NATIONAL DEMAND FOR FRESH ORGANIC AND CONVENTIONAL VEGETABLES: SCANNER DATA EVIDENCE

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Selected Paper Prepared for Presentation at the American Association Agricultural Economics Annual Meeting, Long Beach, CA, July 23-26, 2006

Abstract

Using AC Nielsen scanner data on U.S. household consumption of selected fresh vegetables from 1999 to 2003, this study provides an overview of the organic fresh vegetable market by investigating market shares and price premiums of selected organic fresh vegetables and estimating the interrelationship between consumer demand for organic and conventional fresh vegetables. The linear Almost Ideal Demand System was found to fit the data best among other differential demand models.

Keywords: demand systems, scanner data, organic, fresh produce, price premium

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Introduction

Concerns over health and environment degradation have motivated US consumers to consume more organic produce in recent years. Sales of organic commodities in natural food stores approached $3.3 billion in 1998, compared with $2.08 billion in 1995. In response to the growing popularity of organic items, conventional supermarkets and mass market merchandisers have added shelf space for organic fruits and vegetables. In 2000, for the first time, more organic food was purchased in conventional supermarkets than in any other venue. In 2003, 47 percent of organic foods were sold through conventional channels, 44 percent were sold through natural food stores, and nine percent were sold through direct and other marketing channels, e.g., farmers' markets, restaurants, exports (Organic Trade Association, 2004). Organic foods are now taking market share from conventional foods.

To facilitate the marketing of organic foods, Congress passed the Organic Foods Production Act of 1990 to establish national standards for organically grown commodities. However, final rules for systematic implementation of national organic standards had not come into force until recently. In October 2002, the new USDA standards for organic food were implemented with an 18-month transition period. According to USDA standards, organic production is defined as "A production system that is managed in accordance with the Organic Foods Production Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity (National Organic Program, 2002)." The new USDA standards for

organic food, by standardizing organic production and building consumer confidence in organic products, are expected to facilitate further growth in the organic foods industry.

Although organic food sales make up a small portion of total food retail sales in the United States, some organic fruit and vegetable categories have higher market penetration rates than others. For example, in 2002 organic fresh fruit and vegetable sales accounted for 4.5 percent of total fresh fruit and vegetable sales (NBJ, 2003). *Natural Foods Merchandiser* reported that sales of packaged fresh produce had the highest growth rate among sales of all organic products during 2002-2003, expanding 26 percent to $364 million. Conventional supermarkets accounted for three-fourths of this total. The number of new organic produce items introduced in retail markets has more than doubled over a decade, from 14 in 1993 to 30 in 2003 (USDA, ERS, 2005). In addition, organic produce has the highest market value among all organic foods. Produce accounted for 42 percent of U.S. organic food sales in 2000, according to the market research firm Packaged Facts (Packaged Facts, 2000).

Even though the implementation of organic standards and increasing public awareness of organic food is helpful in promoting organic fresh produce sales, more affordable prices are also important for long-term growth of the organic produce market. Consumers are expected to purchase more organic produce as the price premium for organic produce is reduced. On the other hand, farmers expect a sufficient premium to warrant production of organic produce as organic production usually involves relatively high production costs. In the Organic Farming Research Foundation (OFRF)'s 2001 survey of organic farmers (Walz, 2004), 41 percent of respondents reported receiving price premiums on all items sold, and 71 percent received a premium on at least half of items sold. When asked about the circumstances that made it difficult to receive price

premiums, limited local demand for organic items in some areas (e.g., rural areas) and price competition from conventional items (e.g., corn and strawberries) were some often cited reasons.

An analysis of trends in price premiums and price elasticities of demand can provide insight into relative changes in supply and demand for organic products and a clearer sense of market maturity and the likelihood of further growth. Results of this research can be valuable for farmers and retailers of fresh produce. For farmers, if they know the price premiums of different varieties of fresh produce, they can allocate resources accordingly. For retailers, knowing target consumers and their response to price information can help in formulating more effective marketing strategies.

The main objective of this study is to shed light on trends within the fresh vegetable market and investigate consumer demand for fresh organic vegetables relative to conventional ones using AC Nielsen Homescan data. The paper is organized as follows. The first section encompasses a review of the relevant literature on organic produce demand. In the second section, we introduce how different demand models can be nested and tested within a general differential demand system framework. The formation of the time series data, organic shares and premiums, and trends are described in the third section. The fourth section presents the estimation results and discussion. The last section includes research implications.

