



—Discussion Paper—

ORGANIC AND CONVENTIONAL POTATOES: PRICING AND DEMAND, 2000-2005

FSRG *Discussion Papers* offer insights into ongoing FSRG research. Comments are encouraged; please email the authors below or kdbrown@wisc.edu. Views, interpretations, recommendations, and conclusions expressed are those of the authors and not necessarily of supporting or cooperating institutions.

This discussion paper is based on research by Ming-Feng Hsieh, Paul D. Mitchell, and Kyle W. Stiegert. See the Working Paper at: <http://www.aae.wisc.edu/fsrg/publications/wp2007-01.pdf>.

Food System Research Group
University of Wisconsin-Madison
<http://www.aae.wisc.edu/fsrg/>

February 2007

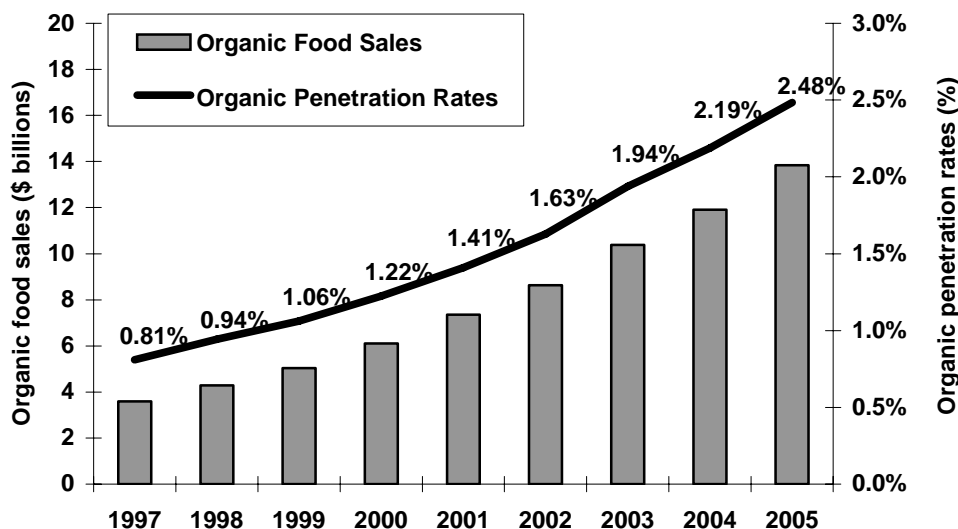
I. ORGANICS: A GROWING INDUSTRY

In the past decade, the US organic food industry has grown nearly 20% annually. The Organic Trade Association reports that sales of organic foods in 2005 accounted for nearly 2.5% of total US food sales (OTA 2006) (see figure 1). Not surprisingly, sales of organic foods at natural food stores such as Whole Foods Market and Wild Oats increased through the first half of the 1990s. In 1995, however, sales at this type of specialty outlet peaked at 68% of total organic sales, while conventional food retailers grabbed a larger share of the growing market. By 2005, the natural food stores' market share had dropped to 47% of sales, while conventional retailers increased their market share from 33% in 1995 to 46% in 2005.

This trend is expected to continue, as Wal-Mart, now the nation's largest grocer, and Target announced a major move into the marketing of organic foods (Mitchell 2006; Pollan 2006). These and other retailers will put downward pressure on organic food prices, making them more accessible and affordable to the tens of millions of Americans who are not currently part of this market (Pollan 2006).

