

**THE POTENTIAL OF THE ARKANSAS SWEET POTATO INDUSTRY: A MATTER
OF VOLATILITY**

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Abstract

This paper characterizes the revitalized sweet potato industry in the Arkansas delta region. Having recently received an infusion of federal funds, the industry has built a storage/processing facility. Through the help of nonprofit organizations, the industry has also received marketing assistance and working capital. One of the industry's strategies for success is the cementing of contracts for the end-use of sweet potatoes.

One of the justifications of a storage facility is that it will allow the farmers to better time the market. This paper analyzes the volatility of Arkansas sweet potatoes and competing products in the fresh market using simple linear regression and graphical analysis, finding that the storage aspect of the facility is unnecessary because insufficient price volatility exists to justify the sales smoothing required to justify long-term storage. Rather, the authors recommend keeping the facility as a curing, sorting, and distribution facility only.

The Potential of the Arkansas Sweet Potato Industry: A Matter of Volatility

Introduction

The sweet potato is an important vegetable. Highly nutritious, sweet potatoes are touted as a good way for developing countries to meet food needs (Low, et al. 2007; Prakash 1994). A popular variety, Beauregard, is well-adapted to the southern United States. North Carolina is the leading producer of sweet potatoes in the U.S., followed by California, Mississippi, and Louisiana (NCSPC, LASPC).

The most impoverished area in Arkansas, the Delta region in the southeast portion of the state at one time had a viable sweet potato industry (Gaul and Morgan 2007). To help the mostly minority farmers of the region develop a cash crop, the USDA has revisited sweet potatoes as an alternative to the more traditional cotton and soybeans. A nagging question about sweet potatoes is storage, since harvest and peak consumption do not coincide (Mutandwa and Gadzirayi 2007). The USDA Federal-State Marketing Improvement Program awarded more than \$285,000 in grants to the Arkansas State Plant Board from 2000 to 2005 to help Arkansas Delta farmers market their products (FSMIP Reports 2000 – 2005). Much of the funding was to complement the \$1.9 million sweet potato storage facility in Helena-West Helena. The facility, completed in 2007, received a \$500,000 grant from the U.S. Department of Commerce (News Release 2006). The facility is designed to accommodate 120,000 bushels of sweet potatoes for up to 12 months and can be expanded to accommodate 300,000 bushels (FSMIP Report 2005).

Why the Facility Was Needed

Curing is necessary to bring out the required flavor of sweet potatoes. After curing, sweet potatoes must be stored at temperatures from 55 to 60 ° F to minimize losses from pests and diseases. Sweet potatoes may be stored in this way for up to a year. Uncured sweet potatoes are referred to as “green.” Intended for use in both curing and storing sweet potatoes, the facility has been projected as a means to store the product while the selling price is low. Then, when the price is higher, the product can be brought out of storage to be sold at a premium. In this regard, the purpose of a storage facility is the same as that of a futures market (there is no futures market for sweet potatoes): to reduce price volatility. Since agriculture is a noted example of an industry in which price swings result in zero long-run economic profit, a steady price would allow sellers to at least cover fixed cost (such as the cost of a storage facility) and thereby stay in business.

The Arkansas Delta Produce Marketing Association (ADPMA) was formed to benefit minority farmers from Lee, Monroe, and Phillips Counties in marketing their products. Arkansas-based non-profit Winrock International helped to negotiate contracts with several companies to provide a steady market. Gerber Foods, the largest baby food manufacturer in the world, has a plant in Fort Smith. Bright Harvest, a leading processor of frozen food products, is located in Clarksville. These two companies have agreed to purchase virtually all the sweet potatoes the farmers can produce during the peak growing season. In

addition, Glory Foods, an Ohio-based retailer of Soul Food, agreed to purchase green sweet potatoes during the months of November and December. In addition, ADPMA has succeeded in selling fresh sweet potatoes to Affiliated Foods for distributed in Arkansas grocery stores and is seeking certification to bid on USDA contracts for public school lunch programs (FSMIP Report 2005).

The success of these efforts in finding specialty markets for Arkansas' local product calls into question the need for storage, since very little, if any, of the product is left to store. Particularly, this paper investigates the volatility of the alternative use of sweet potatoes, the fresh market, to see if sufficient volatility exists to justify the storage function of the facility.

