pecans to improved pecans over the past few decades. The growing relative consumer demand for improved pecans has generated a price premium for improved varieties and provided an incentive for Texas pecan producers to switch production to the improved varieties. The change in pecan varieties available for sale takes time, however, because approximately ten years are required for a newly planted pecan tree to reach its maximum production potential. A distinct transition from native to improved pecans can be seen in the sales data from about 1976 to the present (see Figure 11). Since 1976, Texas sales of improved pecan varieties have been on an upward trend while that of native pecans has been on a downward trend. Consequently, the analysis will test the statistical significance of this structural change on the sales of Texas pecans using an indicator variable (*STRUC*) for 1977 to the present in Model 1. The hypothesis is that the switch in consumer preference from native to improved varieties has boosted overall sales of Texas pecans.

### Models 2 and 3: Sales of Improved Variety and Native Pecans

Models 2 and 3 in Table 1 represent Texas sales of improved pecan varieties ($Y^i$) and native varieties ($Y^n$), respectively. The TPB pecan promotion program has targeted household consumption of pecans through festivals and conferences, media advertisements, recipes at grocery stores, etc. Typically, pecans purchased by households are improved varieties whereas native varieties are typically used in production of candies, baking goods, and other food products (Worley 1994). Therefore, because the TPB may have inadvertently targeted consumption of improved pecans by targeting household consumption of pecans, promotion may have a greater impact on sales of improved varieties than on native pecans.

The specification of Models 2 and 3 in Table 1 include the same variables as Model 1 with some additions. Lagged dependent variables are included in the models to capture potential habit persistence or dynamic response of consumers to changes in market signals. Habit persistence suggests that as price changes, consumers spread their response over some period of time instead of changing their demand immediately because of their habit or tendency to continue purchasing a particular commodity (such as native pecans) even when other forces, such as the availability of a new or improved product (improved variety pecans), provide an incentive to change buying behavior. Habit persistence is not relevant for the aggregate pecans sales demand (Model 1 in Table 1) because native and improved pecan sales are added together. As consumers switch their consumption of pecans from native to improved varieties, the dynamic effects of decreasing sales of native pecans combined with increasing sales of improved pecans creates an offsetting effect in the aggregate model.

A Nerlovian partial adjustment mechanism is adopted for Models 2 and 3 in which changes in pecan sales vary from one period to the next in proportion to the change in last period's pecan sales from the long run equilibrium sales level defined as follows:

(2) $$Y_t - Y_{t-1} = \delta\left(Y_t^L - Y_{t-1}\right)$$

where $Y_t - Y_{t-1}$ is the change in sales (of improved or native pecans) from one period to the next, $Y_t^L$ is the theoretical long-run equilibrium sales level, and $\delta$ is the rate at which sales adjusts each period toward the long-run equilibrium. Consider the following model of long-run equilibrium pecan sales where, for a given year (t), $PROMR_t$ is real TPB promotion expenditures, $PR_t$ is the real price of pecans received by growers, and $Z_t$ represents other relevant variables:

(3) $$Y_t^L = \alpha_0 + \alpha_1 PROMR_t - \alpha_2 PR_t + \alpha_3 Z_t$$

Substituting equation (3) into equation (2) gives the following dynamic relationship for pecan sales:

(4) $$Y_t - Y_{t-1} = \Delta\alpha_0 + \delta\alpha_1 PROMR_t - \delta\alpha_2 PR_t + \delta\alpha_3 Z_t - \Delta Y_{t-1}$$

which can be rearranged to form:

(5) $$Y_t = \Delta\alpha_0 + \delta\alpha_1 PROMR_t - \delta\alpha_2 PR_t + \delta\alpha_3 Z_t + (1-\delta)Y_{t-1}.$$

Simplifying equation (5) for the coefficients to be estimated ($\lambda_i$) gives:

(6) $$Y_t = \lambda_0 + \lambda_1 PROMR_t - \lambda_2 PR_t + \lambda_3 Z_t + \lambda_4 Y_{t-1} + \varepsilon_t$$

where $\varepsilon_t$ is the random, normally distributed residual. Equation (6) forms the basis for the specification of Models 2 and 3 in Table 1.

As previously discussed, Texas sales of native pecans have been trending downward over the years while Texas sales of improved pecans have been trending upward (see Figure 11). The inversely related slopes of the native and improved variety sales reflect the growing tendency of Texas pecan producers over time to switch from native pecans to the higher quality improved varieties of pecans which also tend to exhibit less yield volatility. Because the trends in the

Texas sales of improved and native pecans are in opposite directions, little trend in aggregate pecan sales is apparent (Figure 17).

The prices of both native and improved variety pecans are not included in Models 2 and 3 because they are likely to be highly collinear. Indeed, the correlation coefficient for the two prices is quite high at 0.93 (Table 2). The possibility of multicollinearity between the two prices will be tested using the variance inflation factor (VIF) statistic which measures the degree to which one independent variable is a linear combination of the other independent variables and is calculated as:

$$(7) \qquad VIF_j = \frac{1}{1 - R_j^2}$$

where $R_j^2$ is the coefficient of determination for the $j^{th}$ variable as a function of the other regressors.

Model 2 in Table 1 for improved pecans also includes an additional indicator variable (AD) to capture a change in production in 2001/02 that was the largest nominal variation in sales from an "on" year to an "off" year for improved varieties over the sample period. One of the reasons that Texas pecan growers have been switching from native to improved pecans is that improved pecans are less susceptible to the "on" and "off" yield variation phenomenon that is biologically more pronounced in native pecans. As Figure 18 demonstrates, the 30 million lb decline in improved pecan output from 2001 to 2002 was the largest variation in improved production over the period of the data - a much larger than normal availability constraint. This drastic change took place due to a phenomenal "on" year in 2001/02 which tied for the highest improved production in Texas followed by a detrimental "off year" in 2002/03 which tied for the lowest improved production since 1982/83.

