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## **Potential Impact of Agro-terrorism Perceptions on Demand for Locally Grown Products**

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## **Abstract**

The economics of agroterrorism has not been fully developed within the economics literature, yet with increasing concerns about agroterrorism it is important to understand how consumers will generally respond. This paper presents an overview of food safety issues, and develops an economical model that can be used to illustrate and establish hypotheses regarding consumer behavior and agroterrorism. We then present sample and econometric results from a survey of 304 New Jersey consumers and explain the characteristics of the 33% that confirmed that they have increased purchases of locally grown produce due to terrorism fears.

# Potential Impact of Agro-terrorism Perceptions on Demand for Locally Grown Products

## 1. Introduction

Agroterrorism refers to the instance of bioterrorism against the agricultural and food system. On December 27<sup>th</sup>, 2001 a taped message from Osama bin Laden stated “*It is very important to concentrate on hitting the American economy with every available tool...the economy is the base of its military power...The United States has a great economy but it is fragile*” (Derrickson and Brown, 2002). The agricultural economy is vulnerable to economic sabotage and because of its low elasticity may be more fragile than other segments of the economy. Food security as a national objective is put into jeopardy if any part of the food system is targeted. Derrickson and Brown (2002) report the definition of food security by the Life Science and Research Office of American Societies of Experimental Biology as “*the assured ability to acquire, safe, nutritious, socially, and culturally-acceptable foods*” with the key phrase being the use of the term “safe”. Likewise they define food insecurity “*whenever the availability of nutritionally adequate and safe foods or the ability to acquire foods in socially acceptable ways is limited or uncertain*”. Keenan et al (2001) provide a similar definition while others argue that food security should also include as part of its definition or understanding natural and unnatural threats to the food system including agro or bioterrorism (Dilley and Boudreau, 2001).

With increased public, political, and media attention on terrorist activities there are open questions on how consumers respond to the threat of terrorism. This paper seeks to determine whether the threat of terrorism could change consumer attitudes and

purchasing behavior for locally grown food. It is well known that uncertainty about food safety can impact consumer choices. Important elements to understanding this problem are risk perceptions. Bocker and Hanf (2000) have explored this idea in the context of food safety. They note that after a food scare demand drops, but then slowly builds as probabilistic assessments of food safety from the supplier increases. The mechanism is through reassurance, but Liu et al (1998) have found that reassurance may not cause full restoration. In other words, simply removing the source of uncertainty is not sufficient to regain consumer confidence and a return to initial demand. This may be because food safety has a strong credence component due to the ambiguous causality between eating a food product and getting sick (Caswell and Mojduska, 1996). A consequence of credence is that individuals need more than personal experience to judge the safety of a food item, and rely on third party information (e.g. the supplier) to regain trust and reduce uncertainty (Bocker and Hanf, 2000). For example, Henson and Northen (1998) show that German respondents to a survey indicated that they would look at country of origin in order to qualify food safety. While not specifically targeted towards food safety and agroterrorism the literature on food safety provides guidance in two related parameters. First, consumers generally respond to food safety scares by reducing demand; second, consumers resist purchasing food even if prices fall; third, a threat to food safety persists, even after the adverse event has been resolved; and fourth public policy should be directed at communicating risks to consumers so they can make informed choices.

In an economic system it is not unreasonable for consumers to shift consumption away from what are perceived as high consumption risks to lower consumption risks,

even if that comes at a higher cost. A simple version of this proposition can be seen by defining the Marshallian demand (Turvey et al. 2003)

$$(1) \quad X = A^{(1-\alpha\theta)} P^{(\varepsilon-\beta\theta)} Y^\gamma$$

Where A is the intercept; P is the product price,  $\varepsilon$  its elasticity; Y is consumer income and  $\gamma$  its income elasticity. The variable  $\theta$  represents food safety, with  $\theta=0$  representing pure safety, and  $\theta>0$  representing increasing hazard. The parameters  $\alpha$  and  $\beta$  represent risk perceptions and attitudes towards risk. In the presence of uncertainty (a rise in  $\theta$ ) the weight or credence that one puts on  $\theta$  can have two simultaneous effects. The first is a shift in the demand curve (via  $\alpha$ ) and the second is a twist in the demand curve (via  $\beta$ ), making it more inelastic. The net effect, given by  $dx/d\theta$  theta, is

$$(2) \quad \frac{dX}{d\theta} = -X (\alpha \ln(A) + \beta \ln(P))$$

Which is negative. We can now consider two identical goods in the market. One is a locally grown or produced food which is considered safe  $X_1(P, Y, \theta_1)$  and the other, an imported food  $X_2(P, Y, \theta_2)$  is identical in all respects except that  $\theta_2 > \theta_1$ . We can then state that  $X_1 > X_2$ , or in words, the demand for locally grown food which is perceived to be safer will increase relative to imports.<sup>1</sup>