Data

The Agricultural Market Service (AMS) of the U.S. Department of Agriculture (USDA) maintains a database of prices for agricultural commodities, including sweet potatoes, grown in the U.S. and sold as fresh in fourteen major agricultural markets throughout the U.S. No Arkansas sweet potatoes have been sold in the following markets from 1998 to 2007: Atlanta, Boston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, or Seattle. Negligible amounts have been sold in Baltimore, Chicago, and Detroit. No Louisiana sweet potatoes have been sold in Atlanta for over a year. Since most sweet potatoes are sold from trucks, it is little wonder that the high transport cost to far-flung markets does not justify the effort.

However, in late June, 2005, Arkansas sweet potato farmers began selling their product in Dallas. Sales quickly shifted from St. Louis to Dallas, with the last St. Louis sales occurring in November, 2006. The Dallas market has proven much more reliable than the St. Louis market for Arkansas sweet potatoes, with the only significant break in sales occurring for 14 days over Christmas, 2006.

Since Dallas is the dominant Arkansas sweet potato market, we analyzed price series for the Dallas market to estimate volatilities. Sweet potato prices are quoted for forty pound cartons. To construct a price series, we averaged the prices for a particular product across all sellers that day. For the popular southern Beauregard variety, ungraded, Jumbo size sweet potato, we found only six breaks in Dallas sweet potato sales from all sources. Most of these breaks were for three weeks or less. The longest break was for 100 days, during the first half of 2002. Both high and low prices were reported and used.

Methodology

To test whether or not the price behavior significantly changed during the sample period, we performed three simple linear regressions of the price data against a time trend:

$$\text{Price}_t = a + b_i * \text{Time} + u_t$$

where Time is a monotonically increasing series of integers and i is an index for the regression used. Regression 1 used data from December 8, 1998, to September 24, 2007, inclusively. The results are shown in Table 1.

Table 1

Regression Results for Time Trend Estimations of Prices of Arkansas Sweet Potatoes sold in Dallas

| Regression 1 Price_t = a + b₁ *Time + u_t (12/08/98 to 09/24/07) | | |
|---|---|----------------------------------|
| | Average Low Price Series | Average High Price Series |
| R-squared | .3737 | .3687 |
| Number of Observations | 1929 | 1929 |
| Overall F Ratio | 1149.57* | 1125.28* |
| Estimate of a | 10.15 | 11.06 |
| Estimate of b₁ | .0024* | .0025* |
| Standard Error | 7.21E -.05 | 7.44E -.05 |
| * | Denotes significance at 99 percent level | |
| ** | Denotes significance at 95 percent level | |

Over the entire eight-plus year period, the price trend was very slightly upward, but significantly different from zero at the 99 percent level. The casual observer might infer that the price of sweet potatoes has climbed and continues to climb. A closer inspection of the data, however, indicates that this may not be so. The actual price series is shown in Figure A, with breaks shown as vertical lines at the appropriate intervals. The trend line estimated from Regression 1 also shown. Note that some regularities seem to appear, but regular cyclicity is lacking. What is most noteworthy is the large spike upward in approximately the middle of the dataset (mid-August, 2003). This means that the trend estimated with the entire dataset is misleading. Instead, we should look at sub-periods both before and after the peak to see what the trends would appear to be to one who is in that market.

Regressions 2 and 3 were performed for just that purpose: to identify different regimes in prices that occurred from 1998 to 2007. Regression 2 used data from December 8, 1998, to August 13, 2003, inclusively, with the results shown in Table 2. An August 13, 2003, date was chosen to separate the regression periods since that is the date that the price peaked. As can be seen from the table, the time trend estimate for the pre-peak period is virtually identical to that of the entire time period. Similarly, Regression 3 used the post-peak data to estimate a time trend as reported in Table 3. Figure B shows the trend line estimated from Regression 3.