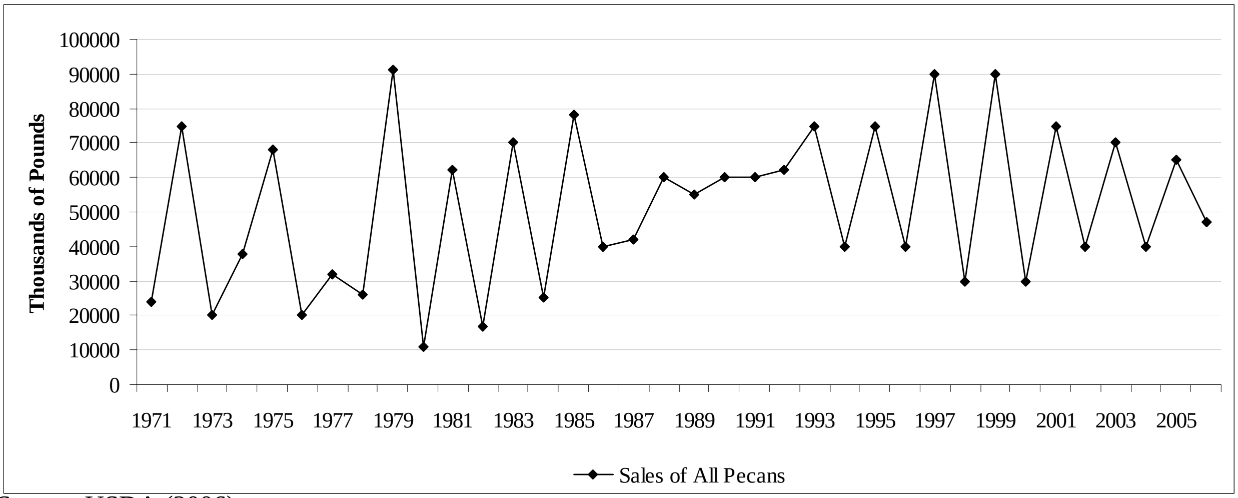
### *Benefit-Cost Analysis*

To measure the cost effectiveness of the TPB pecan promotion program in increasing the sales of Texas pecans, the results of the statistical analysis will be used to calculate the benefit-cost ratio (BCR) associated with the program. In fact, various BCRs will be calculated including a revenue BCR (RBCR), a net revenue BCR (NBCR), a discounted BCR (DBCR), and a sales BCR (SBCR). The RBCR is simply the ratio of the total gross additional revenues generated by the promotion program (*R*) to the total promotion expenditures (*PROM)*. The resulting RBCR is the additional revenues generated by promotion per dollar spent on promotion:

$$(8) \qquad RBCR = \frac{\sum_{t=1}^{T} R_t}{\sum_{t=1}^{T} PROM_t}.$$

where t = year and T = the total number of years being analyzed.

**Figure 17: Sales of Improved and Native Pecan Varieties Combined, Crop Years1971/72-2005/06**




Source: USDA (2006).

The calculation of the NBCR (net revenue BCR) nets out the cost of promotion from the additional revenue generated by the promotion before dividing by the promotion dollars spent. That is, the NBCR is calculated as the total additional net revenues generated by promotion divided by total promotion expenditures where net revenues is the difference between gross revenues generated from additional sales in each year and promotion expenditures:

(9) $$NBCR = \frac{\sum_{t=1}^{T}(R_t - PROM_t)}{\sum_{t=1}^{T} PROM_t}$$

The calculation of the DBCR discounts the additional net revenue generated over time to account for the time value of money before dividing by the promotion dollars spent. The discounted net revenue (*D*) is calculated as:

(10) $$D = \sum_{t=1}^{T}[R_t - PROM_t]/(1+i)^T$$

where *i* is the interest rate. Instead of using an arbitrary rate of discount as done in some studies, Williams (1999) suggests using the 30-day U.S. Treasury bill (T-bill) rate because it represents a conservative, alternative investment for commodity checkoff groups like the Texas Pecan Board. In this case, over the period of analysis D is calculated for each year using the T-bill interest as:

(11) $$D = \frac{R_1 - PROM_1}{(1+i_1)} + \frac{R_2 - PROM_2}{(1+i_1)(1+i_2)} + \cdots + \frac{R_T - PROM_T}{(1+i_1)(1+i_2)(1+i_3)\cdots(1+i_T)}$$

where $i_t$ is the 30-day Treasury bill interest rate in year t = 1,…,T.

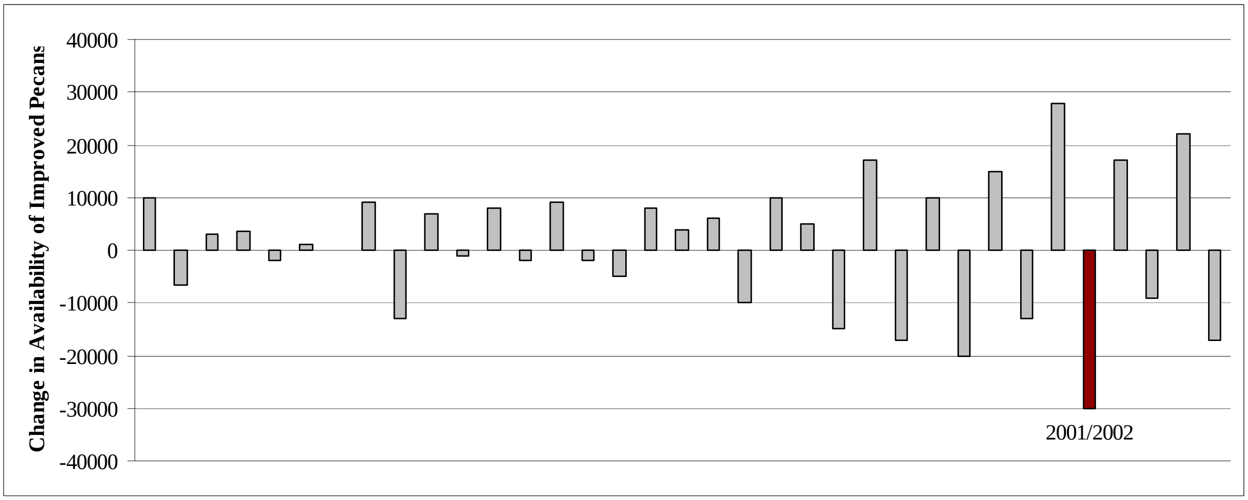
## Table 2: Correlation Matrix of Population, Acreage, Availability, and Inflation-Adjusted Prices and Income[a]

| | $Y^P$ | $Y^i$ | $Y^n$ | $PR^P$ | $PR^i$ | $PR^n$ |
|---|---|---|---|---|---|---|
| $Y^P$ | 1 | 0.63 | 0.83 | -0.59 | -0.54 | -0.41 |
| Yi | | 1 | 0.08 | -0.49 | -0.65 | -0.53 |
| $Y^n$ | | | 1 | -0.39 | -0.22 | -0.14 |
| $PR^P$ | | | | 1 | 0.94 | 0.93 |
| $PR^i$ | | | | | 1 | 0.93 |
| $PR^n$ | | | | | | 1 |
| $PR^A$ | | | | | | |

| | $PR^A$ | $PR^W$ | ACREAGE | AV | DIR | TXPOP |
|---|---|---|---|---|---|---|
| $Y^P$ | -0.10 | -0.30 | 0.27 | 0.85 | 0.27 | 0.27 |
| $Y^i$ | -0.07 | -0.46 | 0.75 | 0.23 | 0.72 | 0.73 |
| $Y^n$ | -0.07 | -0.05 | -0.19 | 0.93 | -0.18 | -0.19 |
| $PR^P$ | 0.15 | 0.48 | -0.45 | -0.34 | -0.44 | -0.46 |
| $PR^i$ | 0.18 | 0.55 | -0.64 | -0.22 | -0.62 | -0.64 |
| $PR^n$ | 0.11 | 0.52 | -0.59 | -0.09 | -0.53 | -0.57 |
| $PR^A$ | 1 | 0.62 | -0.07 | -0.10 | -0.21 | -0.19 |
| $PR^W$ | | 1 | -0.49 | -0.06 | -0.58 | -0.60 |
| ACREAGE | | | 1 | -0.22 | 0.90 | 0.94 |
| AV | | | | 1 | -0.15 | -0.17 |
| DIR | | | | | 1 | 0.99 |
| TXPOP | | | | | | 1 |

[a] See Table 1 for variable names and descriptions except ACREAGE = Texas bearing acreage of pecans and TXPOP = Texas population.