As the trend of increased organic food sales continues, people in the industry and policymakers can benefit from a better understanding of market impacts on competing food groups. Organic foods and beverages are available in nearly every category of food sold in the US, and fresh

Figure 1. The rise of organic food sales



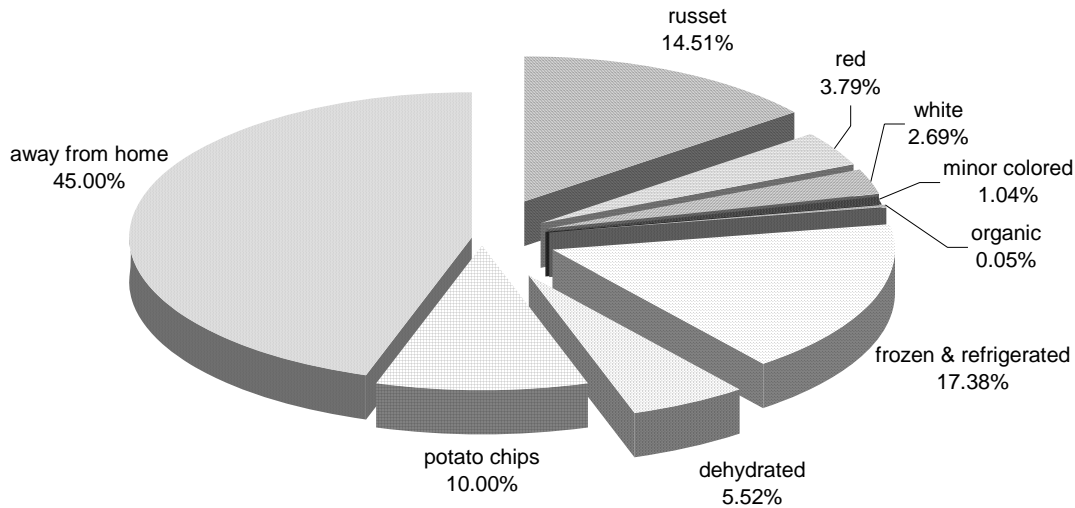
Source: Nutrition Business Journal estimates based on OTA's 2006 Manufacturer Survey, annual Nutrition Business Journal surveys of manufacturers. SPINS.

fruits and vegetables are the most frequently purchased category of organic foods, accounting for 39% of total organic food sales (OTA 2006). Survey results show that 73% of organic food purchasers make at least one purchase of a fruit or vegetable per store visit (Whole Foods Market 2006). Among fresh vegetables, the top organic purchases are lettuce, tomatoes, broccoli, onions, and potatoes. Among selected vegetables, a recent US study found the largest organic premium was for potatoes (Zhang et al. 2006). From 1999-2003, the average organic potato price premium was 75% higher than the conventional potato aggregate price, compared to price premiums of 20-30% for other organic vegetables (Dimitri and Greene 2002). The high organic premiums reflect not only higher costs associated with organic production but also consumers' increasing demand for organics.

Demand analysis of potatoes and/or organics is sparse (see, for example, Gao, Richards and Kagan 1997; Richards, Kagan and Gao 1997; Zhang et al. 2006). The FSRG study contributes to the literature in several ways. First, we use data from the most recent years, when organic products have been more accessible to the public. Second, we use data aggregated from transaction level data, which usually generate a better quality of demand measures. Third, we examine different types of potatoes while considering consumption by quarter and regional differences in consumption patterns.

Our approach improves the understanding of price elasticities among various types of potato products, as well as the role played by demographics, seasonality, regional differences, and supply shocks in price and demand.

Figure 2. Average US potato consumption pattern, 2000-05



II. ANALYSIS OF PRICE AND DEMAND

At-home consumption data for potatoes were drawn from AC Neilsen supermarket sales data from 2000 to 2005. Data were at an aggregate level for four regions in the United States: north, south, east and west. There were 24 quarterly observations across the four regions for each potato category used in the analysis: fresh organic, fresh conventional (russet, white, red, and minor colored), frozen/refrigerated, and dehydrated.

Based on USDA's 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII), about 55% of the U.S. potato crop was used for food consumed at home. More than 80% of fresh, dehydrated, and canned potatoes, plus potato chips, were sold through retailers and consumed at home. Conversely, frozen potatoes, especially French fries, were sold mainly for away-from-home consumption. (Potato chips are not included in this study due to data availability, yet this exclusion can be justified on the grounds that potato chips are more appropriately a snack food rather than a close substitute for other potato products.) In sum, the data used in our analysis represent the majority of demand for fresh and processed potatoes consumed at home. Figure 2 reveals typical US potato consumption.