Figure A

**Plot of Sweet Potato Prices Sold in Dallas Market
(Variety: Beauregard; Size: Jumbo; Ungraded)**

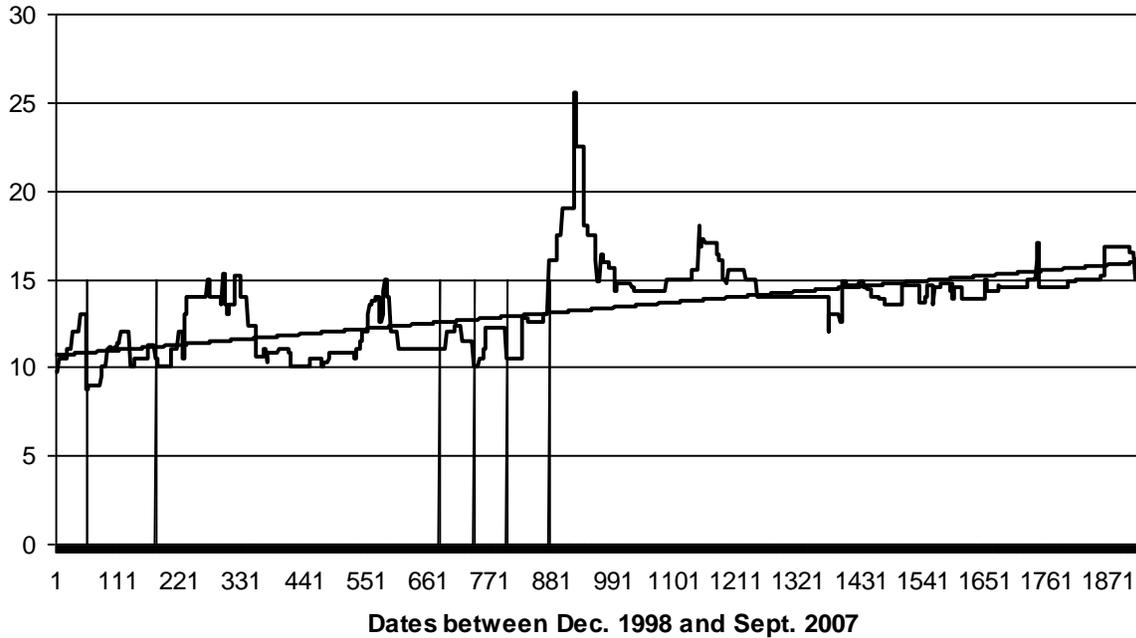


Table 2

Regression Results for Time Trend Estimations of Prices of Arkansas Sweet Potatoes sold in Dallas

| Regression 2 Price_t = a + b₂ *Time + u_t (12/08/98 to 08/13/03) | | |
|---|---------------------------------|----------------------------------|
| | Average Low Price Series | Average High Price Series |
| R-squared | .1168 | .1204 |
| Number of Observations | 925 | 925 |
| Overall F Ratio | 122.04* | 126.32* |
| Estimate of a | 9.83 | 10.65 |
| Estimate of b₂ | .0027* | .0028* |
| Standard Error | .0002 | .0002 |
| * Denotes significance at 99 percent level | | |
| ** Denotes significance at 95 percent level | | |

