Price Relationships in the U.S Tree Nut Market

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Abstract

Although most U.S. tree nuts have very specific and different uses, some substitutability does occur, complicating the price analysis in the tree nut market. We examine the relationships among U.S. tree nut prices using the Johansen's cointegration procedure. We found long run equilibrium among some nut prices, namely, pecans, walnuts, and almonds. These findings are consistent with recent suggestions that cointegration exist among substitutes.

Key Words: substitutability, cointegration, tree nuts, long-run, equilibrium
I. Introduction

The U.S. is not only the world's leading producer but also the leading exporter of tree nuts (Johnson, 1998). Tree nuts remain an important component of the American diet. The growth in demand for tree nuts may be attributed to the increase in knowledge of the health benefits of nuts, increase in per capital incomes and the increase in the introductions of new products by a rapidly expanding bakery and confectionery industry. U.S. tree nuts (henceforth referred to as nuts) are used for snacks, morning cereals, ice cream, and confections (Lin et al, 2001). The U.S. tree nut industry is a multibillion industry (USDA, 2003). Some of the most popular tree nuts are almonds, pecans, and walnuts. Although all the nuts have very specific and different uses, some substitutability does occur between and among the nuts (Florkowski and Lai, 1997). For example, walnuts or almonds cannot be substituted for pecans in a pecan pie but this can happen in a morning cereal or nut mix snack.

Thus, the examination of the relationships among nut prices is appropriate and timely. The results of this study can be used to explore market structure, product substitutability and competitiveness of the nut markets. It can also be used in guiding model specification of more detailed structural analysis of the U.S. nut market.

Review of literature reveals that empirical studies dealing with price relationships in the U.S. tree nut market is currently limited. The literature, however, provides examples of how cointegration testing (e.g., Engle and Granger, 1987; Johansen, 1988; Johansen and Juselius, 1990; Luppold and Prestemon, 2003) may be useful for evaluating the long run
relationships among prices. In the context of nuts, Florkowski and Lai (1997) studied the relationship between pecan prices and other edible nuts using the cointegration technique. The study found a cointegration between prices of pecans, almonds and walnuts and was used in making better forecasts. Florkowski and Lai (1997), however, used prices of two grades of each edible nut at the grower level.

The objective of this study is to examine the relationships among U.S. tree nut prices using the cointegration approach. The use of cointegration procedure allows the verification of long run relationships between and among economic variables. The Johansen and Juselius (1990), also known simply as Johansen’s test, maximum likelihood procedure is frequently employed in the estimation and testing for cointegrated time series in recent years. The main advantage of the Johansen test consists of its ability to determine the number of cointegrating vectors (Gonzalo, 1994). The rest of the paper is organized as follows. The next section describes the analytical approach, followed by description of data. Following this section are the results of the analysis. The final section of the paper highlights the policy implications of the study.

II. Model Specification

The cointegration concept, first introduced by Engle and Granger (1987), accommodates deviations from the equilibrium condition for two or more economic variables that are nonstationary when taken by themselves. In this study, two or more prices are cointegrated if they share a stochastic trend. Following Johansen and Juselius (1990), the error correction model can be written as
\[ \Delta X_t = \sum_{i=1}^{p-1} \Phi_i \Delta X_{t-i} + \Pi X_{t-p} + AD_t + \epsilon_t \]

where \( \Phi_i = -(I + \Gamma_1 + \ldots, \Gamma_i) \),

and \( \Pi = -(I - \Gamma_1 - \ldots - \Gamma_p) \)

\( \epsilon_t \) are the error terms and are drawn from a p-dimensional i.i.d. normal distribution with covariance \( \Lambda \). \( D_t \) is a deterministic term which may contain a constant, a linear trend and or seasonal dummy variables. The impact matrix, \( \Pi \), determines whether or not there significant long-run relationships among variables in the system. If the rank of \( \Pi \) matrix \( r \) is \( 0 < r > p \), then there are two matrices \( \alpha \) and \( \beta \) each with dimension \( p \times r \) such that \( \alpha \beta' = \Pi \), \( r \) is the number of cointegrating relationships among variables of \( X_t \). \( \beta \) is the matrix of \( r \) cointegrating vectors and has the property that the elements of \( \beta'X_t \) are stationary. \( \alpha \) is the matrix of error correction parameters that measure the speed of adjustments in \( \Delta X_t \).