Table 1 reveals characteristics about potato expenditures and consumption. Notable points:

- The mean value of expenditure on all potato varieties across the US is \$2.28 per capita each quarter.
- Russet potatoes have the largest share of consumer expenditure, with over 30% market share.
- Processed potatoes have a combined expenditure share of more than 50% of the food-at-home market. Processed potatoes implicitly contain less raw potato input in their total cost structure

and are probably less price responsive to quantity or cost factors at the farm level.

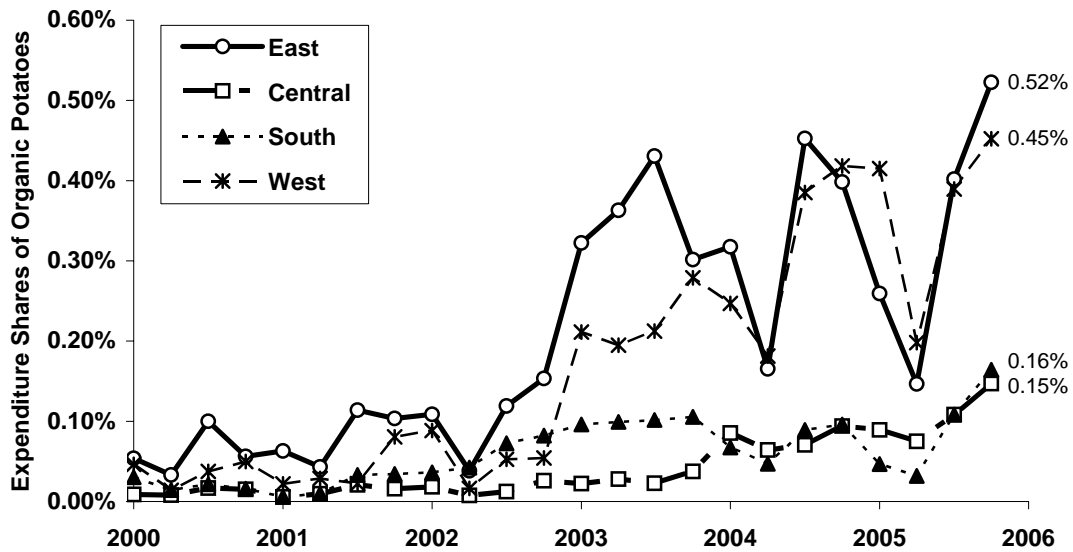
- Among four seasons, we observe a constant tendency for individuals to consume more fresh than processed potatoes in the fourth quarter.
- Potato consumption differs considerably across regions. Average per capita consumption is highest in the eastern region and lowest in the western region.
- Consumers spend very little on organic potatoes compared to conventional potatoes, with the average share of expenditure on organic potatoes only 0.12%. Even in the eastern region, it is only 0.21% on average. Yet, consumption of organic potatoes has grown over time. By the fourth quarter of 2005, eastern region consumption of organic potatoes was 0.52% of total expenditure on potatoes (see figure 3.)

Table 1. Mean values of potato expenditure, shares, and prices in the US, 2000-05

