The Demand for Organic Agriculture: A Study of the Frozen Pea Market

Angela Lengyel, Mary Washington College

Consumers worldwide exhibit growing food safety concerns as well as worries over the future of the environment. Such concerns over pesticide residue for consumers, as well as pesticide damage to wildlife, farm workers and the environment, have contributed to the growing demand for organic food. Fresh fruits and vegetables are the most often consumed organic foods and would be the most logical product to study. However, supermarket scanners have been unable to accurately tabulate sales of fresh produce due to the difficulty of attaching UPC bar codes to items. An alternative to studying the demand for fresh produce is to track the sales of processed produce, such as frozen vegetables. This paper will estimate the determinants of the demand for a specific organic product--the frozen pea.

Organic pea prices and quantities, conventionally grown pea prices, income, female labor force participation rates, and seasonal variables will be examined to determine their influence on the quantity demanded of organic frozen peas. These results will determine whether frozen and conventional products are substitutes and if so, their cross-price elasticity.

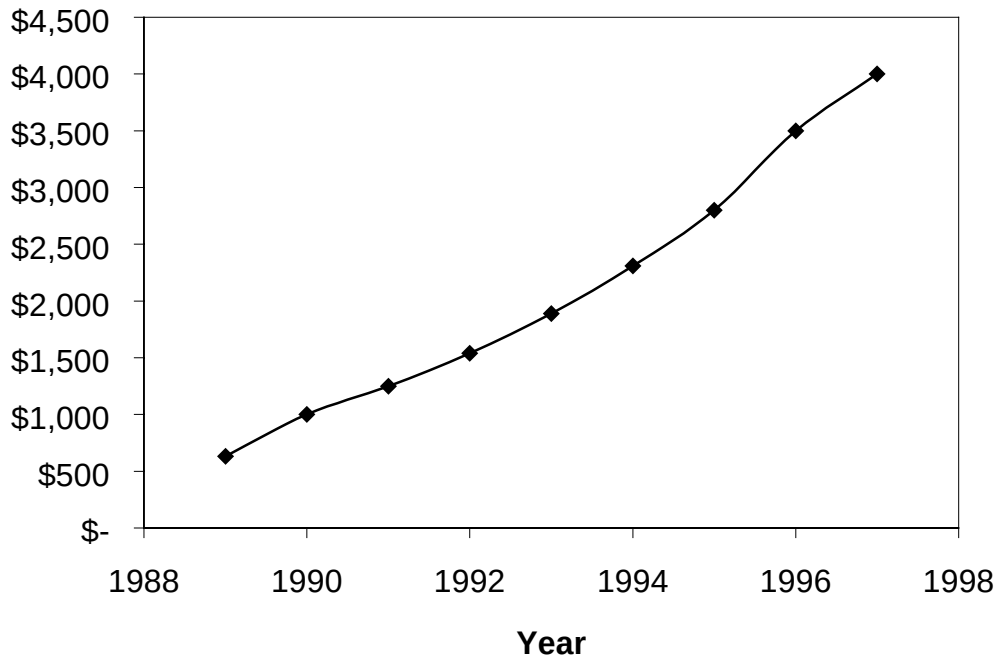
I. Organic Market History

The defining characteristic of organic agriculture is the absence of synthetic chemical pesticides. Organic foods are therefore distinguished from conventionally grown products in their manner of production, not physical features. Organic farmers use techniques such as composting, rotating crops, and green manuring to enhance the biological activity of farm soil. Organic foods reduce exposure to pesticide residue, which entices consumers to pay a price premium for what they perceive as healthier, better tasting and more nutritional food. Surveys indicate that consumers are willing to pay significantly more for organic foods as long as the

cosmetic quality is comparable to that of conventionally grown counterparts (Barbara Goldman and Katherine Clancy 1991; Chung Huang 1995).

Despite the higher costs associated with organic foods, the market is the fastest growing agricultural segment of the economy, growing nearly ten times as fast as overall grocery sales (Carmine Gallo 1996). According to the Organic Trade Association (OTA), organic sales reached $3.5 billion in 1996 and double-digit growth is projected to continue for the next five years. The increased supply and wider variety of organic products available have complemented the expanding industry as the demand for clean, safe, healthy foods continues to grow. Graph 1 illustrates the growing organic food sales as reported by the OTA.