**Figure 18: Annual Variation in Texas Improved Variety Pecan Production, 1971/1972 - 2005/2006**




Source: Calculated from data in USDA (2006).

Using the discounted net revenue as calculated in (11), the DBCR is calculated as:

(12) $$DBCR = \frac{D}{\sum_{t=1}^{T} PROM_t}$$

Finally, the SBCR provides a measure of the additional quantity sold (in pounds) as a result of the promotion programs per dollar spent on promotion:

(13) $$SBCR = \frac{\sum_{t=1}^{T} S_t}{\sum_{t=1}^{T} PROM_t}$$

where $S_t$ is the additional sales of pecans in year t as a result of promotion and is calculated as:

(14) $$S_t = e_t^{PROM} \times Y_t$$

where $e_t^{PROM}$ is the pecan sales elasticity of promotion in year t (defined as the estimated percent change in sales in year t due to a percent change in promotion in year t) and $Y_t$ is the actual level of sales in year t. The promotion elasticity in a given year ($e_t^{PROM}$) can be calculated from the estimated coefficient of the promotion variable in the model:

(15) $$e_t^{PROM} = \lambda_1 \frac{PROMR_t}{Y_t}$$

where $\lambda_1$ is the estimated coefficient of the real promotion expenditure variable ($PROMR_t$) in equation (6).

To calculate the RBCR, the NBCR, and the DBCR, the additional revenues generated by promotion in each year ($R_t$) must first be calculated. Using equation (14), $R_t$ is calculated simply as:

(16) $$R_t = S_t \times P_t$$

where $P_t$ is the actual price of pecans in year t.

*Data Used in the Analysis*

Texas pecan sales data were collected from the USDA Fruit and Tree Nut Reports over the 1971/72-2006/07 period (USDA 2006). Those reports provide crop year utilized production by state. Pecan sales data are also provided by the reports but only on a national level and not at the state level. USDA defines national sales as being equivalent to national utilized production. Consequently, the terms "sales" and "utilized production" are used interchangeably in this study. Texas utilized production is reported in thousands of pounds per crop year for all pecans and disaggregated into utilized production of improved varieties and of native and seedling varieties.

Prices for pecans, almonds, and walnuts were also collected from the USDA Fruit and Tree Nut Reports. They represent average crop year grower prices and were measured in cents per pound. For the analysis, the prices were deflated by the consumer price index to account for inflation, creating "real" or "deflated" prices. The thirty-day Treasury Bill (T-Bill) rates were collected from the International Financial Statistics published by the International Monetary Fund (IMF).

Promotion expenditures were collected from the Texas Pecan Growers Association (TPGA) which has maintained the accounting records for the Texas Pecan Board over the years. Although the TPB was created in 1998, promotion expenditures did not commence until crop year 1999/00. The data as provided by the TPGA were compiled on a crop year basis because prices and sales are reported on a crop year basis[3]. Zero values for pecan promotion were assigned for crop years 1971/72 through 1998/99 prior to the establishment of the TPB since there was no promotion of Texas pecans prior to 1999/00.

Unpublished total bearing pecan acreage[4] data for Texas was provided by the USDA-NASS office in Austin, Texas. The acreage data was used to compute pecan yield for total, improved, and native pecans as a proxy for availability. Disposable income, the consumer price index, and

---

[3] The Texas pecan harvesting and marketing seasons typically take place between September 15 and January 31. The crop year is defined as September 15 and the succeeding 12 months.
[4] Total acreage for pecans was calculated by the Census of Agriculture including bearing and nonbearing acreage.

population statistics were collected from the Bureau of Economic Analysis (BEA) for 1971/72 through 2006/07.

## Statistical Analysis

Following the procedures outlined in the preceding section, the parameters of the three models specified in Table 1 were estimated to measure of the effects of the TPB promotion expenditures on sales of all Texas pecans (improved and native varieties combined) and on the sales of native and improved varieties separately.

### *Model 1 – Sales of All Texas Pecan***s**

Based on the conceptual specification in Table 1, Model 1 representing the sales of all Texas pecans is specified as follows for estimation purposes:

(17) $$Y = f\,(PR^P,\ PR^A,\ PR^W,\ \sqrt{PROMR_{t-j}},\ DIR,\ AV,\ STRUC)$$

where all variables are subscripted with t for a given time period unless otherwise noted, $Y$ is sales of all pecans, $PR^P$ is the real price of all pecans (weighted average of improved and native), $PR^A$ is the real price of almonds, $PR^W$ is the real price of walnuts, $PROMR_{t-j}$ is real promotion expenditures with *j* lags, $AV$ represents availability of pecans using yield as a proxy, *DIR* is real U.S. disposable income, and *STRUC* is a binary variable representing a structural change in the industry.

The parameters of equation (17) were estimated using the OLS estimator assuming a linear in logs (constant elasticity) structural form. Because the promotion data included zeroes as data points in the years prior to the establishment of the Texas Pecan Checkoff Program (1971/72 - 1998/99), the natural logarithm of *PROMR* could not be calculated over the full time period of analysis (1971/72 – 2006/07). Consequently, to maintain a diminishing marginal returns relationship between *PROMR* and pecan sales (*Y*) in equation (17), a square root transformation of the promotion data was used to represent promotion expenditures following Williams, Capps, and Palma (2007).

To account for potential carryover effects of the Texas Pecan Board promotion program, we tested both a geometric lag and a polynomial distributed lag (PDL) formulation of promotion expenditures in equation (17). The search for lag length and, in the case of the PDL, the polynomial degree associated with the carryover effects involves a series of regression estimations with various lags. There were limitations on the number of lags and the degree of lag that could be used because the data were on a crop year (12-month) basis and the TPB has only been promoting pecans since 1999/00. Based on the AIC and SIC statistics, a single, non-weighted lag of promotion was employed.