Literature Review

The price premium of organic produce, the percent increase over conventional prices, is an important measure to assess the market growth potential of organic produce. A part of the price premium is compensation for higher production and distribution costs

on the supply side. The other part comes from the demand side, which reflects the additional amount consumers are willing to pay for organic produce.

Existing studies (Oberholtzer et. al., 2005; Sok and Glaser, 2001) on price premiums of organic produce, limited by data, mainly focused on the price premiums at the farmgate and wholesale levels using the average prices reported to regional trade associations (mainly Boston and San Francisco markets). Using wholesale prices in the Boston area during 2000 to 2001, Sok and Glaser (2001) found that the organic premium averaged 130 percent of the conventional prices for broccoli, 125 percent for carrots, and only 10 percent for mesclun. Oberhotzer (2005) recorded a similar pattern for these three organic produce items using 2000 to 2004 data. However, as Sok and Glaser (2001) pointed out, the conclusions do not necessarily reflect the entire industry as the price relationships between organic products reflect price movements of only three vegetables in one particular wholesale market. If and when more organic produce moves through terminal markets, the data may provide a better indication of industry trends. Since consumers are the final link in the marketing channel, knowing the trend of price premiums for the main organic produce items at the retail level can enable us to better understand the degree of maturity of the organic market.

To date, only a few studies have focused on the interrelationship between demand for organic food and conventional food. Using U.S. monthly supermarket AC Nielsen scanner data for the period from September 1990 to December 1996, Glaser and Thompson (1998) found own-price elasticities for selected frozen vegetables (broccoli, green beans, green peas, and sweet corn) range from -1.63 to -2.27, indicating that small changes in price elicit large changes in quantity purchased. Response to price change is two to three times as sensitive as for conventional counterparts. Despite large standard

errors, there appears to be a tendency toward asymmetry in cross-price responses: changes in organic quantity as conventional prices change are larger than changes in conventional quantity as organic prices change.

Using monthly data from 1988 to 1999, Thompson and Glaser (2001) studied the demand for organic and conventional baby food. Their results suggest that reductions in organic price elicit limited substitution away from conventional products. However, as market share grows over time, the substitution effect can be expected to increase. Any increase in conventional baby food prices tends to boost purchases of organic baby food by a relatively larger amount. Surprisingly, the expenditure elasticities for both organic and conventional baby food items calculated from their model displayed erratic variation from -4.78 to 5.44, but none of them were significantly different from zero.

In this study, we include several top fresh vegetables in Americans' diet in a demand system. The selected types take the lion's share of U.S. vegetable consumption. Weak separability of the demand for these fresh vegetables is assumed in our demand analysis. In addition, various functional forms of the demand system are compared and tested so that the most appropriate functional form is used to obtain reliable estimated elasticities for economic interpretation.

Differential Demand Systems

The Almost Ideal Demand System (Deaton and Muellbauer, 1980), the Rotterdam model (Barten, 1964; Theil, 1965), and their variants are probably the most commonly used functional forms in empirical demand analysis. The Rotterdam model is derived from a first-order approximation to arbitrary Marshallian demand functions. The Almost Ideal Demand System (AIDS) in its original formulation is derived from the

maximization of an explicit indirect utility function or, equivalently, from the minimization of an explicit expenditure/cost function of price independent generalized logarithmic (PIGLOG) form. Since these functional forms cannot be nested within their original formulations, it is impossible to test one against the other. Therefore, in most demand analyses, it is often a practical matter for researchers to choose a specific functional form. Using a differential form of the linear AIDS model, Barten (1993) showed that the linear AIDS model, the Rotterdam model, and their variants can actually be nested in a general differential model which can be used to test the fit of different models.