We investigate this proposition using results from a mail survey of New Jersey consumers. In November 2003 1000 surveys were mailed to randomly selected NJ consumers. Each survey included a cover letter and a written survey. Pretests on the survey indicated that it would take about 15 minutes to complete the survey. To provide

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<sup>1</sup> This should be viewed in the short run. As demand for safer food increase its price will rise making it less attractive, while the demand for less save food falls making it more attractive. But the result should hold under a new equilibrium.

incentive, a dollar bill was included in each mailing. A follow up letter was sent after 15 days and by January 2004, 321 usable surveys for a response rate of 32% were returned.

## **2. Survey Summary**

Respondents were specifically asked if the threat of terrorism increased their preference for locally grown food defined as fresh fruits and vegetables marketed under the state-sponsored Jersey Fresh label. Of the 304 responses, 104 (34%) indicated that the threat of agroterrorism increased their preference for locally grown food. Table 1 shows the frequency of responses by household size. The results show that 40% or more single households and households of 4 or 5 members are most likely to purchase locally grown food. Smaller households of size 2 or less are least likely to respond. More females (191) responded to the survey than males (131) and the results indicate that women are more likely to respond to terrorism (36%) than males (30%). Respondents showed an increasing preference for locally grown food with age. Only 21.5% of respondents below the age of 35 indicated a preference, whereas 37% of those between 51 and 65 years, and 45% of those above 65% showed a preference. Results also showed that education affects choices; increasing education decreases the preference for locally grown food. For example 39% of respondents with only high school revealed a preference while only 19% of those with postgraduate education showed a preference. Occupation revealed mixed preferences. The largest defined group was retired persons with a frequency of 46%. In addition, 35% of homemakers, 33% of self-employed and 27% of those employed by others showed a preference towards locally grown food. Interestingly, the preference for locally grown food decreased with increasing income. Respondents with less than \$20,000 in income were most likely to purchase locally

grown food (44%), about 31% of those earning between \$60,000 and \$99,000, showed preference, while only 23% of those earning more than \$100,000 showed a preference. The relationship between marital status and preference was mixed. Widowed persons represented the largest group with 52% revealing preference. Married (34%) or separated (33%) persons showed similar preferences, as did single (23%) or divorced (27%) persons.

**Table 1: Descriptive Tabulation of Explanatory Variables**

<b>Variable</b>		<b>Frequency</b>	<b>Percent/ Mean</b>	<b>Std. Dev</b>
Those who definitively consider changing their usual shopping market to be able to purchase Jersey Fresh				
CHANGESHOP	YES	63	19.63	0.40
	NO	258	80.37	0.40
Those who shop more than once a week for fresh produce during the summer				
SHOPWEEK	YES	114	35.51	0.48
	NO	207	64.49	0.48
Those who shop based on the availability and quality of fresh produce				
SHOPQUALITY	YES	251	79.68	0.41
	NO	64	20.32	0.41
Those who always check ingredient label on food when purchasing				
FOODLABEL	YES	72	22.43	0.42
	NO	249	77.57	0.42
Those who plan before shopping fresh produce				
PLANSHOP	YES	237	25.47	0.44
	NO	81	74.53	0.44
Those who regularly read food advertisements in newspaper/ grocery-brochures				
BROCHURE	YES	230	72.56	0.45
	NO	87	27.44	0.45