Graph 1. Organic Food Sales (in millions)



Prior attempts to analyze consumer demand for organics have relied almost exclusively on self-reporting of purchase behavior and attitudes as discovered through questionnaires or

interviews (Patrick Byrne, Ulrich Toensmeyer, Carl German and H. Reed Muller, 1991; Jennifer Wilkins and Virginia Hillers, 1994). The venues of organic purchases have limited researchers to rely solely on self-reporting. The majority of organic purchases occur in co-ops and nature food stores that are not equipped with scanner data to reflect sales information (Gary Thompson 1998). The growth and consolidation of natural food supermarkets have increased retail sales and also provided scanner information that directly captures the organic consumer's behavior. Such information provides the opportunity to examine the factors that have contributed to the demand for organic food.

Data collected from supermarket scanners allow econometric testing of the determinants of organic food demand. By using supermarket scanner data, this study will examine the demand for organic frozen peas over a period of 6 years. My objective is to determine which variables influence the organic food market. When deciding which frozen vegetable to study, I chose peas since they are a popular frozen product and available in comparable organic and conventional varieties.

II. Model Specifications

The price and quantity data used in this study are from the A.C. Nielsen SCANTRACK Market Planner and include 76 monthly observations from September 1990 to December 1996. Neilsen Market Research tabulates supermarket scanner data monthly from supermarkets categorized as large grocery stores with annual sales of $2 million or more. The data represent approximately 83 percent of US retail food sales, but exclude sales from health food stores and food cooperatives unequipped with UPC scanners.

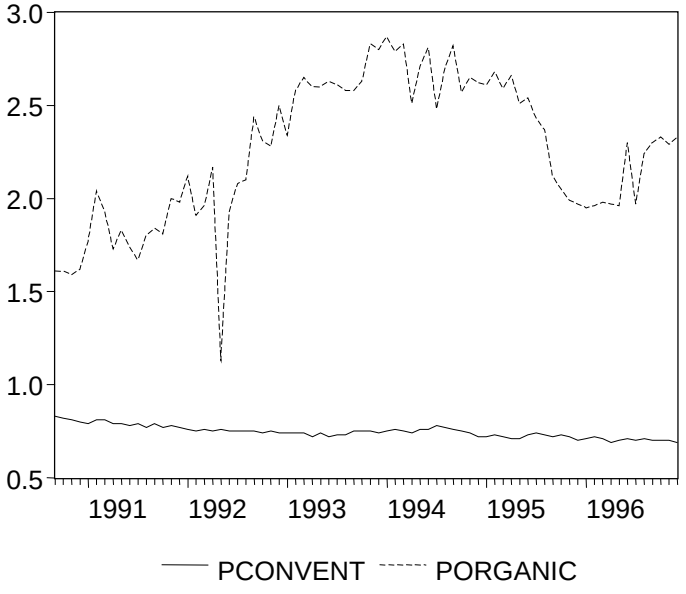
The dependent variable in this study (QORGANIC) represents 16-ounce units of frozen organic peas. Since the scanner data did not differentiate organic frozen vegetables from their

conventional counterparts, I contacted all frozen pea processors and questioned them as to their growing practices[1].

I compared only identically processed peas in order to capture the most accurate price differences. This was to avoid capturing the price premium paid for processing different peas, as well as avoiding the higher prices associated with different strains of vegetables such as snap peas and sweet peas. I considered only conventional and organic "regular green peas" to be substitutes for one another. The difference in packaging costs between bags versus boxes was negligible, so I ignored container type.

The prices of organic peas (PORGANIC) are consistently three times the prices of conventionally grown peas (PCONVENT) with means of $2.25 and $.74 respectively, and standard deviations of 0.38 and 0.03 respectively. Graph 2 depicts the prices of both products over the time period studied. The price of conventional peas fell over the time period, whereas the price of organics increased.

Graph 2. Prices in the Frozen Pea Market



My hypothesis was that the demand equation would take the following form:

(1) $Q_d = f(PORGANIC, PCONVENT, FLFPR, INCOME, SUMMER, HOLIDAY, TREND)$

For this study, I expect price and income to have their usual demand effects as suggested by theory. The majority of organic buyers are from households with incomes greater than $50,000 (Patrick Byrne, Ulrich Toensmeyer, Carl German, H. Reed Muller 1991). The high disposable income enables consumers to pay the organic price premiums and purchase more organics, which suggests income will have a positive effect on quantity demanded. Income data (INCOME) represent per capita disposable personal income in chained 1992 US dollars, as reported quarterly by the *Economic Report of the President.*

The price of organic peas should have a negative effect on the organic quantity demanded despite the "loyalty" organic consumers' claim towards their expensive products (Julia Cluett 1997). Conventional food counterparts will serve as substitutes to organic food and therefore conventional pea prices are expected to have a positive effect on the quantity of organic foods purchased. The prices for both conventional and organic products are measured in 1984 $US.