The Rotterdam model, developed by Barten (1964) and Theil (1965), takes the following differential form:

(1) $$w_i \mathrm{d}\log q_i = \theta_i \mathrm{d}\log Q + \sum_j \pi_{ij} \mathrm{d}\log p_i$$
$$i = 1, 2, \ldots, n,$$

where $w_i = (w_{it} + w_{i,t-1})/2$ represents the average expenditure share for commodity i with subscript t standing for time; $\mathrm{d}\log q_i = \log(q_{it}/q_{i,t-1})$ is the log change in the consumption level for commodity i; and $\mathrm{d}\log p_i = \log(p_{it}/p_{i,t-1})$ is the log change in the price for commodity i. The term $\mathrm{d}\log Q$ is an index number (Divisia volume index) for the change in real income and can be written as

(2) $$\mathrm{d}\log Q = \sum_i w_i \mathrm{d}\log q_i \,.$$

The time subscripts implied by the equations are omitted for convenience. The demand parameters θ_i and π_{ij} are given by

(3) $$\theta_i = p_i(\partial q_i/\partial y), \qquad \pi_{ij} = (p_i p_j/y)s_{ij}, \text{ and } s_{ij} = \partial q_i/\partial p_j + q_j \partial q_i/\partial y,$$

where y is the total outlay or the budget and s_{ij} is the (i, j)th element of the Slutsky substitution matrix, parameter θ_i is the marginal budget share of commodity i, and π_{ij} is a compensated price effect. The constraints of demand theory can be directly applied to the Rotterdam parameters. In particular, we have

(4) Adding-up $\sum_i \theta_i = 1, \ \sum_i \pi_{ij} = 0,$

(5) Homogeneity $\sum_j \pi_{ij} = 0,$

(6) Slutsky Symmetry $\pi_{ij} = \pi_{ji}.$

The Rotterdam model is a particular parameterization of a system of differential demand equations where demand parameters θ_i's and π_{ij}'s are assumed to be constant. However, there is no strong a priori reason that the θ_i's and π_{ij}'s should be held constant. By relaxing the marginal budget share parameter to be variable, Keller and van Driel (1985) further proposed the CBS (Central Bureau of Statistics) model:

(7) $w_i \mathrm{d}\log q_i = (\beta_i + w_i)\mathrm{d}\log Q + \sum_j \pi_{ij} \mathrm{d}\log p_i,$

where β_i and π_{ij} are constant coefficients and $\beta_i + w_i$ is the marginal budget share.

Different from the Rotterdam model, the original AIDS model, in its original formulation, is not a differential function. It is specified as

(8) $w_i = \alpha_i + \sum_j \gamma_{ij} \log p_i + \beta_i \log(y / P),$

where P is a price index defined by

(9) $\log P = \alpha_0 + \sum \alpha_k \log p_k + 1/2 \sum_k \sum_l \log p_k \log p_l .$

The adding-up restriction requires that $\sum_i \alpha_i = 1$, $\sum_i \beta_i = 0$, and $\sum_i \gamma_{ij} = 0$; homogeneity is satisfied when $\sum_i \gamma_{ji} = 0$; and symmetry is satisfied if $\gamma_{ij} = \gamma_{ji}$.

The differential form of equation (8), based on Deaton and Muellbauer's suggestion of substituting the Divisia Price index $\sum_i w_i d\log p_i = 0$ for $d\log P$, is

(10) $dw_i = \beta_i \log Q + \sum_j \gamma_{ij} d\log p_i$ or

(10a) $w_i d\log q_i = (\beta_i + w_i) d\log Q + \sum_j [\gamma_{ij} - w_i(\delta_{ij} - w_j)] d\log p_i$,

where δ_{ij} is the Kronecker delta equal to unity if $i = j$ and zero otherwise (Barten, 1993). To derive (10a) from (10), one can use the relations

$dw_i = w_i(d\log p_i + d\log q_i - d\log y)$ and $d\log y = d\log P + d\log Q$.

A fourth alternative, the National Bureau of Research (NBR) model (Neves, 1987), can be derived by substituting $\theta_i - w_i$ for β_i in (10a) so that it has the Rotterdam income coefficients but the AIDS price coefficients. Specifically, the NBR is

(11) $dw_i + w_i d\log Q = \theta_i \log Q + \sum_j \gamma_{ij} d\log p_i$.

Similarly, equation (11) can be rewritten as

(11a) $w_i d\log q_i = \theta_i d\log Q + \sum_j [\gamma_{ij} - w_i(\delta_{ij} - w_j)] d\log p_i$.