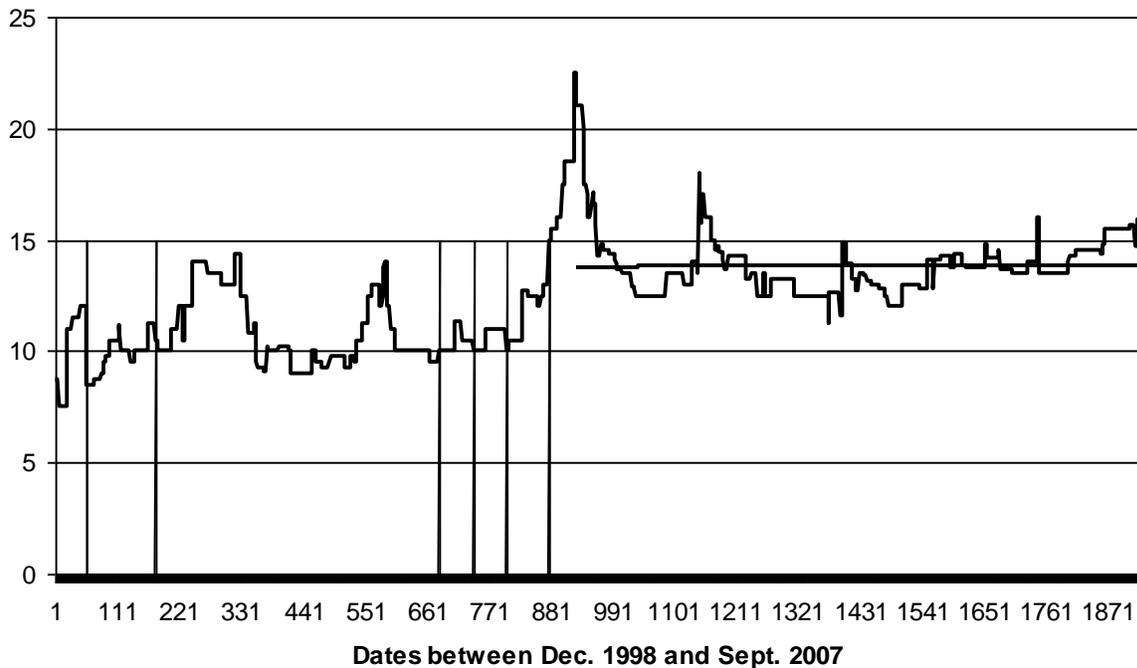
Table 3

Regression Results for Time Trend Estimations of Prices of Arkansas Sweet Potatoes sold in Dallas

| Regression 3 Price_t = a + b₃ *Time + u_t (08/14/03 to 09/24/07) | | |
|---|---------------------------------|----------------------------------|
| | Average Low Price Series | Average High Price Series |
| R-squared | .0003 | .0318 |
| Number of Observations | 1004 | 1004 |
| Overall F Ratio | 0.2911 | 32.87** |
| Estimate of a | 13.716 | 16.052 |
| Estimate of b₃ | 7.87E -05 | -.0008** |
| Standard Error | .0002 | .0001 |
| * Denotes significance at 99 percent level | | |
| ** Denotes significance at 95 percent level | | |

Figure B

Plot of Sweet Potato Prices Sold in Dallas Market (second sub-period)



While the low price seems to be flat during this time period, the high price is actually slightly declining. This would seem to indicate no need for a storage facility.

Breaking up the latter period still further, we treated the period August 14, 2005, through July 20, 2005, as a period of correction for the sweet potato market in Dallas and the period July 21, 2005, through September 24, 2007, as a period of recovery. Simple regressions, as reported in Tables 4 and 5, were used to estimate those time trends. The signs of the coefficients and t-tests affirm that these were indeed periods of correction and recovery, respectively. The trends are shown in Figures C and D.

Table 4

Regression Results for Time Trend Estimations of Correction and Recovery in Prices of Arkansas Sweet Potatoes sold in Dallas

| Regression 4 Price_t = a + b₄ *Time + u_t (08/14/03 to 07/20/05) | | |
|---|---------------------------------|----------------------------------|
| | Average Low Price Series | Average High Price Series |
| R-squared | .2694 | .3362 |
| Number of Observations | 471 | 471 |
| Overall F Ratio | 172.914* | 237.539* |
| Estimate of a | 21.321 | 23.439 |
| Estimate of b₁ | -.0065* | -.0072* |
| Standard Error | .0005 | .0005 |
| * Denotes significance at 99 percent level | | |

Table 5

Regression Results for Time Trend Estimations of Correction and Recovery in Prices of Arkansas Sweet Potatoes sold in Dallas

| Regression 5 Price_t = a + b₅ *Time + u_t (07/21/05 to 09/24/07) | | |
|---|---------------------------------|----------------------------------|
| | Average Low Price Series | Average High Price Series |
| R-squared | .4940 | .4323 |
| Number of Observations | 533 | 533 |
| Overall F Ratio | 518.46* | 404.78* |
| Estimate of a | 7.032 | 8.712 |
| Estimate of b₂ | .0041* | .0036* |
| Standard Error | .0002 | .0002 |
| * Denotes significance at 99 percent level | | |