The frozen vegetable market as a whole exhibits seasonal shifts in demand. Seasonal shifts in the quantity demanded are evident from examining time series graphs of sales. More frozen peas are consumed in the month of December due to increased holiday meal cooking. Fewer frozen peas are consumed in the summer months of July and August due to the wider variety of fresh vegetables available. I included two separate dummy variables (SUMMER; HOLIDAY) to capture the seasonal shifts in demand.

Frozen peas are marketed as convenient alternatives to fresh peas. Since women are typically the principal meal planners in a family, as more women work outside the home, they

have less meal preparation time. As the number of women in the labor force increased, I expected the consumption of frozen peas to increase due to the product's convenience. The female labor force participation rate (FLFPR), as recorded in the *Economic Report of the President* should have a positive effect on the demand for frozen peas.

The final and most significant demand factor in this study is the growing awareness of the benefits from organic foods. Increased media coverage, academic studies and medical reports claiming related health benefits all positively influence the demand for organic foods. Such media attention influences consumers' preferences towards organics. In order to account for changes in preferences, I placed a trend variable in the equation.

Table 1 includes the mean and standard deviation of the previously mentioned variables.

Table 1: Variable Means and Standard Deviations: 1990-1996 Data

	QORGANIC[a]	PORGANIC[b]	PCONVENT[b]	INCOME[c]	FLFPR	SUMMER	HOLIDAY	TREND
Mean	1761.6	2.255	0.746	8449	58.3	0.1578	0.0921	27
Standard Deviation	1787.3	0.3897	0.0324	3361.2	0.75	0.367	0.291	28.1

[a]Quantities represent 16 ounce units.
[b]Prices represent 1984 US$.
[c]Income represents 1992 US$.

III. Estimation Results

I used the Ordinary Least Squares method for estimating several specifications of the model in order to generate the most accurate regression equations. The seven independent variables created 69 degrees of freedom, generating a critical T-Statistic of 1.67 and critical Durbin-Watson values of 1.39 and 1.70 at a 5 percent level of significance. Table 2 presents the

OLS coefficients and t-statistics from regressions with different combinations of independent variables.

Equation 1 includes all variables previously mentioned that I predicted would impact the quantity demanded of organic peas. All variables have the signs I predicted except for FLFPR, which is also not statistically significant in this equation. The t-statistics for PCONVENT, INCOME, and FLFPR are small enough that the null hypothesis that the coefficient is zero cannot be rejected using a one-tailed test at the 5- percent level. Despite the low t-statistics, those variables theoretically impact the quantity demanded of frozen peas so I will leave them in the equation.

Table 2. Demand Determinants Regression Coefficients (Absolute value of t-statistics in parenthesis)

	Equation 1	Equation 2	Equation 3
PORGANIC	-2019.6	-1594.67	-2551.97
	(6.73)*	(4.71)*	(10.53)*
PCONVENT	4281.9	-13089.11	1044.52
	(0.83)	(2.83)*	(0.23)
INCOME	0.05	0.16	-
	(0.099)	(2.92)*	
FLFPR	-414.7	11.62	-
	(1.12)	(4.75)*	
SUMMER	-888.5	-697.48	-886.52
	(4.45)*	(3.03)*	(4.50)*
HOLIDAY	700.5	745.36	674.03
	(2.79)*	(2.53)*	(2.70)*
TREND	93.4	-	84.16
	(5.18)*		(12.58)*
C	1743850	-53966.34	3611.47
R^2:	0.891	0.85	0.888
Adjusted R^2:	0.881	0.836	0.88
DW:	1.35	1.23	1.4
F-Statistic:	80.09	64.69	111.38
N:	76	76	76

*Significantly different than 0 at the 5-percent level

After examining the correlation coefficients, high correlation became evident between QORGANIC, INCOME, FLFPR and the trend variable as they all increased steadily throughout the time period examined. This presented the researcher with a problem since income and the female labor rate theoretically should impact the quantity demanded, but when including the

trend variable, OLS has difficulty distinguishing the accurate impact of each variable on QORGANIC. I believe this is what caused the low t-statistics on INCOME and FLFPR. To remedy this, I ran a second regression that did not include the trend variable.