The results from estimating the parameters of Model 1 for all Texas pecan sales as represented by equation (17) are presented in Table 3 where the variables are defined as given in Table 1. Application of the OLS estimator to equation (17) determined that the effects of the real price of almonds ($PR^A$), the real price of walnuts ($PR^W$), and real U.S. disposable income (*DIR*) on Texas pecan sales over the period of analysis were not statistically significant at the 95% confidence level. Also, the error term exhibited serial correlation as indicated by a Durbin-Watson statistic of 1.033 implying that the residuals were not randomly distributed (Table 3). The error term correlation may have been due to some non-random information that influences pecan sales not accounted for by the specification of Model 1. To improve the accuracy of the predicted values and correct for the serial correlation, an autoregressive error correction model (ECM) was adopted using the Yule-Walker method. The ECM model uses lags of the error term to correct for autocorrelation and create a random, normally distributed error term. The analysis utilized the backwards elimination (BACKSTEP) option in SAS to remove insignificant autoregressive parameters starting in order of least significance. The procedure determined that one lag of the error term is most appropriate for removing serial correlation.

The estimated parameters of the model after correcting for autocorrelation are provided in Table 4. The autocorrelation correction process increased the Durbin-Watson statistic (DW) of the estimated model to 1.5797 (Table 4). Using a five percent significance for the Durbin-Watson test with $n$=36 observations and $k$=4, the upper and lower bounds are $D_U = 1.73$ and $D_U = 1.24$, respectively, suggesting that the results are indeterminate regarding remaining autocorrelation of the error term. However, according to the p- value for testing autocorrelation, the DW is significant at the ten percent level at which the null hypothesis that positive autocorrelation exists is rejected. The coefficient of determination ($R^2$) of the error corrected model is 0.9856, indicating that the model accounts for a nearly 99% of the variation of the sales of Texas pecans over the period of analysis (19).

The results of the error corrected Model 1 in Table 4 indicate clearly that promotion expenditures by the TPB have had a statistically significant albeit lagged effect on the sales of Texas pecans measured in the aggregate. The p-value for the promotion variable is 0.0051 implying that promotion is highly significant at the 99% level. The short-run promotion elasticity of Texas pecan sales over the period of analysis (that is, the responsiveness of sales to a change in promotion expenditures) can be calculated from the estimated parameter for the square-root of promotion variable ($\lambda^{PROM}$) in Model 1 (Table 4) as follows:

$$e^{PROM} = \frac{\lambda^{PROM}}{2}\sqrt{\frac{\sum_{t=1}^{T-1} PROMR_t}{T}} \tag{18}$$

where $e^{PROM}$ is the promotion elasticity of pecan sales, T is number of years, and $\sqrt{\frac{\sum_{t=1}^{T-1} PROMR_t}{T}}$ is the mean real promotion expenditure from 1971/72 through 2006/07. Note that real promotion expenditures ($PROMR_t$) are summed only through the next to last year of the period of analysis since the effects of promotion on sales were found to be lagged one period. Using equation (18),

**Table 3: Model 1 ( Sales of All Texas Pecans) - OLS Results without Correction for Autocorrelation[a]**

Dependent Variable – ln(Y) (natural log of all Texas pecan sales)

| | | | |
|---|---|---|---|
| SSE | 0.20407287 | DFE | 30 |
| MSE | 0.00680 | Root MSE | 0.08248 |
| SBC | -62.95948 | AIC | -70.736221 |
| Regress R-Square | 0.9783 | Total R-Square | 0.9783 |
| Durbin-Watson | 1.0330 | Pr < DW[b] | 0.0002 |
| | | Pr > DW[b] | 0.9998 |

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 5.1975 | 0.2344 | 22.18 | <.0001 |
| ln ($PR^P$) | 1 | -0.002453 | 0.000797 | -3.08 | 0.0044 |
| SQRT($PROMR_{t-1}$) | 1 | 0.000688 | 0.000156 | 4.42 | 0.0001 |
| ln (AV) | 1 | 1.0025 | 0.0347 | 28.88 | <.0001 |
| STRUC | 1 | 0.4800 | 0.0497 | -9.66 | <.0001 |

Estimates of Autocorrelations

| Lag | Covariance | Correlation | -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1 |
|---|---|---|---|
| 0 | 0.00583 | 1.000000 | \| \|********************\| |
| 1 | 0.00272 | 0.466418 | \| \|********* \| |
| 2 | 0.00264 | 0.453572 | \| \|********* \| |
| 3 | 0.00155 | 0.265088 | \| \|***** \| |
| 4 | 0.00109 | 0.186195 | \| \|**** \| |
| 5 | 0.000797 | 0.136651 | \| \|*** \| |

Backward Elimination of Autoregressive Terms

| Lag | Estimate | t Value | Pr > \|t\| |
|---|---|---|---|
| 5 | -0.022541 | -0.11 | 0.9111 |
| 3 | 0.019061 | 0.09 | 0.9272 |
| 4 | 0.046761 | 0.26 | 0.7995 |
| 2 | -0.301648 | -1.67 | 0.1052 |

Preliminary MSE 0.00456

[a] See Table 1 for variable names and descriptions.
[b] NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

**Table 4: Model 1 - OLS Results Using an Autoregressive Error Correction Model[a]**

Dependent Variable – ln(Y) (natural log of all Texas pecan sales)

| LAG | Coefficient | Std. Error | t Value |
|---|---|---|---|
| 1 | -0.466418 | 0.164259 | -2.84 |

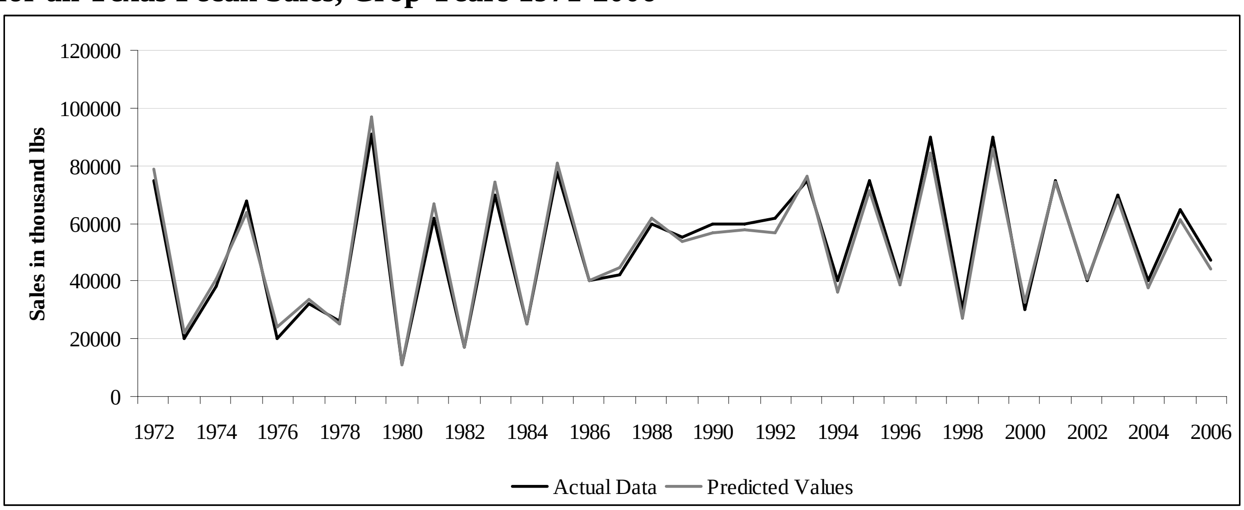
Yule-Walker Estimates

| | | | |
|---|---|---|---|
| SSE | 0.16570295 | DFE | 29 |
| MSE | 0.00468 | Root MSE | 0.06841 |
| SBC | -73.439121 | AIC | -82.77121 |
| Regress R-Square | 0.9913 | Total R-Square | 0.9856 |
| Durbin-Watson | 1.5797 | Pr < DW[b] | 0.0860 |
| | | Pr > DW[b] | 0.9140 |