Figure C

Average Sweet Potato Prices in Dallas Market Showing Correction

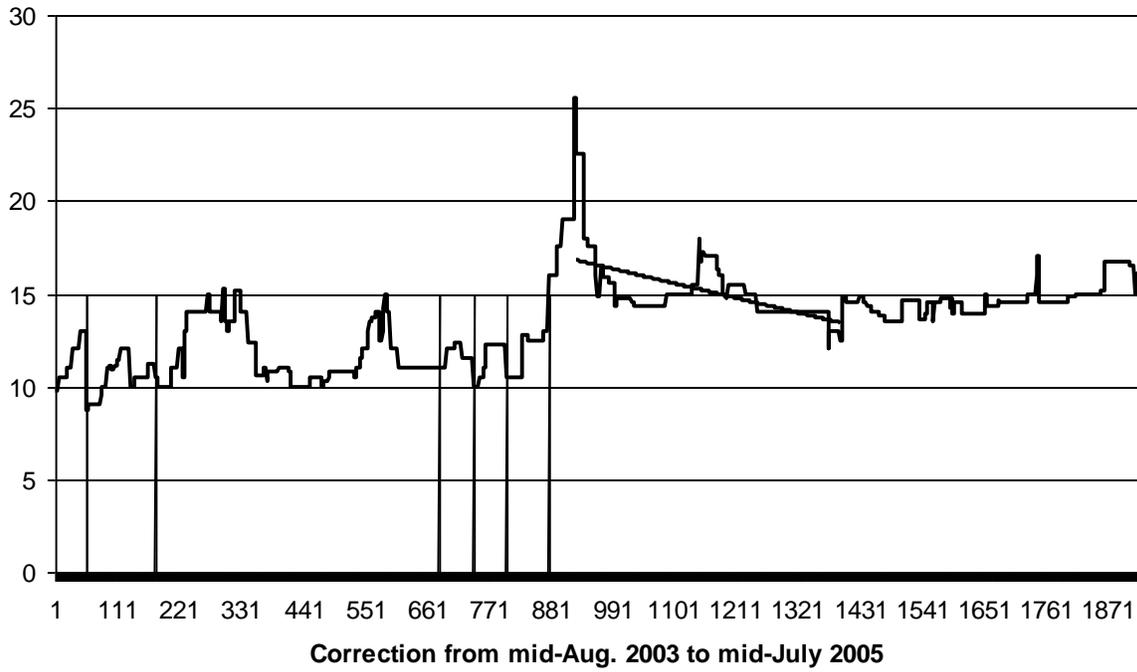
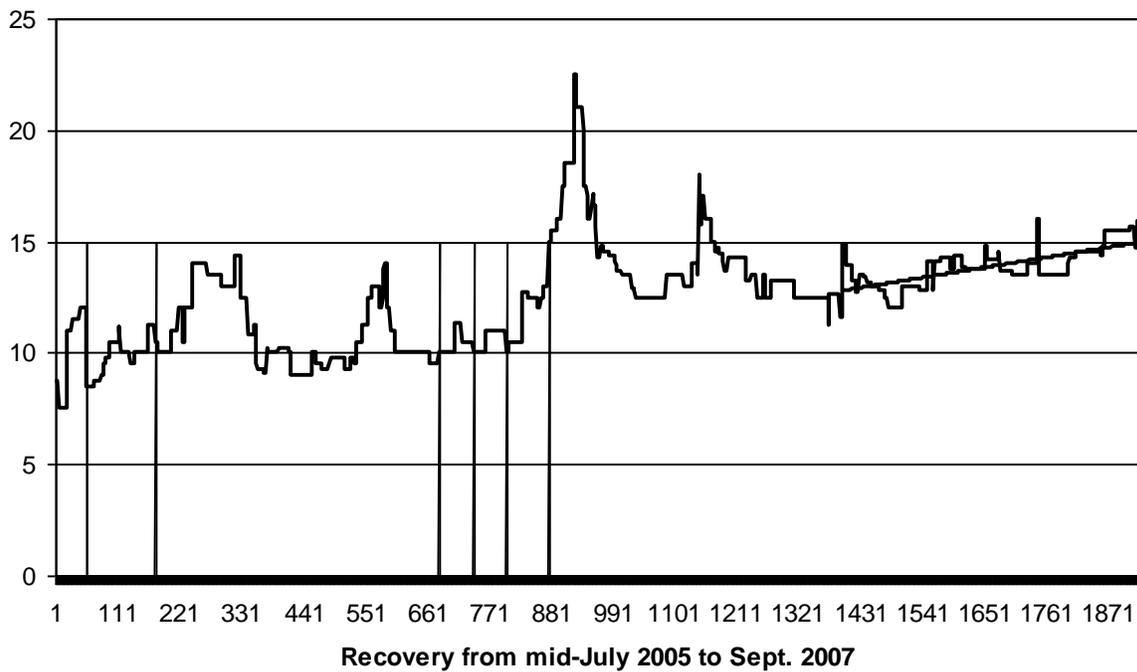