(2) $Q_d = f(PORGANIC, PCONVENT, FLFPR, INCOME, SUMMER, HOLIDAY)$

All variables became statistically significant and the signs on FLFPR and INCOME changed to their theoretical predictions once I omitted the trend variable. However, the coefficient for PCONVENT is negative, contradicting theory. One possible explanation is the "loyalty" that organic consumers claim they have towards their products. As previously shown in Graph 1, the price of organic peas during the examined period increased by 45 percent, whereas the price of conventional peas decreased by 18 percent, yet consumption of organic peas increased by 243 percent. Therefore, the prices of conventionally grown products do not have a significant positive impact on the quantity of organics purchased. Equation 1 also displays this conclusion in the small t-statistic for PCONVENT. Prices of conventional peas do not impact the quantity demanded of organic peas, proving that in this study conventional peas are not strong substitutes for organic peas. One possible explanation for this is that organic consumers purchase other organic frozen products, such as frozen broccoli, at the rise of frozen pea prices. For this reason, other organic products might be stronger substitutes for frozen peas.

Equation 2 has a lower adjusted R-Squared value, but all the variables are statistically significantly different than zero. The R-Squared value of .849 demonstrates that 85 percent of the variation of QORGANIC around its mean is explained by this equation.

The Durbin-Watson value suggests negative autocorrelation that could be explained in the fact that there is an omitted variable. The F-Statistic of 64.69 represents the explained

variation of QORGANIC around its mean divided by the unexplained variation. This value explains that R-Squared is indeed statistically significant. I am confident in rejecting the null hypothesis that all coefficients in this equation are equal to zero.

(3) $Q_d = f(PORGANIC, PCONVENT, SUMMER, HOLDIAY, TREND)$

Despite omitting the trend variable, multicollinearity remains evident in Equation 2. High correlation coefficients between FLFPR, INCOME and PORGANIC might create invalid t-statistics for this equation. In an attempt to avoid multicollinearity, I excluded FLFPR and INCOME from a third equation and replaced the trend variable. In this case, the adjusted R-Squared increased and all variables except PCOVENT are statistically significantly different than zero, which is explained in the fact that the items are not substitutes. The Durbin-Watson value increased in Equation 3 and the analytic ability of the equation improved with the F-Statistic increasing to 111. Yet multicollinearity remains present between PORGANIC, QORGANIC, and the trend variable.

IV. Conclusion

The results from econometric testing of the frozen organic pea market support the negative own-price/quantity relationship, as the price coefficient was negative. However, the price of conventionally grown products does not have a strong positive impact on the quantity of organic counterparts purchased. I cannot confirm that conventional prices are significantly related to organic demand. The cross-price elasticity between organic and conventional peas is not high since according to recent prices, consumers are willing to pay twice as much for organic products. The pea market indeed exhibits seasonal variations in demand as the quantity varies

significantly as hypothesized in the holiday month of December due to holiday cooking, and in the summer months due to the variety of fresh vegetables available.

Higher income and the female labor force participation rates positively impact the amount of frozen organic peas consumed, but in this study their impact was distorted due to the necessity of a trend variable.

Organic food consumption has increased steadily due to a trend factor, but the researcher encountered difficulties with accurate estimation results due to the correlation of income, female labor rates, and a dummy trend variable. Perhaps a more specific trend variable such as a media or news article statistic used by Oral Capps and John Schmitz would be more appropriate (1992). For their study, the number of articles available to the medical profession linking cholesterol to heart disease was tabulated and included in regression equations on the demand for healthier foods. An equivalent variable would be the number of news articles and stories reported each month on the benefits of organic food. A more specific trend variable that directly captures consumer awareness to the benefits of organics might prevent autocorrelation.

A second suggestion for future regression research would be to have simultaneous equations with supply and demand data. A limitation to this method is that ample supply data on organic produce are difficult to obtain. The only national data for prices and quantities available to this researcher was from Nielsen Market Research, which only tabulates sales in supermarkets with sales of at least $2 million. Although 42 percent of mainstream supermarkets carry organic products, only 10 percent of organic sales occur at supermarkets (OTA). Most organic purchases occur at co-ops, Mom & Pop grocery stores, and smaller nature food stores, which are not equipped with UPC scanners to capture organic data. Data used in this study only tabulate consumers who visit mainstream grocery stores to purchase conventional products and possibly

organic products. These data exclude devoted organic consumers who shop only at small nature food stores. The data would be improved if price and quantity statistics covered a larger percentage of the organic market.

As the production of organic food expands and prices decline, the market will continue to grow, moving organic food from a specialty crop towards a commodity. Organic food retailers have begun to educate their customers through signage and educational material, creating their own demand rather than just responding to market demand. Since more mainstream stores are carrying organic products, the consumers' cost of search time has decreased, increasing demand. The numbers of organic food producers as well as the number of outlets selling organics have begun a long-term expansion that will continue upwards. Decreasing the price premium and improving information and distribution are the keys to expanding the organic market and improving available data for future research.

REFERENCES

Brown, Mark G. "The Demand for Fruit Juices: Market Participation and Quantity Demanded." *Western Journal of Agricultural Economics,* 1986, 11(2), pp. 179-183.