The four models [equation (1), (7), (10a), and (11a)] have the same left-hand side variable $w_i d\log q_i$ and right-hand side variables $d\log Q$ and $d\log p_i$. These models can be considered as four different ways to parameterize a general model. Marginal budget shares are assumed to be constant (i.e., θ_i) in the Rotterdam and NBR model but variable (i.e., $\beta_i + w_i$) in the AIDS and CBS. The Slutsky terms are considered to be constants (i.e., π_{ij}) in the Rotterdam and CBS and variables [i.e., $\gamma_{ij} - w_i(\delta_{ij} - w_j)$] in the AIDS and NBR. The CBS and NBR can be considered as income-response variants of the Rotterdam and AIDS, respectively.

These four models are not nested, but following Barten (1993), a general demand system can be developed which nests all four. The general system is

(12) $w_i d\log q_i = (d_i + \delta_1 w_i) d\log Q + \sum_j [e_{ij} - \delta_2 w_i (\delta_{ij} - w_j)] d\log p_i$, $i = 1,2,...,n$,

where $d_i = \delta_1 \beta_i + (1-\delta_1)\theta_i$ and $e_{ij} = \delta_2 \gamma_{ij} + (1-\delta_2)\pi_{ij}$; δ_1 and δ_2 are two additional parameters to be estimated. Note that (12) becomes the Rotterdam when both δ_1 and δ_2 are restricted to be zero, the CBS when $\delta_1 = 1$ and $\delta_2 = 0$, the AIDS when $\delta_1 = 1$ and $\delta_2 = 1$, and NBR when $\delta_1 = 0$ and $\delta_2 = 1$. The demand restrictions on (12) are

(13) Adding-up $\sum_i d_i = 1 - \delta_1$, $\sum_i e_{ij} = 0$,

Homogeneity $\sum_j e_{ij} = 0$ and

Slutsky Symmetry $e_{ij} = e_{ji}$.

For application to discrete data, the specifications are approximated by replacing w_{it} by $(w_{it} + w_{it-1})/2$, $d\log q_{it}$ by $\log(q_{it}/q_{it-1})$ and $d\log p_{it}$ by $\log(p_{it}/p_{it-1})$, where subscript t indicates time. Since the four models have the same set of parameters and can be nested in the general demand system as four special cases, the magnitude of the maximum likelihood value can be used as a criterion to evaluate the goodness of fit of each nested model and the likelihood ratio test (LRT) can be used for model selection.

Data and Trends

Consumption data for organic and conventional fresh vegetables were drawn from AC Neilson Homescan panel data from 1999 to 2003. The panel is nationally representative of U.S. households and provides food purchase data for at-home consumption. Each week, a panel household scanned either the Uniform Product Code

(UPC) or a designated code (for random weight) for all of their purchases at all retail outlets. The data include detailed product characteristics, quantity, expenditures, and promotion information as well as household income and demographic information. We included only those households which reported purchases for at least 10 months in a year. There were between 7,124 and 8,833 households on the consumer panel for each respective year during the five-year period. To study the trend in organic consumption and make consumption data comparable, we kept only 2,845 households who stayed on the panel for all five years. Consumption data for these 2,845 households were aggregated weekly to give 260 time-series observations. .

Four popular vegetables in consumers' diet, potatoes, tomatoes, onions, and lettuce, are considered in the study. Classified into organic and conventional, eight items in total are included in the demand system. Among these vegetables, tomatoes and lettuce are among the top organic vegetables purchased by U.S. consumers. According to a Fresh Trends 2002 survey, tomatoes (37% of the respondents) and leafy vegetables (18%, mostly lettuce) are the two most popular organic vegetables purchased (June – December, 2001) (Shaffer, 2002).

The new USDA standards for organic food were implemented in October 2002, so packaged organic vegetables with UPC codes in AC Neilson data for 2002 and after are explicitly labeled either with "organic seal" (USDA certified organic) or "organic claim" (producer-claimed organic). In this study, vegetables with either one of the two organic labels were regarded as organic. Organic vegetables sold in random weights were identified by examining their names, which are provided in the data.