| variables | mean values | | mean values (by region) | | | mean values (by quarter) | | | |
|---|-------------|-------|-------------------------|-------|-------|--------------------------|-------|-------|-------|
| | U.S. | East | Central | South | West | Q1 | Q2 | Q3 | Q4 |
| potato expenditure (\$) | 2.28 | 2.69 | 2.46 | 2.36 | 1.59 | 2.34 | 2.21 | 2.16 | 2.40 |
| expenditure shares (as % of expenditure on potatoes) | | | | | | | | | |
| russet | 32.25 | 28.52 | 30.23 | 35.57 | 34.67 | 31.45 | 31.93 | 31.74 | 33.87 |
| red | 8.43 | 10.66 | 9.04 | 9.29 | 4.74 | 7.71 | 8.89 | 9.33 | 7.80 |
| white | 5.98 | 11.66 | 2.77 | 6.91 | 2.60 | 5.48 | 5.52 | 6.89 | 6.05 |
| minor colored | 2.32 | 3.33 | 1.58 | 2.76 | 1.60 | 2.36 | 2.01 | 2.19 | 2.73 |
| organic | 0.12 | 0.21 | 0.04 | 0.06 | 0.17 | 0.11 | 0.08 | 0.14 | 0.16 |
| frozen & refrigerated | 38.63 | 35.01 | 42.12 | 34.94 | 42.45 | 40.41 | 40.00 | 37.90 | 36.21 |
| dehydrated | 12.26 | 10.60 | 14.21 | 10.46 | 13.78 | 12.49 | 11.57 | 11.82 | 13.19 |
| prices (\$/lb) | | | | | | | | | |
| russet | 0.33 | 0.43 | 0.30 | 0.34 | 0.26 | 0.32 | 0.33 | 0.36 | 0.32 |
| red | 0.54 | 0.65 | 0.46 | 0.53 | 0.54 | 0.51 | 0.55 | 0.58 | 0.53 |
| white | 0.34 | 0.37 | 0.27 | 0.37 | 0.35 | 0.31 | 0.37 | 0.35 | 0.32 |
| minor colored | 0.61 | 0.70 | 0.56 | 0.56 | 0.63 | 0.57 | 0.64 | 0.65 | 0.59 |
| organic | 0.72 | 0.78 | 0.76 | 0.72 | 0.62 | 0.71 | 0.75 | 0.73 | 0.68 |
| frozen & refrigerated | 1.12 | 1.24 | 1.07 | 1.03 | 1.13 | 1.12 | 1.13 | 1.11 | 1.11 |
| dehydrated | 2.96 | 2.90 | 2.95 | 2.58 | 3.42 | 2.94 | 3.01 | 3.03 | 2.86 |

Our study controlled for demand effects from factors other than prices and expenditures. These include a time trend, regional and seasonal variables, and socio-demographic variables (age, race, and women's workforce participation rate). The trend in organic consumption was measured by the penetration rate of organic foods relative to total food sales in the US (OTA 2006). These data proxy the growing interest in organic foods due to perhaps taste, health,

Figure 3. US consumption trend for organic potatoes, 2000-05



environmental, or other preferential concerns. We also were able to observe varying responses among regions.

Table 2 reports the signs of parameter estimates, which are statistically significant, for the expenditure share equations. A plus sign means the factor increases the share of potato expenditures on that category, while a minus sign means the opposite, and a blank means the factor had no statistically significant effect.

- The time trend was significant only for dehydrated potatoes, which lost market share through the 2000-2005 period due to factors not associated with any included variables.
- Race was not statistically important in explaining changes for any potato category market share. However, though not conclusive, russet demand may have increased as the percent of Caucasians increased in the market. As the percentage of young people (<25 years) increased, the frozen/refrigerated market share increased and the dehydrated share decreased. As participation of women in the workforce increased, market share gains were found for russet, white and red potatoes. These findings suggest a demographic profile of the market and may provide useful information for potato market boards, branded processors, and other industry participants developing promotional campaigns.
- Variation was mainly across potato categories and not across regions. For example, three of four interaction terms for both white potatoes and dehydrated potatoes were significant, but parameter estimates for both categories were in a tight range. Thus, while a growing demand for organic foods did influence demand for certain categories, the effect did not differ greatly across regions. A possible exception is the russet potato—in the eastern region, russet demand has seen a large and positive demand shift explained by the growing trend in organic food

demand. Overall, it appears white and dehydrated potatoes expenditure shares increased from the emergence of organic foods. Interestingly, only one of the interaction parameters in the organic potato category was statistically significant and all were close to zero.