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 5.2593 | 0.1819 | 28.91 | <.0001 |
| ln ($PR^P$) | 1 | -0.001901 | 0.000718 | -2.65 | 0.0129 |
| SQRT($PROMR_{t-1}$) | 1 | 0.000564 | 0.000186 | 3.03 | 0.0051 |
| ln (AV) | 1 | 0.9847 | 0.0247 | 39.93 | <.0001 |
| STRUC | 1 | 0.4095 | 0.0556 | 7.36 | <.0001 |

[a] See Table 1 for variable names and descriptions.
[b] NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

**Figure 19: Actual Data Compared to Predicted Values Using the Error Corrected Model 1 for all Texas Pecan Sales, Crop Years 1971-2006**



the promotion elasticity ($e^{PROM}$) was calculated to be 0.03114 meaning that doubling promotion expenditures (a 100% increase) would lead to about a 3.1% increase in pecan sales which is consistent with the calculated promotion elasticities reported for other commodity promotion programs (Williams, Capps, and Palma 2007).

The results of estimating the other parameters of Model 1 in Table 4 are consistent with theoretical expectations. The variable STRUC, an indicator variable accounting for structural change during the period of time prior to the industry transition from native to improved pecans (1971/72 – 1975/76), has a coefficient of 0.4095 meaning that from 1976/77 - 2006/07, the model underestimated pecan sales due to the structural changes in the industry. Although the price of pecans is found to be a statistically significant determinant of Texas pecan sales, the estimated price coefficient of -0.0019 indicates a highly inelastic response of pecan sales to changes in price. Combined with an estimated Availability (AV) elasticity of 0.9847, the low estimated price elasticity implies that Texas pecan sales are much more responsive to changes in the availability of pecans form year to year than to changes in price.

However, the highly price inelastic demand for pecans may also suggest that combining native and improved varieties into a single, aggregate sales equation creates statistical problems. Even though improved and native varieties are substitutes, using a weighted average of the prices of the two varieties in the aggregate sales equation (Model 1) forces native and improved varieties to be complements. Thus, for example, increases in the price of improved pecans should decrease sales of improved pecans but increase the sales of native pecans. However, as a component of an aggregate weighted pecan price, an increase in the price of improved pecans increases the weighted average price and reduces sales for all pecans, both native and improved. This offsetting effect may result in the highly price-inelastic estimated effect of the weighted average price on aggregate sales of pecans. To resolve this problem, equation (17) is disaggregated into separate sales equations (Models 2 and 3) for improved and native pecans. The parameters of the two equations are then jointly estimated using the seemingly unrelated (SUR) estimator.

### *Models 2 and 3 – Sales of Improved and Native Pecans*

TPB promotion expenditures promote pecan sales primarily through festivals and conferences, advertisements on the radio, recipes at grocery stores, etc. and, thus, focus primarily on household consumption. Pecans purchased by households are typically improved varieties. Native pecans, on the other hand, are purchased primarily for use in the production of candies, baking goods, and other food products (Worley 1994). Therefore, as noted earlier, the Texas Pecan Checkoff Program may have had a different impact on sales of improved pecan varieties than on those of native pecans.

Separating the two categories of pecans into two different sales models allows the estimation of the individual effects of promotion on each of the two general types of pecans. Based on conceptual Models 2 and 3 in Table 1 representing the sales of improved pecan varieties and native pecans, respectively, the estimating models are defined as follows:

(19) $$Y_t^i = f(PR_t^i, PR_t^A, PR_t^W, PROMR_{t-j}, Y_{t-1}^i, AV_t, STRUC_t, AD_t, DIR_t)$$

(20) $$Y_t^n = f(PR_t^n, PR_t^A, PR_t^W, PROMR_{t-j}, Y_{t-1}^n, AV_t, DIR_t)$$

where all variables are as defined earlier (see equation (17)), the superscript *i* denotes improved variety-specific variables, the superscript *n* represents native-specific variables, *j* is the number of lags of the promotion variable, and *t* designates year. The time period of analysis continues to be 1971/72-2006/07. For estimating the parameters of the two models, the relationship among the variables in each model was assumed to be linear in logarithms as was assumed for Model 1. Again, this functional form assumes that the own-price and promotion elasticities of the demand for Texas pecans in each equation are constant over the sample period. Also, the use of the logarithmic transformation insures that the normal assumption of diminishing marginal returns with respect to promotion expenditures is met.

Given the high correlation found between native and improved pecan prices (see Table 2), we tested for presence of multicollinearity between the two price series using the variance inflation factor (VIF) test. The VIF measures the degree to which an exogenous variable is a linear combination of other independent variables. By rule of thumb, values greater than 5 or 10 tend to be the accepted critical values. The test failed to reject the null hypothesis that multicollinearity is present at a critical value of VIF=5 with VIF statistics of 11.39 and 9.88 for improved and native pecan prices, respectively. Therefore, to avoid statistical issues associated with multicollinearity, only the price of improved pecans was included in the improved pecan sales model (equation (19)) while only the price of native pecans was included in the native pecan sales model (equation (20)).

To account for potential carryover effects of promotion, as was done for Model 1, we again tested both a geometric lag and a polynomial distributed lag (PDL) formulation of promotion expenditures in each equation. The search for lag length and, in the case of the PDL, the polynomial degree associated with the carryover effects again required a series of regression models for each equation with various lags on promotion. Based on the AIC and SIC statistics, a single, non-weighted lag of promotion again was employed for Models 2 and 3 (equations (19) and (20)) as was the case for Model 1.

The parameters of the two models were estimated together using the seemingly unrelated regression (SUR) estimator. Models 2 and 3 (equations (19) and (20)) are conceptually related in that they are demand equations for closely related commodities with similar variables. When estimating the parameters of such equations, there is a potential for their error terms to be correlated (Pindyck and Rubinfeld 1996). In this case, the use of the OLS estimator as used for Model 1 for all pecan sales could lead to inefficient parameter estimates. The SUR estimator is a more appropriate technique for addressing cross-equation error correlation and results in more efficient parameter estimates. If the disturbances or error terms of these two models are unrelated, then there is no relationship between the two models and the empirical results will be the same as estimating the parameters of the two models separately using the OLS estimator assuming that each variable has the same number of data points.