The budget shares and premiums of the selected vegetables for the selected households are shown in Figure 1. Although the organic fresh produce market is growing

fast, the share of organic vegetables in consumer vegetable expenditures is still low compared with those of conventional counterparts. Among the four vegetables, lettuce has the highest organic share which accounts for 3.76% of total lettuce sales on average during the five-year period. Tomatoes are in second place with 3.74% of tomato consumption devoted to organic. Organic onions and potatoes hold 1.50% and 1.10% of their respective markets when measured in value terms. Growth patterns of the selected organic vegetables, lettuce and tomato in particular, are also divergent during the years from 1999 to 2003. The organic share of lettuce went up steadily, while that of tomatoes decreased from 4.5% to 3.2%. There was not much change in organic share for onions and potatoes. For the overall organic share of consumer expenditure on these four vegetables, the pattern suggests that after a slight decline in the first four years, it began to pick up in 2003.

Organic premiums vary by vegetable. The largest organic premium was found for potatoes, with organic prices about 75% higher than conventional potatoes and the premium rising during these five years. The same pattern was found for onions with organic premium rising to 34% in 2003 from 11% in 1999. In contrast, for lettuce and tomatoes which have relatively higher organic market penetration, the organic premium appears to have declined for lettuce (from 36% to 26%) and remained unchanged for tomatoes (around 13%).

Estimation Results

As a result of the adding-up conditions, the full $n \times n$ matrices of all five demand systems are singular by construction (n is the number of goods). Therefore, the five demand systems were estimated by dropping the last equation, the equation for

conventional lettuce. The parameter estimates are invariant to which equation is omitted. As the 2,845 consumers appearing in all five years are price takers in the market, prices in the demand system can be treated as exogenous. The models were estimated by the maximum likelihood method with homogeneity and symmetry conditions imposed.

The maximum likelihood values of the five demand systems are reported in Table 1. The general demand system, of course, has the highest maximum likelihood value because the two parameters, δ_1 and δ_2 are unrestricted. It has a statistically better fit to the data than any one of nested models. Among four nested demand systems, the linear AIDS model is found to have the highest maximum likelihood value. Because the four nested systems have the same set of parameters, the linear AIDS model, with the highest maximum likelihood value, is found to fit the data better than the Rotterdam, CBS and NBR models and thus selected as the best one among four nested models. Only results based on the linear AIDS model are reported and discussed in this section.

Elasticities

The income elasticity and compensated price elasticity of the linear AIDS were computed as follows:

(24) Income elasticity: $\eta_i = \theta_i / w_i$ or $\eta_i = 1 + \beta_i / w_i$,

(25) Compensated price elasticity: $\eta_{ij} = \pi_{ij} / w_i$ or $\eta_{ij} = \gamma_{ij} / w_i - \delta_{ij} + w_j$.

Since both expenditure and compensated price elasticities are functions of budget shares, they were computed at the sample means. The results are presented in Table 2

All income elasticities except that for organic lettuce are positive and significant at the 10 percent significance level. It is interesting to note that, the income elasticities of all organic vegetables are higher than those of their conventional counterparts which

implies that given an increase in the budget share on the four selected fresh vegetables, consumers will allocate a higher share of the budget to organic than to conventional vegetables. All own-price elasticities are negative and statistically significant. It is interesting to note that the magnitudes of own-price elasticities for the organic vegetables are not always higher than those for conventional ones. For potatoes and tomatoes, own-price elasticities of organic types are found to be higher than those for conventional types in magnitude, whereas the opposite is found for onions and lettuce. The only commodity with an elastic own-price effect is organic potatoes. All other own-price elasticities are less than one in magnitude, implying inelastic consumption with respective to own-price change. The result contrasts with that for frozen vegetables reported by Glaser and Thompson (1998) who found responsive own-price elasticities for all four frozen vegetables, broccoli, corn, green peas, and green beans. One should note that in Glaser and Thompson (1998) study, demand for organic and conventional frozen vegetables was estimated with a three-good system (organic, conventional, and all else) for each vegetable, which probably masks the substitution effect of other vegetables and a substantial left-out group, fresh vegetables.

Among all cross-price elasticities between organic and conventional vegetables, only organic and conventional potatoes have a significant substitution relationship. Positive and significant cross-price elasticities imply that decreasing organic price premiums are likely to boost consumption of organic vegetables. The difference in magnitude also suggests asymmetry in the substitution effect, implying that changes in the price of conventional potatoes tend to have a larger impact on consumption of organic potatoes than vise versa. This is consistent with findings of Glaser and Thompson (1998) and Thompson and Glaser (2001). Because the cross-price elasticities (η_{ij}) are computed

as $\gamma_{ij} / w_i + w_j$ and γ_{ij} are symmetric, the asymmetry in cross-price elasticities between organic and conventional groups is not surprising given such contrasting differences in budget shares of the organic and conventional vegetables.