- If regional differences are present, we could not identify them under our aggregation scheme.

Table 2. Statistical significance in potato expenditure shares

| Variables | russet | white | red | minor colored | organic | frozen & refrigerated | dehydrated |
|--------------------------|--------|-------|-----|---------------|---------|-----------------------|------------|
| time trend | | | | | | | - |
| age (% below 25) | | | | | | + | - |
| race (% white) | | | | | | | |
| women participation rate | + | + | + | | | | |
| organic trend * east | + | + | | | | | + |
| organic trend * central | | | | | | + | |
| organic trend * south | | + | | | | | + |
| organic trend * west | | + | | | + | | + |

Table 3 reports the signs of parameter estimates with statistical significance for price equations, also providing information about demographic, seasonal, and production factors that explain potato prices. A plus sign means the factor increases the price of that category, while a minus sign means the opposite, and a blank means the factor had no statistically significant effect.

- The percentage of young people (<25 years) has a negative effect on most prices, except organic and frozen/refrigerated, but the only significant effects are negative effects on the prices of reds, minor colored, and dehydrated potato products. Race as the percentage of Caucasian in the population only has a significant (and positive) effect on the price of red, while women’s workforce participation rate significantly decreases the price for white potatoes and increases the price for organic potatoes.
- One major finding relates to the increasing trend for organic food demand. The increasing trend for organic food demand had a downward effect on fresh non-organic potato prices—all 16 coefficients were negative and 11 were significant. Furthermore, the same interaction variables were statistically significant and explained higher organic potato prices in all four regions. Though results in Table 2 show that trends in organic consumption have not changed the market share of organic potatoes, results in Table 3 show that potato prices, particularly organic and fresh potatoes, were impacted by the trend in organic food demand.
- The average U.S. potato yield had a negative and statistically significant effect on retail prices for non-organic fresh potatoes, but no statistical impact on explaining either processed potato prices or fresh organic potatoes. Several farm cost variables explained fresh potato prices, which suggests that potato markets respond rapidly to production costs. Fertilizer and

chemical price indices were significant, but of the incorrect sign—higher production costs led to lower potato prices. This may suggest that larger potato farmers are indifferent to these input prices and/or that acreage shifts into potato production to reduce total chemical input usage in other crops.

Table 3. Statistical significance in potato prices

| Variables | russet | white | red | minor colored | organic | frozen & refrigerated | dehydrated |
|----------------------------|--------|-------|-----|---------------|---------|-----------------------|------------|
| time trend | + | | + | | | | |
| age (% below 25) | | | - | - | | | - |
| race (% white) | | | + | | | | |
| women participation rate | | - | | | + | | |
| organic trend * east | - | | - | - | + | | |
| organic trend * central | - | | - | - | + | | - |
| organic trend * south | - | | - | | + | | |
| organic trend * west | - | | - | - | + | | |
| average yield | - | - | - | - | | | |
| farm labor price index | | + | | | | | |
| autos trucks price index | - | - | - | - | | | |
| storage price index | | + | + | + | | | |
| 3-month t-bill rate | + | + | + | + | | | |
| fertilizer price index | - | - | - | | | | |
| chemical price index | - | - | - | | | | |
| machinery price index | | | | | | | |
| organic acreage | | | | | + | | |
| transportation price index | | | | | | | |
| energy price index | | | | | | | |
| labor (food manuf.) | | | | | | | |
| service (food manuf.) | | | | | | | |

Interaction terms in the price equations also provide an interesting story regarding white potatoes. In Table 3, white potato prices were negatively impacted by the trend in organic consumption, but none of the coefficients were significant. Since the market share of white potatoes grew as organic food consumption increased, white potatoes may be emerging as a potentially strong substitute for organic potatoes and may be a conventional potato product that competes well with the emerging organic market.