A check of the cross-equation error correlation matrix for the two equations revealed a high cross-equation error correlation of -0.81576. Because the correlation of factors embedded in the disturbance terms which are common to both equations is taken into account, the SUR estimator provides more precise estimates of the structural parameters for each of the two models than could be achieved by estimating the parameters of each equation separately with the OLS estimator. The application of the SUR estimator to equations (19) and (20) determined that the real price of almonds ($PR^A$), the real price of walnuts ($PR^W$), and real U.S. disposable income (*DIR*) again were not statistically significant determinants of the Texas sales of either improved varieties or native pecans as was the case for the aggregate sales of pecans (Model 1).

The modified Models 2 and 3 representing Texas sales of improved varieties and native pecans, respectively, were thus specified as follows:

$$(21) \qquad \ln Y_t^i = \lambda_0^i + \lambda_1^i \ln PR_t^i + \lambda_2^i \sqrt{PROMR_{t-1}} + \lambda_3^i \ln Y_{t-1}^i + \lambda_4^i \ln AV_t + \lambda_5^i STRUC_t + \lambda_6^i AD_t + \omega_t^i$$

$$(22) \qquad \ln Y_t^n = \lambda_0^n + \lambda_1^n \ln(PR_t^n) + \lambda_2^n \sqrt{PROMR_{t-1}} + \lambda_3^n \ln(Y_{t-1}^n) + \lambda_4^n \ln(AV_t) + \omega_t^n$$

where all variables are as defined earlier (see Table 1), the $\lambda$ are the parameters to be estimated, and $\omega_t^i$ and $\omega_t^n$ are the residuals of the improved and native pecan sales equations, respectively.

The SUR parameter estimates for the two models are provided in Table 5. No correction for autocorrelation was necessary for either model. Price ($PR^i$) was found to be a statistically significant determinant of the demand for improved pecan varieties but not for native pecans ($PR^n$). The estimated short-run own-price elasticity of improved pecan variety sales is -0.3231 indicating that a 10% increase in price leads to a 3.2% decline in sales of improved varieties. Following Labys (1973), the long-run own-price elasticity of improved variety sales ($e_L$) was calculated by dividing the short-run elasticity ($e_S$) by the coefficient of adjustment ($\delta$) which is calculated as one minus the estimated coefficient for the lagged dependent variable ($\lambda_{LD}$):

$$(23) \qquad \delta = 1 - \lambda_{LD}$$

$$(24) \qquad e_L = \frac{e_S}{\delta}.$$

The $\delta$ describes the speed of adjustment of sales in a given period to the desired long-run equilibrium and is calculated as 0.607 using equation (23). Using that result in equation (24) yields a long-run price elasticity estimate for improved varieties of -0.5320.

The statistical insignificance of the real price of native pecans ($PR^n$) in Model 3 does not mean that consumers do not consider price when making their purchasing decisions. Rather, the results suggest that changes in price do not result in large changes in purchases of native pecans and that purchases are more sensitive to changes in other variables such as the availability of pecans for sale than to changes in price.

**Table 5: Models 2 and 3 SUR Results**[a]

***Model 2 – Texas Sales of Improved Variety Pecans***

Dependent Variable - $\ln(Y^i)$ (natural log of improved variety pecan sales)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 3.891423 | 1.174182 | 3.31 | 0.0025 |
| $\ln(PR^i)$ | 1 | -0.32312 | 0.140502 | -2.30 | 0.0291 |
| $SQRT(PROM_{t-1})$ | 1 | 0.000801 | 0.000396 | 2.02 | 0.0531 |
| $\ln(Y^i_{t-1})$ | 1 | 0.392642 | 0.051400 | 7.64 | <.0001 |
| $\ln(AV)$ | 1 | 0.646930 | 0.079014 | 8.19 | <.0001 |
| STRUC | 1 | 0.68397 | 0.095997 | -7.12 | <.0001 |
| ANOM | 1 | -0.28401 | 0.131801 | -2.15 | 0.0399 |

| | |
|---|---|
| Durbin-Watson | 2.51789 |
| Number of Observations | 35 |
| First-Order Autocorrelation | -0.29533 |

***Model 3 – Texas Sales of Native Variety Pecans***

Dependent Variable - $Y^n$ (sales of native variety pecans)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 2.218923 | 0.988572 | 2.24 | 0.0323 |
| $\ln(PR^i)$ | 1 | 0.103086 | 0.118872 | 0.87 | 0.3927 |
| $SQRT(PROM_{t-1})$ | 1 | 0.000163 | 0.000492 | 0.33 | 0.7423 |
| $\ln(Y^i_{t-1})$ | 1 | -0.08370 | 0.049658 | -1.69 | 0.1023 |
| $\ln(AV)$ | 1 | 1.411479 | 0.100765 | 13.01 | <.0001 |

| | |
|---|---|
| Durbin-Watson | 1.831096 |
| Number of Observations | 35 |
| First-Order Autocorrelation | -0.29533 |

System Statistics

| | |
|---|---|
| System Weighted MSE | 1.0012 |
| System Weighted R-Square | 0.9714 |

[a] Note: See Table 4 for variable nomenclature and descriptions.

The most interesting result is the significance of the promotion variable at the 10% level (p-value=0.0531) in Model 2 (improved variety pecan sales) and the insignificance of the promotion variable in Model 3 (native pecan sales) providing evidence in favor of the hypothesis that promotion has had a positive impact on sales of improved varieties and little or no statistically measureable effect on the sales of native pecans. The short-run promotion elasticity of improved variety sales was calculated to be 0.04422 using equation (18) except that promotion expenditures were lagged one period given the one-period lag of promotion in Model 2 (Table 5). The elasticity estimate implies that a 100% increase in pecan promotion expenditures would result in a 4.2% increase in sales of improved pecans in the next period. Following the same process described above to calculate the long-run price elasticity, the long-run elasticity of promotion was calculated as 0.07285 meaning that a 100% increase in promotion expenditures in the first period would result in a total 7.3% increase in pecan sales after eight years.

Availability (AV) was also found to be a highly significant (<0.0001) determinant of the sales of both improved and native varieties of pecans. Thus, perhaps the most important determinant of pecan sales in most years is yield variation which constrains the availability of pecans for sale in some years and allows greater market responsiveness in other years. As discussed earlier, native varieties are more susceptible to year-to-year yield fluctuations in yields than is the case for improved varieties. Thus, not surprisingly, the estimated coefficient for the availability of pecans for native/seedling varieties (1.4114) is more than double that for improved varieties (0.6469).

The lagged dependent variables in each equation were also found to be statistically significant at the 1% and 10% levels, respectively (Table 5). The positive estimated coefficient for the lagged sales of improved pecan varieties and the negative estimated coefficient for lagged sales of native pecans in their respective models reflect the trend by buyers toward improved varieties and away from native pecans.