Positive cross-price elasticities are also found between organic and conventional onions, though they are not statistically significant. For tomatoes and broccoli, the cross-price elasticities are negative but not significantly different from zero. The cross-price elasticities between demands for organic and conventional fresh vegetables seem to suggest that demand for organic vegetables is not responsive to price changes in conventional vegetables except for some items with very low organic shares and high price premiums, such as potatoes.

Conclusion

Using AC Nielsen scanner data on selected fresh vegetable sales from 1999 to 2003, this study analyzes consumption patterns and price premiums for organic fresh vegetables and selects the best model to investigate the interrelationship between consumption of organic and conventional fresh vegetables.

The general differential demand system which nests the linear AIDS, the Rotterdam model, and their variants can be very useful in selecting the best model. It can avoid the bias of the parameter and elasticity estimates resulting from a suboptimal model. In this study, linear AIDS model was found to fit the fresh vegetable consumption data the best among four nested models.

The results of the analysis have several implications for producers and retailers of fresh organic produce. Differences in organic premiums among alternative fresh vegetables are quite marked, with the highest relative organic premium (potatoes) more

than five times higher than the that for lowest one (tomatoes). If the difference cannot be fully explained by the difference in production cost for organic farming versus conventional farming, producers may be able to increase profit by allocating more resources to organic vegetables with higher profit margins.

Income elasticities for organic vegetables are found to be higher than those for conventional vegetables for all four vegetables included in the model, which suggests that if U.S. consumers were to increase expenditures on fresh vegetables, they would spend a larger portion of their budget on organic vegetables. With the exception of potatoes, all other vegetables are found to have inelastic own-price effects and cross-price effects between organic and conventional vegetables, implying that a drop in the organic premium does not necessarily guarantee an increase in total organic revenues.

Most organic vegetables are about 10 to 30 percent higher in prices than conventional counterparts except for some newly introduced organic vegetables with relatively thin market shares and high premiums. The room for price promotion of these organic vegetables is limited. Considering the fact that the fresh organic produce market is still thin (the highest organic share is less than 4% among the four vegetables in the study) but becoming more standardized and accessible to the public, we can expect that the market for organic fresh vegetables will continue to grow in the foreseeable future while the organic premiums are not likely to drop much.

Acknowledgement

Research for this paper was supported by USDA-ERS Cooperative Agreement 43-3AEM-5-80043. The views in this paper are those of the authors and do not necessarily reflect the views or policies of the US Department of Agriculture.

Reference

Barten, A. P. "Family Composition, Prices, and Expenditure Pattern." In Econometric Analysis for National Economic Planning. P. E. Hart, G. Mills, and J. K. Whitaker, eds., London: Butterworth, 1964.

Barten, A. P. "Consumer Allocation Models: Choice of Functional Form." *Empirical Economics*. 18(1993):129-158.

Deaton, A., and Muellbauer, J. *Economics and Consumer Behavior*. Cambridge: Cambridge University Press, 1980

Glaser, L. K. and G. D. Thompson. "Demand for Organic and Conventional Beverage Milk." Paper presented at the Western Agricultural Economics Association annual meeting, held June 29 – July 1, 2000.

Glaser, L. K. and G. D. Thompson. "Demand for Organic and Conventional Frozen Vegetables." Paper presented at the Annual Meeting of American Agricultural Economics Association, Nashville, Tennessee, held Aug. 8-11, 1998.

Keller, W. J., and J. van Driel. "Differential Consumer Demand Systems." *European Economic Review* 27 (1985): 357-390.

Nutrition Business Journal (NBJ). The NBJ/SPINS Organic Foods Report 2003. Penton Media, Inc. Cleveland, OH.

Neves, P. "Analysis of consumer Demand in Portugal, 1958-1981." Memoire de maitrise en sciences economiques, Universite Catholique de Louvain, Louvain-la-Neuve, 1987.