Table 4 presents elasticity estimates for what percentage expenditure on all potatoes increases with a 1% increase in the factor. As the price of bread or the price of frozen vegetable increased

by 1%, consumers increased their expenditures on potatoes by about 1.5% and 1.8% respectively. Also, when the aggregate potato price index rose by 1%, total expenditures rose by only about 0.4% (suggesting a negative quantity response). When income rose by 1%, expenditures on potatoes declined by 0.4%, implying that, in the aggregate, potatoes are in inferior good.

Table 5 reports uncompensated price and income elasticities. Price elasticities measure what percentage the quantity demanded falls with a 1% increase in the price, while income elasticities measure what percentage the quantity demanded changes with a 1% increase in income. All own-price elasticity estimates are negative, with the white, red and minor colored potato estimates statistically significant. In the fresh market, the demand for minor colored potatoes was the most price-elastic (-2.80) followed by red and then white potatoes. Organic and white potatoes have nearly identical own-price elasticities. A related study by Zhang, Huang, Lin, and Epperson (2006) found an own-price elasticity of -1.11 for organic potatoes using scanner data between 1999 and 2003, while our estimates imply a statistically insignificant elasticity of -0.58. The two processed potato own-price elasticities were also not significant.

Elasticities for average income in Table 5 are quite interesting. Because the estimate of income elasticity of the expenditure equation was negative and significant, the aggregate potato complex acts as a set of inferior goods. However, this does not imply that all potato categories are inferior, which was borne out in our results. Income elasticities for russet, white and dehydrated potatoes were all negative and statistically significant. Not surprising, dehydrated potatoes were the most sensitive to income increases. The only superior (but insignificant) potato category was minor colored, which are the most expensive fresh conventional potato.

Table 4. Elasticity of potato expenditure with respect to variables, 2000-05

| Variables | Expenditure elasticity |
|------------------------------|------------------------|
| income | -0.41 |
| potato price index | 0.39 |
| rice and pasta price index | -1.05 |
| bread price index | 1.52 |
| fresh vegetable price index | -0.03 |
| frozen vegetable price index | 1.80 |
| food price index | -1.14 |

Table 5. Selected price and income elasticities for potato products, 2000-05

| Potatoes | Price elasticity | Income elasticity |
|-----------------------|------------------|-------------------|
| russet | -0.11 | -0.34 |
| white | -0.65 | -0.96 |
| red | -0.88 | -0.12 |
| minor colored | -2.81 | 0.54 |
| organic | -0.58 | -0.30 |
| frozen & refrigerated | -0.01 | -0.05 |
| dehydrated | -3.08 | -1.90 |

Note: Bold indicates statistical significance.

We can compute elasticity of potato demand with respect to carbohydrate prices, and prices of food, from the results of Table 4 and 5. We found statistical support implying that bread and processed vegetables act as substitutes to russet, white and dehydrated potatoes. No other potato categories were statistically significant.

Based on the cross-price elasticities, strong substitutability relationships exist among three fresh categories: organic, minor colored and white. Not surprisingly, the cross-price elasticities show white potatoes to be the only statistically significant substitute category for organic potatoes and confirm our earlier findings that these are strong substitutes. Quantities demanded of organic potatoes are shown to be very sensitive to the price of white potatoes, reflecting their substitutability and the small market share of organic potatoes. Similar statistically strong findings occurred for the cross-price relationship between white potatoes and minor colored potatoes. Though not significant, the cross price relationship between minor colored and organics displayed the same pattern. For instance, a 1% price increase in minor colored potatoes generates almost a 2% increase in the organic potato quantity demanded. Overall, the prices of white and minor colored potatoes independently and jointly have the potential to dramatically shift the market share of organics. As a result, organic producers, processors and retailers should pay close attention to pricing within this trio of products.

V. KEY FINDINGS

This FSRG study investigated pricing and demand issues characterizing the US food-at-home market for potatoes. Five major findings are drawn from this study.