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<b>Variable</b>		<b>Frequency</b>	<b>Percent/ Mean</b>	<b>Std. Dev</b>
Those who buy certified organic produce				
BUYORGANIC	YES	226	74.83	0.44
	NO	76	25.17	0.44
Those who heard about Integrated Pest Management (IPM)				
HEARDIPM	YES	32	10.67	0.31
	NO	268	89.33	0.31
Those who spend (average) on produce in a month				
SPENDPRODUCE		238	70.17	65.27
Those who live in urban area				
URBAN	YES	38	11.84	0.32
	NO	283	88.16	0.32
Those who live in New Jersey (average years)				
YEARSINNJ		312	37.00	21.77
Those who have a garden at home				
HOMEGARDEN	YES	145	46.33	0.50
	NO	168	53.67	0.50
Number of persons below age 17 in your household				
BELOWAGE17		304	0.66	1.04
Gender by Male/Female				
GENDER	Male	116	37.18	0.48
	Female	196	62.82	0.48
Age between 51 and 65				
AGE51TO65	YES	84	26.17	0.44
	NO	237	73.83	0.44
Education with Post-graduation				
POSTGRADUATE	YES	59	18.38	0.39
	NO	262	81.62	0.39
Ethnicity				
ETHNIC	WHITE	259	80.69	0.40
	OTHER	62	19.31	0.40
Annual Average income \$100,000 or more				
INCOME100K	YES	87	27.10	0.46
	NO	234	72.90	0.46

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### 3. Econometric Model and Variable Definitions

Our survey included a range of questions dealing with consumer purchasing behaviour of produce in NJ. The previous section discussed some of the attributes of individual consumers that could show a preference for locally grown food, however the results do not quantify how a preference for locally grown food correlates with demographic variables under an agroterrorism scenario. In this section we present the results of a Logit regression. The model assumes that the probability of purchasing locally grown foods as a response to agroterrorism ( $P_i$ ) depends upon a vector of independent socio-demographic and behavioral variables ( $X_{ij}$ ) associated with consumer  $i$  and variable  $j$ , and a vector of unknown parameters  $\beta$ . More specifically the Logit model can be represented as:

$$P_i = F(Z_i) = \frac{1}{1 + \exp(-Z_i)}$$

Where:

$P_i$  = the probability of purchasing locally grown foods as a response to the threat of agriterrorism depend upon a vector of independent variables  $X_{ij}$ s

$F(Z_i)$  = represents the value of the standard logistic density function associated with each possible value of the underlying index  $Z_i$ .

$Z_i$  = the underlying index number or  $\alpha + \beta X_{ij}$

And  $\beta X_{ij}$  is a linear combination of independent variables so that:

$$Z_i = \log [P_i / (1 - P_i)] = \beta_{i0} + \beta_{i1}X_{i1} + \beta_{i2}X_{i2} + \dots + \beta_{in}X_{in} + \epsilon_i$$

Where:

$i$  = 1, 2, . . . , n are observations

$Z_i$  = the unobserved index level or the log odds of choice for the  $i^{\text{th}}$  observation

$X_{in}$  = the  $n^{\text{th}}$  explanatory variable for the  $i^{\text{th}}$  observation

$\beta$  = the parameters to be estimated

$\varepsilon$  = the error or disturbance term

The model can be specified as:

$$\begin{aligned} \text{AGRITERROR} = & \beta_0 + \beta_1 \text{CHANGESHOP} + \beta_2 \text{SHOPWEEK} + \beta_3 \text{SHOPQUALITY} + \\ & \beta_4 \text{FOODLABEL} + \beta_5 \text{PLANSHOP} + \beta_6 \text{BROCHURE} + \\ & \beta_7 \text{BUYORGANIC} + \beta_8 \text{HEARDIPM} + \beta_9 \text{SPENDPRODUCE} + \\ & \beta_{10} \text{URBAN} + \beta_{11} \text{YEARSINNJ} + \beta_{12} \text{HOMEGARDEN} + \\ & \beta_{13} \text{BELOWAGE17} + \beta_{14} \text{GENDER} + \beta_{15} \text{AGE1TO65} + \\ & \beta_{16} \text{POSTGRADUATE} + \beta_{17} \text{ETHNIC} + \beta_{18} \text{INCOME100K} \end{aligned}$$

Where:

**AGRITERROR** =1 if the respondent prefers locally grown foods due to the increased threats of domestic terrorism and 0 otherwise.

**CHANGESHOP** =1 if the respondent definitely consider changing their usual shopping market to be able to purchase fresh produce and 0 otherwise.