Figure D

Plot of Average Sweet Potato Prices in Dallas Market Showing Recovery



We further tested the hypothesis that the time trend estimates from Regression 1 were statistically identical to those from Regression 2. From Gujarati (1978) it may be shown that the estimates from two linear regression estimates may be compared to each other using student's t-distribution. For example, if the null hypothesis is that the time trend from Regression 2 is identical to that from Regression 1, then

$$H_0: b_2 = b_1 \text{ and } H_1: b_2 \neq b_1.$$

If H_0 is true, then

$$\Pr[b_1 - t_{sig/2} * s.e.(b_2) \leq \beta_2 \leq \beta_1 + t_{sig/2} * s.e.(b_2)] = 1 - sig$$

(where "sig" is the level of significance). Using this equation to construct intervals for the time trends resulted in the ANOVA Table 6. This table indicates that the time trends from Regressions 1 and 2 are indeed identical, while the time trend from Regression 3 is statistically different from the other two.

Table 6

Results of t-tests for Differences in Time Trends

| Relevant Hypothesis Test | Average Low Price Series | | | Average High Price Series | | |
|--|-------------------------------|---------------|---------------|--------------------------------|----------------|----------------|
| | for 95 % level | lower bound | upper bound | for 95 % level | lower bound | upper bound |
| H₀: b₂ = b₁ H₁: b₂ ≠ b₁ | b₂ = .00270 | .00197 | .00292 | b₂ = .00273 | .00202 | .00297 |
| H₀: b₁ = b₂ H₁: b₁ ≠ b₂ | b₁ = .00244 | .00241 | .00284 | b₁ = .00250 | .00246 | .00288 |
| H₀: b₃ = b₁ H₁: b₃ ≠ b₁ | b₃ = .00000 | .00216 | .00273 | b₃ = -.00081 | .00222 | .00277 |
| H₀: b₁ = b₃ H₁: b₁ ≠ b₃ | b₁ = .00244 | .00000 | .00022 | b₁ = .00250 | -.00096 | -.00067 |

These results indicate that the sweet potato market in Dallas underwent multiple regime changes. Near the turn of the century, prices were significantly rising. Later, prices underwent a

correction. Lately, prices have been climbing again, but much more slowly than before. At this point, it is instructive to analyze the price volatility of sweet potatoes sold in Dallas. As indicated in Table 7, the volatility up to and including the peak of the market (which occurred on August 13, 2003, was about 24 percent. Since the peak, however, the volatility has been much lower, at about 15 percent.

Table 4

Price Volatilities of Sweet Potatoes (all states) Sold in Dallas

| | |
|---|--------------------------|
| Entire Time Period (12/08/98 – 09/25/07) | 19.58 percent |
| Up to and Including Peak (12/08/98 – 08/13/03) | 23.58 percent |
| After Peak (08/13/03 – 09/25/07) | 14.97 percent |

Conclusion

We maintain that the volatility of fresh sweet potato prices is insufficient to justify timing the market through the use of a storage facility. The fact that virtually all of ADPMA’s product is sold to captive markets would indicate that the farmers have effectively succeeded in persuading their customers to absorb storage costs (in a variation on the just-in-time inventory theme). The Helena-West Helena facility is still of great potential value, but as a sorting, curing, and distribution hub from which sweet potatoes are rapidly forwarded to final destinations rather than held in storage. In this regard, marketing techniques seem to have reached an optimal market solution much more cheaply than traditional methods of getting sweet potatoes to market.

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