## Analysis of the Effectiveness of Texas Pecan Promotion

The results of the statistical analysis presented in the previous section allows an analysis of the two key questions that are the specific focus of this study: (1) What have been the effects of the Texas Pecan Promotion Program on sales of Texas pecans? (2) What has been the return on investment made by Texas pecan producers on the promotion of sales of Texas pecans?

In analyzing the answer to first question, the focus is on whether the expenditures of pecan checkoff assessment revenues by the TPB to promote Texas pecan sales have effectively and consistently increased the sales of Texas pecans over the eight-year period of 1999/00 to 2006/07. The analysis of the answer to the second question (whether there has been any return to Texas pecan promotion activities) emphasizes the Benefit-Cost Ratio (BCR) related to Texas pecan promotion which is calculated as the dollar increase in sales per promotion dollar spent over the 1999/00 to 2006/07 period.

*Effects of Promotion on Sales of Texas Pecans*

The statistical analysis in the previous section implies that pecan promotion has effectively shifted out the demand for Texas pecans in general, thus increasing the quantity of total pecans sold over the eight-year period of 1999/00 through 2006/07. The statistical results for Model 1 (all pecans sales) from Table 4 imply that pecan promotion has effectively shifted out the demand for Texas pecans in general, thus increasing the quantity of total pecans sold. The results for Models 2 and 3 (improved and native pecan sales, respectively) from Table 5 indicate that sales of improved varieties have been effectively enhanced by TPB promotion activities while those of native variety pecans have not. The implication is that the TPB promotion program has effectively "moved the needle" at least for improved variety pecans.

The statistical results indicate that promotion expenditures added an average of 3.1 million lbs annually to Texas sales of improved variety pecans for a total of 21.5 million lbs over the eight years since the promotion program began (1999/00 through 2006/07) that would have not been sold without the promotion program (Table 6). Given that total Texas sales of pecans over that eight-year period were about 436 million lbs, the promotion program is estimated to have accounted for about 4.9% to total sales during that period. In terms of additional industry revenues, the analysis indicates that the promotion program added an average of over $4.2 million annually for a total of over $29.4 million in additional sales of improved variety pecans over the same eight years that would not have been added without the promotion program.

For native pecans, however, the analysis indicates that promotion expenditures had no statistically discernible effect on sales. Since its inception, the TPB has focused on increasing the visibility of pecans for home consumption. This analysis suggests that by doing so, the TPB may have unintentionally promoted sales of improved varieties of pecans over those of native pecans since improved varieties tend to be used for home consumption and native pecans for food and candy production as discussed earlier.

*Benefit-Cost Analysis of Texas Pecan Promotion Programs*

Although the Texas Pecan Promotion Program over the last eight years has effectively increased Texas sales of improved pecan varieties as shown in the previous section, the critical question is whether the cost of achieving the increase has been less than the revenues generated by the increased sales. In other words, whether or not the promotion program can be judged to be "effective" depends not only on whether sales have been enhanced by the program but whether and how much of a return on their investment contributors to the program have received. To explore this question, the statistical results were used to calculate benefit-cost ratios (BCRs), as defined earlier, as measures of the cost effectiveness of the promotion program. In general, if the calculated BCR is greater than one, the promotion program is deemed "effective" because more than one dollar in sales revenue is generated for every dollar spent. On the other hand, if the calculated BCR is less than one, the program is deemed "ineffective."

In calculating the BCRs, two modifications in the BCR formulas presented earlier in the methodology section (equations (8) through (16)) were made. First, recall in the discussion of the

**Table 6: Benefit-Cost Analysis of Texas Pecan Promotion, 1999/00-2006/2007**[a]

| | *Improved Varieties* | *Native Varieties*[b] |
|---|---|---|
| **Additional Sales (lbs)** | | |
| Crop Year Average | 2,691,815.4 | -- |
| Eight-Year Total | 21,534,522.9 | -- |
| **Average Nominal Price ($/lb)** | 1.31 | |
| **Additional Revenue ($)** | | |
| Crop Year Average | 3,675,119.3 | -- |
| Eight-Year Total | 29,400,954.4 | -- |
| **Promotion Expenditures ($)** | | |
| Crop Year Average | 101,976.6 | -- |
| Eight-Year Total Expenditures | 815,813.1 | -- |
| **Revenue BCR (RBCR) ($/$)** | 36.0 | -- |
| **Net Revenue BCR ($/$)** | 35.0 | -- |
| **Discounted BCR ($/$)**[c] | 30.5 | -- |
| **Sales BCR (lbs/$)** | 26.4 | -- |

[a] These estimates measure the effects of promotion on pecan sales after accounting for cross-equation error correlation between native and improved pecan sales equations.
[b] Promotion expenditures were found to have no statistically significant effect on sales of native pecans.
[c] Discounted BCR computed using the 30-day U.S. Treasury bill interest rate.

final estimated models of the sales of improved and native pecans (Models 2 and 3 in Table 5) that statistical testing determined that pecan promotion expenditures tend to impact sales with a lag of one period. Consequently, promotion expenditures ($PROM_t$) were summed only to the next to last period (T-1) in the denominators of the various BCR calculations. Also, given that the promotion variable used in Models 2 and 3 in Table 5 was the square root of real promotion expenditures as explained earlier, the elasticity of promotion for improved variety pecan sales or for native variety pecan sales in a given year ($e_t^{PROM}$) from equation (15) was calculated as:

$$e_t^{PROM} = \frac{\lambda_2}{2}\sqrt{PROM_{t-1}} \quad (25)$$

where $\lambda_2$ is the estimated coefficient for the promotion variable for improved variety or native pecan sales from equations (21) and (22) and presented in Table 5.

Based on the statistical analysis presented in the preceding section of the report and using the BCR formulas derived earlier, the revenue BCR (RBCR) for the Texas Pecan promotion program over the eight-year period of 1999/00 through 2006/07 is calculated to be 36.0 to 1 meaning that for every dollar spent by the Texas Pecan Board on promotion of pecan sales, the return was $36.0 in additional Texas dollar sales of pecans (Table 6). Recall that the statistical analysis found the TPB promotional activities since 1999/00 to have a statistically significant effect on Texas sales of improved variety pecans but not on sales of native pecans. Thus, the $36.0 return per dollar spent by TPB was all from additional sales of improved variety pecans as a result of promotional activities. The Net Revenue BCR (BCR) was calculated to be 35.0 to 1 while the Discounted BCR, which discounts the value of the return back to present value, was calculated to be 30.5 to 1 over the eight-year period (Table 6). The Sales BCR (SBCR) is 26.4 which indicates that TPB has generated an average of 26.4 lbs in additional sales of improved pecan varieties for every dollar spent on promotion (Table 6).