1. There is little evidence that potato demand differs across the four study regions. Only one of 21 stand-alone regional dummies was significant. Regional dummies were also included in the price equations, and significant price activity was noted for red potatoes, with decreases in the east and central and increases in the south.
2. Changing consumer tastes for organic food demand significantly impact pricing for fresh potatoes. The magnitude of statistically significant price declines was highest for red and russet potatoes, with smaller declines for minor colored. White potato prices declined, but not with statistical significance. Prices of organic potatoes rose significantly as a result of the general trend in organic demand. White potato and dehydrated potato market shares increased in response to organic trends.
3. White potatoes were the only conventional fresh market potato to respond positively to the trends in organics, and did so without a related price decline. Both organic potatoes and minor colored potatoes had only one statistically significant substitution relationship—with white potatoes. When system expenditures rise, the share of white potatoes is statistically shown to be the only fresh market potato to gain in market share. Thus, it appears that white potatoes, despite a low price profile, compete effectively with pricier minor colored and organic potatoes. White potatoes seem positioned to gain in market share relative to other conventional fresh market potatoes in the emerging organic-oriented marketplace.
4. For the potato complex as a whole, increasing the overall potato price index by 1% led to only a 0.4% increase in potato expenditures. This implies that demand for aggregate “potatoes” can be viewed as inelastic, which is not surprising given that only two of the seven categories (minor colored and dehydrated) had elastic own-price elasticities. Thus, at least in an aggregate average sense, potatoes price will remain quite sensitive to available supplies. The

expenditure effects on market shares of each category are mixed. As system expenditures expand, we found no statistical support for making claims about category winners or losers. However, white potatoes and dehydrated potatoes seem to do better than russet and organic potatoes, and substantially better than red, frozen, and minor colored potatoes. In terms of income effects, we found strong statistical support that russet, dehydrated and white potatoes are inferior goods. Potato market boards may need to incorporate such findings into advertising and promotional campaigns aimed at bettering the potato's market image.

5. Competing carbohydrate groups impact the potato market. Lower bread or frozen vegetables prices lead to a reduction in system expenditures on potatoes. Neither rice/pasta nor fresh vegetable prices were statistically important in explaining expenditures. Dehydrated potatoes are overwhelmingly the most sensitive to competing carbohydrate prices, while frozen, organic, minor colored and red potato shares are not affected. Surprisingly, the price of fresh vegetables, which usually are sold in close store proximity to fresh potatoes, had no influence on potato market shares.

REFERENCES

- Dimitri, C., and C. Greene. 2002. "Recent Growth Patterns in the U.S. Organic Foods Market." Economic Research Service, USDA, *Agriculture Information Bulletin No. (AIB777)*, Washington, DC.
- Gao, X.M., T.J. Richards, and A. Kagan. 1997. "A Latent Variable Model of Consumer Taste Determination and Taste Change For Complex Carbohydrates" *Applied Economics* 29: 1943-54.
- Mitchell, D. 2006. "Retailers Push Wholesalers for More Organics." *The Packer*, November 27.
- Organic Trade Association. 2006. "The OTA 2006 Manufacturer Survey Overview." Organic Trade Association, Greenfield, MA.
- Pollan, M. 2006. "Mass Natural." *The New York Times*, June 4, 2006.
- Richards, T.J., A. Kagan, and X.M. Gao. 1997. "Factors Influencing Changes in Potato and Potato Substitute Demand." *Agricultural and Resource Economics Review* 26(1): 52-66.
- Whole Foods Market. 2004. "Organic Foods Continue to Grow in Popularity According to Whole Foods Market Survey." *Whole Foods Market Reports*, October 21, 2004.
- Zhang, F., C.L. Huang, B.-H. Lin, J.E. Epperson. 2006. "National Demand for Fresh Organic and Conventional Vegetables: Scanner Data Evidence." Selected Paper: The American Agricultural Economics Association Annual Meeting, Long Beach, CA, July 23-26.