III. Data

Monthly prices of the highest U.S. tree nut grades were obtained from USDA sources for the periods January 1992 to December 2004. The data include pecan (fancy halves), walnuts (light halves and pieces), and almonds (nonpareil supreme) prices. We chose to analyze the three price series because of the paucity of data for the other nuts. Moreover, the chosen nuts appear to be the three most popular U.S. nuts. It should be noted that all the data are on shelled basis, nominal and wholesale prices (free on board) in the U.S. southeast.
IV. Results

Before reporting the cointegration results, let us take a look at the descriptive statistics of U.S. nut prices. Prices for pecans, almonds and walnuts between 1992 and 2004 appear in Figure 1. Table 1 shows the summary statistics for the nut price series. Pecans were traded at premiums to both walnuts and almonds with mean prices of $1.41 and $1.26 per pound higher, respectively. Walnuts, on the other hand, sold at a premium to Almonds with a mean price of $0.15 per pound higher.

According to Jumah and Kunst (1996), most agricultural time series display some form of seasonality. As such, the overall dataset was seasonally adjusted and transformed into logarithm of prices prior to their use in accordance with previews studies (e.g. Engle and Granger, 1987).

Cointegration test was preceded by tests of stationarity using the Dickey Fuller test. The results of the stationarity test are summarized in Table 2. All the price series were found to be nonstationary. Following most applications of Johansen (e.g. Johansen, 1988; Johansen and Juselius, 1990), we tested for cointegration among the U.S. nut prices. The results of the Johansen’s test are presented in Table 3. For the null hypotheses of r = 0 or r > 0, the trace statistic of 39.62 is greater than the 5% critical value, but the rest (11.21 and 3.78) are less than their respective critical values (15.34 and 3.84, respectively). The results indicate the existence of cointegration with a rank of 1. This suggests the presence of cointegration among the variables which is interpreted as long run relationships among
substitutes. These findings are consistent with earlier conclusions by Florkowski and Lai (1997).

V. Concluding Remarks

The objective of this study was to examine the long-run relationships in the U.S. tree nut market using monthly data on pecans, walnuts and almonds prices from January 1992 to December 2004. The Johansen’s trace test was applied in conducting cointegration tests. The study found that long-relationships existed among the nut prices, namely, pecans, walnuts, and almonds. This implies that market forces can bring prices of substitutes to long run equilibrium. Furthermore, these findings will not only aid stakeholders in the tree nut industry to better understand these price relationships in the nut market, but also help them make informed and efficient decisions.
Table 1. Summary of some U.S. Tree Nut Prices

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean ($/lb)</th>
<th>Standard Deviation</th>
<th>Coefficient of Variation</th>
<th>Minimum ($/lb)</th>
<th>Maximum ($/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pecan</td>
<td>3.47</td>
<td>0.73</td>
<td>21.14</td>
<td>2.03</td>
<td>5.00</td>
</tr>
<tr>
<td>Almond</td>
<td>2.06</td>
<td>0.52</td>
<td>25.36</td>
<td>1.23</td>
<td>3.25</td>
</tr>
<tr>
<td>Walnut</td>
<td>2.21</td>
<td>0.37</td>
<td>16.84</td>
<td>1.58</td>
<td>3.05</td>
</tr>
</tbody>
</table>

Table 2. Augmented Dickey Fuller Unit Root Testing Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Specification</th>
<th>DF Test Statistic</th>
<th>DF Test p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pecans</td>
<td>Single Mean</td>
<td>-2.58</td>
<td>0.0993*</td>
</tr>
<tr>
<td>Pecans</td>
<td>Trend</td>
<td>-2.60</td>
<td>0.2798</td>
</tr>
<tr>
<td>Walnuts</td>
<td>Single Mean</td>
<td>-2.18</td>
<td>0.2137</td>
</tr>
<tr>
<td>Walnuts</td>
<td>Trend</td>
<td>-2.36</td>
<td>0.4009</td>
</tr>
<tr>
<td>Almonds</td>
<td>Single Mean</td>
<td>-1.57</td>
<td>0.4971</td>
</tr>
<tr>
<td>Almonds</td>
<td>Trend</td>
<td>-1.52</td>
<td>0.8191</td>
</tr>
</tbody>
</table>

*nonstationary at 10%

Table 3. Johansen Cointegration Testing Results

<table>
<thead>
<tr>
<th>H0: Rank=( r )</th>
<th>H1: Rank&gt;( r )</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>5% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0.171</td>
<td>39.62</td>
<td>29.38</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.048</td>
<td>11.21</td>
<td>15.34</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.025</td>
<td>3.78</td>
<td>3.84</td>
</tr>
</tbody>
</table>
Figure 1. U.S. Tree Nut Prices

Source of data: USDA (various years)
References