Oberholtzer L., C. Dimitri, and C. Greene, "Price Premiums Hold on as U.S. Organic Produce market Expands.", U.S. Department of Agriculture, Economic Research

Service (USDA, ERS). Outlook Report No. (VGS30801) 22 pp, May 2005 http://www.ers.usda.gov/Publications/vgs/may05/VGS30801/

Organic Trade Association (OTA). *The OTA 2004 Manufacturers' Survey Review* 2004

Packaged Facts. *The U.S. Organic Food Market*. 2000

Shaffer, E. "Organic Produce Sales Climb." *Fresh Trends* 2002: 33-35.

Sok. E., and L. Glaser. "Tracking Wholesale Prices for Organic Produce." *Agricultural Outlook.* U.S. Department of Agriculture, Economic Research Service, October 2001, available at www.ers.usda.gov/publications/agoutlook/oct2001/ao285d.pdf

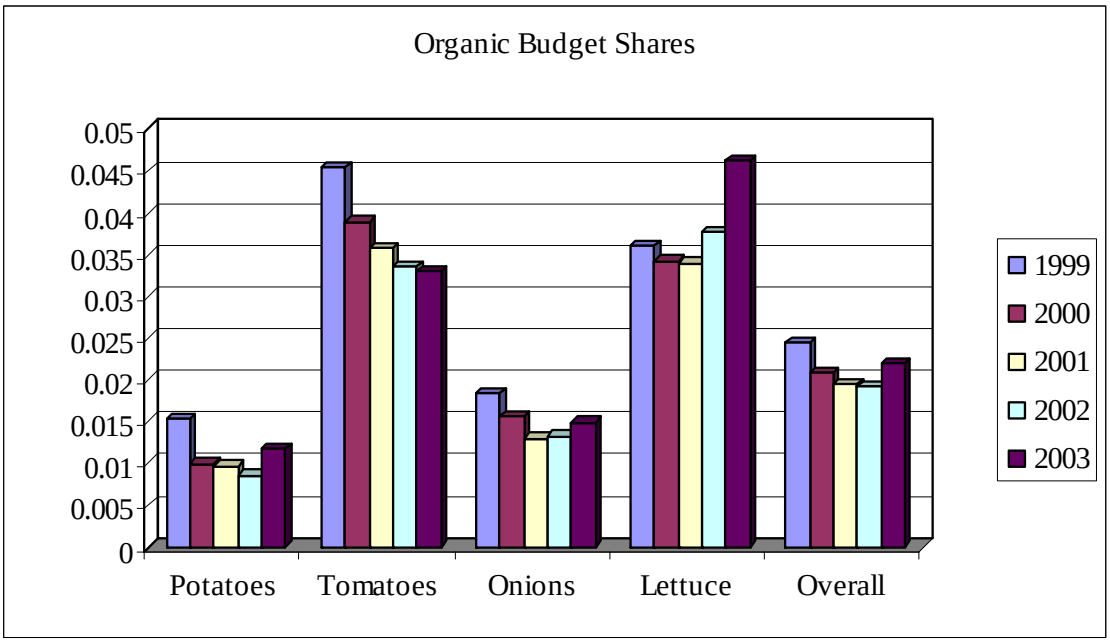
Theil, H. "The Information Approach to Demand Analysis." *Econometrica* 33 (1965): 67-87.

Thompson, G. D. and L. K. Glaser. "National Demand for Organic and Conventional Baby Food." Paper presented at the Western Agricultural Economics Association annual meeting, held July 9 – July 11, 2001.

U.S. Department of Agriculture, Economic Research Service (USDA, ERS). *U.S. Market Profile for Organic Food Products,* February 2005. Washington DC.

Walz, E. "Final Results of the Fourth National Organic Farmers' Survey: Sustaining Organic Farms in a Changing Organic Marketplaces." Organic Farming Research Foundation, 2004. www.ofrf.org/publications/survey/index.html

Figure 1. Organic Budget Shares and Premiums of the Selected Vegetables for 1999-2003