## Conclusions and Implications

The general conclusion of this study is that pecan promotion and advertising expenditures by the Texas Pecan Board and funded by the Texas Pecan Checkoff Program since its inception in 1998 have been effective in augmenting Texas pecan sales. With respect to the two key questions posed at the beginning of this report, the specific findings of this study are the following:

- *Texas Pecan Board Pecan promotion expenditures have effectively shifted out the demand for Texas pecans and increased the quantity of total pecans sold over the eight-year period of 1999/00 through 2006/07.*

  Promotion expenditures since the inception of the Texas Pecan Checkoff Program have added an average of nearly 2.7 million lbs annually to Texas pecan sales for a total of 21.5 million lbs (4.9% of actual sales) from 1999/00 through 2006/07 that would have not been sold without the promotion program. In terms of industry revenue, the promotion program added an average of nearly $3.7 million annually for a total of over $29.4 million in additional sales of pecans over the period that would not have been added without the promotion program. The implication is that the Texas Pecan Board promotion program has effectively "moved the needle" for pecan sales.

- *Sales of improved varieties of pecans have been the main beneficiary of the promotion program.*

  The promotion-led increase in sales experienced by the Texas pecan industry has been composed primarily of improved variety pecans rather than native pecans. The promotion expenditures of the Texas Pecan Board were found to have a statistically significant effect on Texas sales of improved pecans such that a doubling of expenditures would result in a 4.2% increase in sales of improved pecans in the next period. This result is consistent with the estimated effects of promotion on sales of other checkoff commodities reported in the literature. For native pecans, promotion expenditures were found to have no statistically discernible effect on sales. Since its inception, the Texas Pecan Board has focused on increasing the visibility of pecans for home consumption and, by doing so, may have unintentionally promoted sales of improved varieties of pecans rather than sales of native pecans since improved varieties tend to be used for home consumption while native pecans tend to be used for food and candy production.

- *TPB pecan promotion programs have generated a net revenue to the industry of $36 for every pecan checkoff dollar spent on promotion or $30.5 on a discounted, present value basis.*

- *In terms of sales, the promotion programs have generated 26.4 lbs in additional sales of improved varieties of pecans per dollar spent on promotion.*

The general implication of the study results is that TPB promotion efforts have been working to improve Texas pecan sales and returns to Texas pecan producers. The results also provide some important insights for management of the program:

- *The Texas pecan promotion program is greatly under-funded.*

  The BCRs calculated for the Texas Pecan Promotion Program seem high relative to those generally reported for the larger commodity promotion programs. Reported BCRs for commodity checkoff programs typically range from about 2:1 to 10:1 although much higher BCRs (from 12:1 up to 50:1 and higher) are not uncommon (Williams and Capps 2006). Given the low level of promotion expenditures for Texas pecans compared to the promotion expenditures for the major checkoff commodities like cotton, soybeans, beef, and pork, however, the somewhat higher BCRs found for Texas pecans are not unreasonable. The higher BCRs imply that while Texas pecan promotion efforts have been successful, the promotion activities also are greatly under-funded. Both experience and the theory of advertising suggest strongly that a substantial increase in funding over time would likely reduce the Texas pecan BCR to levels more in line with those of the better-funded commodity promotion programs.

- *Free riders are limiting the funds available for promotion and industry revenues.*

  There is currently little or no enforcement of the mandatory checkoff collection due to a lack of funds and manpower at the Texas Department of Agriculture. As a result, only about 44% of the total potential assessment is collected on average each year which effectively limits the potential impact of the Texas Pecan Checkoff Program (Adams 2007). The consequence is that a large portion of the additional industry revenues generated by the pecan promotion program is being earned by those who have chosen not to contribute to the cost of the promotion. Unfortunately, an increase in the assessment rate to those already paying the assessment would likely be necessary to generate sufficient funds to pay the cost of a collections program. For example, at the current $0.005/lb assessment rate, payment of the assessment on an additional 10 million lbs of pecan sales each year would be necessary for TPB to generate just $50,000 that could be used for an assessment collections program. If the cost exceeded that amount, the collections program would not be worth the investment. The implication is that while the current low assessment rate does generate additional industry revenues, it also allows free riders to enjoy the benefits of the program without being required to pay the cost.

- *A high BCR does not imply a large impact of the program on sales.*

  The high estimated BCR should not be mistaken to imply large absolute impacts of the pecan checkoff program on Texas pecan sales. A BCR of 36:1 results by dividing a $36 billion industry profit benefit by a $1 billion checkoff investment or by dividing a $36 benefit by a $1 investment. For pecans, like most commodity promotion programs, the value of the expenditures on promotion activities is extremely small in comparison to the total value of industry sales. Commodity promotion expenditures generally amount to a fraction of 1% of the total industry sales each year (Williams and Capps 2006) . With such a low level of investment compared to sales, the overall impact of a commodity promotion program like the Texas Pecan Promotion Program could hardly be expected to be significant in a *practical* sense in its effects on sales even though the impact was found to be *statistically* significant. In the case of pecans, the study results imply that the pecan promotion program can take credit for up to about 5% of total pecan sales since the beginning of the program. Although seemingly small, this level of impact is quite large given the small amount of funds available to the TPB for promotion. The danger is that, in its efforts to encourage compliance with the assessment requirement or to sell the program during a referendum, the Board could imply that the high BCR found for the promotion program means that the promotion program has been a major factor influencing Texas pecan sales. This misinterpretation of the BCR is a common occurrence among commodity checkoff programs and leads contributors to expect large impacts on their sales and revenues (Williams and Capps 2006). When such impacts do not occur, support for the program among contributors begins to wane. A more prudent message to contributors is that the per unit return is large but on a very few dollars available for investment implying the need for more investment for more meaningful returns. At the same time, the promotion program could be better sold to contributors as *producer controlled tools* that pay more than they cost to help reduce downside pressure on sales in bad years and contribute to sales in good years rather than as a panacea to the financial problems they face.

- *Not all contributors receive the same benefits.*

  The positive BCR calculated for the pecan promotion program indicates that contributors gain "on average" from the program. Chung and Kaiser (2000) point out, however, that the benefits of a checkoff program may not be evenly distributed among contributors with some gaining more than others. They conclude that more of the benefits accrue to larger producers although smaller producers benefit more in terms of the net revenues accrued *per unit of assessed checkoff*. If the smaller producers tend to be the higher cost producers and the large producers tend to be the lower cost producers, then their results indicate that the high cost producers benefit the most and the low cost producers benefit the least. That is, those that pay the most receive the least per dollar that they pay in checkoff assessment. Thus, a checkoff program works as a mechanism to redistribute income from large, low cost producers to small, high cost producers. If this is the case and the differences in benefits are substantial, larger producers may begin to feel somewhat disenfranchised over time and to be less supportive of the checkoff program. Several checkoff programs (for example, beef and cotton) have experienced these problems which has led to protracted court cases related to the mandatory nature of the program.

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