Brown, Mark G. and Jong-Ying Lee. "Orange and Grapefruit Juice Demand Factors." *Food Demand Analysis: Implications for Future Consumption.* Blacksburg, Virginia: Virginia Polytechnical Institute and State University Press, 1986, pp. 215-227.

Byrne, Patrick, Ulrich C. Toensmeyer, Carl L. German and H. Reed Muller. "Analysis of Consumer Attitudes Towards Organic Produce and Purchase Likelihood." *Journal of Food Distribution Research*, June 1991, 22(2), pp. 49-62.

Byrne, Patrick, Ulrich C. Toensmeyer, Carl L. German and H. Reed Muller. "Evaluation of Consumer Attitudes Towards Organic Produce in Delaware and the Delmarva Region." *Journal of Food Distribution Research*, February 1992, 23(1), pp. 29-44.

Capps, Oral Capps, Jr. and Benjamin Senauer. *Food Demand Analysis: Implications for Future Consumption*. Blacksburg, Virginia: Virginia Polytechnical Institute and State University Press, 1986.

Capps, Oral Jr. and John D. Schmitz. "A Recognition of Health and Nutrition Factors in Food Demand Analysis." *Western Journal of Agricultural Economics*, 1992, 16(1), pp. 21-35.

Cluett, Julia S. "Organic Consumer Values Quality Over Price." *Natural Food Merchandiser,* September 1997, p. 62.

Companies and Their Brands. Detroit: Gale Research, 1998.

Council of Economic Advisors. *Economic Report of the President.* Washington, DC: US Government Printing Office, various annual issues.

Gallo, Carmine. "Healthy Goes Mainstream." http://cnnfn.com/hotstories/economy/9609/10/organic_pkg/index.htm, September 10, 1996.

Goldman, Barbara J. And Katherine L. Clancy. "A Survey of Organic Produce Purchases and Related Attitudes of Food Cooperative Shoppers." *American Journal of Alternative Agriculture,* 1991, 6(2), pp. 89-96.

Hennessy, Terry. "Organics: Banking on the Boomers." *Progressive Grocer,* July 1997 pp. 95-100.

Huang, Chung. "Consumer Preferences and Attitudes Towards Organically Grown Produce." *European Review of Agricultural Economics*, March 1995, pp. 331-342.

Huang, Kuo S. and Richard C. Haidacher. "Projecting Aggregate Food Expenditures to the Year 2000." in *Food Demand Analysis: Implications for Future Consumption.* . Blacksburg, Virginia: Virginia Polytechnical Institute and State University Press, August 1998, pp. 67-83.

Kennedy, Kevin. "As Organic Premiums Come Out of the Closet, Prices Will Come Down." *Natural Food Merchandiser,* February 1994, p. 30.

Community Alliance with Family Farmers. *National Organic Directory 1997.*

Putnam, Judith Jones and Jane E. Allshouse. *Food Consumption, Prices, and Expenditures, 1970-1995, SB-939.* Washington, DC: USDA, Economic Research Service, August 1997.

Organic Trade Association. *Retail Trends*.

Raunikar, Robert and Chung-Liang Huang. *Food Demand Analysis: Problems, Issues and Empirical Evidence*. Iowa State University Press, 1987.

SCANTRACK Market Planner User Guide for CD-Rom. Northbrook Illinois: Nielsen Marketing Research, 1991.

Studenmund, A.H. *Using Econometrics: A Practical Guide*. Reading, Massachusetts: Addison Wesley Longman, Inc., 1997.

The Directory of the Canning, Freezing, Preserving Industries 1996-97. Westminster, Maryland: Edward E. Judge & Sons, Inc, 1996.

Thomas Food Industry Register. New York: Thomas Publishing Company, 1998.

Thompson, Gary. "Consumer Demand for Organic Foods." Working Paper, Department of Agricultural & Resource Economics, University of Arizona, May 1998.

Vegetables and Specialties Situation and Outlook Report, VGS-274. Washington, D.C.: USDA, USDA Economic Research Service, April 1998.

Wilkens, Jennifer L. and Virginia N. Hillers. "Influences of Pesticide Residue and Environmental Concerns on Organic Food Preference among Food Cooperative Members and Non-Members in Washington State." *Journal of Nutrition Education,* Jan/Feb 1994, 26(1), pp. 26-33.

[1] Neilsen Marketing Research reported 40 known processors of frozen peas of which I was unable to contact eight and therefore unable to classify those products as organic or conventional. Excluded data for the eight processors not used in this study due to ambiguous classification represented 0.8 percent of total frozen pea production.