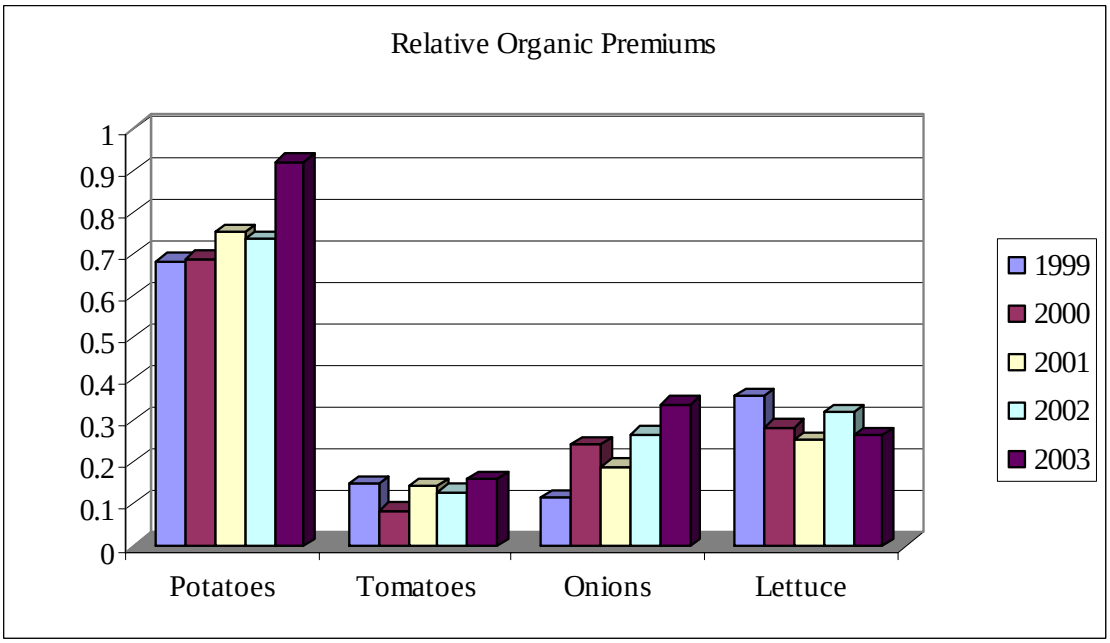


Table 1. Test Results for the Rotterdam Model, CBS, LA/AIDS, NBR and General Model

Model	Restrictions	Log Likelihood	$-2[L(\theta^*) - L(\theta)]$ [a]
General Model	no	6224	
Rotterdam	$\delta_1 = 0$, $\delta_2 = 0$	6165	118
CBS	$\delta_1 = 1$, $\delta_2 = 0$	6190	68
Linear AIDS	$\delta_1 = 1$, $\delta_2 = 1$	6212	24
NRR	$\delta_1 = 0$, $\delta_2 = 1$	6186	76

[a] $L(\theta^*)$ and $L(\theta)$ are restricted and unrestricted maximum likelihood values, respectively.

The table value for $\chi^2_{(2)} = 5.99$ at α =0.05 level.

Table 2. Compensated Price Elasticities and Income Elasticities Evaluated at Means of Budget Shares (LA-AIDS model) for Both Organic and Conventional Vegetables

Commodity Group		Compensated Price Elasticities								Income Elasticities
		Potatoes		Tomatoes		Onions		Lettuce		
		Organic	Conventional	Organic	Conventional	Organic	Conventional	Organic	Conventional	
Potatoes	Organic	-1.1136**	1.8686*	-0.3195	-1.8101**	0.0857	1.1026*	0.0135	0.1727	2.2619*
	Conventional	0.0211*	-0.5871**	0.0280	0.1841**	0.0041	0.1389**	0.0089	0.2021**	1.7653**
Tomatoes	Organic	-0.1015	0.7883	-0.7250**	-0.4872	-0.0922*	-0.0782	0.1006	0.5953	0.6153*
	Conventional	-0.0235**	0.2120**	-0.0199	-0.2726**	-0.0040	0.0064	0.0243**	0.0774	0.4744**
Onions	Organic	0.1258	0.5309	-0.4260*	-0.4483	-0.5312**	0.6886	-0.0032	0.0632	1.4787**
	Conventional	0.0269*	0.3007**	-0.0060	0.0120	0.0115	-0.6223**	-0.0439**	0.3212**	0.9808**
Lettuce	Organic	0.0073	0.4243	0.1709	1.0100**	-0.0012	-0.9716**	-0.5893**	-0.0505	0.4592
	Conventional	0.0036	0.3738**	0.0391	0.1244	0.0009	0.2744**	-0.0020	-0.8141**	0.4584**

Single and double asterisks indicates statistical significance level at 10% and 5%, respectively.