**SHOPWEEK** =1 if the respondent shops more than once a week for fresh produce during the summer and 0 otherwise.

**SHOPQUALITY** =1 if the respondent shops based on the availability and quality of fresh produce and 0 otherwise.

**FOODLABEL** =1 if the respondent always checks ingredient label on food when purchasing and 0 otherwise.

**PLANSHOP** =1 if the respondent plans before shopping fresh produce and 0 otherwise.

**BROCHURE** =1 if the respondent regularly reads food advertisements in newspaper/grocery-brochures and 0 otherwise.

**BUYORGANIC** =1 if the respondent buy certified organic produce and 0 otherwise.

**HEARDIPM** =1 if the respondent heard about Integrated Pest Management (IPM) and 0 otherwise.

**SPENDPRODUCE** =respondent's expenditure on produce per month.

URBAN	=1 if the respondent lives in urban area and 0 otherwise.
YEARSINNJ	=respondent lives in New Jersey (average years).
HOMEGARDEN	=1 if the respondent has a garden at home and 0 otherwise.
BELOWAGE17	=number of person's (average) below age 17 in the household.
GENDER	=1 if the respondent is a female and 0 if the respondent is a male.
AGE51TO65	=1 if the respondent's Age between 51 to 65 and 0 otherwise.
POSTGRADUATE	=1 if the respondent's Education with Post-graduation and 0 otherwise.
ETHNIC	=1 if the respondent's ethnicity is white and 0 otherwise.
INCOME100K	=1 if the respondent's Annual Average income is \$100,000 or more and 0 otherwise.

#### **4. Econometric Results**

The chi-square statistic clearly rejects the null hypothesis that all of the independent variables together as a set were not statistically significant at the 1 percent level. The goodness of fit is shown by McFadden's R-square of 0.14, which is not unreasonable, while low for cross-sectional data. Approximately 66 percent of the survey respondents were correctly classified as either preferring or not preferring locally grown foods. Table 2 provides the estimation results. Of the 18 independent variables, six were significant at least at the 10% level. Respondents who read food labels or brochures are more likely to show preference. These consumers are likely to be more concerned about the nutrient value of what they are consuming and are likely careful in their selection of food. Households with children below the age of 17 also show a preference, which indicates increased concern for food security and safety, and consumers who showed knowledge or intellectual interest of agricultural production by responding positively to

knowledge about integrated pest management also have an increased probability towards locally grown food. Increased probabilities were also positively related to the amount of produce purchased in a month, whether they live in an urban area versus a rural area, the number of years lived in New Jersey, and the age between 51 and 65. Racially, respondents who are white are also more likely to prefer locally grown food.

**Table 2: Logit Modeling - Preference for Locally grown Food due to Agroterrorism**

	<b>Parameter Estimate</b>	<b>Standard Error</b>	<b>Change in Probabilities</b>
INTERCEPT	-2.366	0.8193	
CHANGESHOP	0.582	0.3934	
SHOPWEEK	-0.402	0.3617	
SHOPQUALITY	-0.110	0.4541	
FOODLABEL*	0.721	0.4068	0.155
PLANSHOP	-0.458	0.4068	
BROCHURE**	1.125	0.4791	0.197
BUYORGANIC	0.331	0.4028	
HEARDIPM**	1.274	0.4991	0.293
SPENDPRODUCE*	0.004	0.0025	0.001
URBAN	0.431	0.4849	
YEARSINNJ	0.003	0.0086	
HOMEGARDEN	-0.234	0.3366	
BELOWAGE17*	0.293	0.1716	0.057
GENDER	-0.244	0.3413	
AGE51TO65	0.337	0.3937	
POSTGRADUATE**	-1.065	0.4794	-0.178
ETHNIC	0.441	0.4691	
INCOME100K	-0.640	0.42	

\*\*\* Significant at 1%  
 \*\* Significant at 5%  
 \* Significant at 10%

Those with a negative probability are those that shop weekly for food. Frequent purchases of food may represent habit formation, but also may represent a shopping pattern that is easily reversible. Likewise those that shop for quality or plan purchases ahead of time are less likely to purchase locally grown food because they are already conscious and comfortable with their shopping preferences and feel secure that their food purchases are secure. Respondents who home garden are also less likely to shop locally for food. These respondents may be self sufficient through the local harvest season in NJ and therefore do not ordinarily purchase produce at any rate, or post-harvest, they may store or preserve homegrown produce. The econometric results for gender, postgraduate education and income also show lower probabilities. The gender results reflects the fact that men are less likely to be concerned about terrorism, which is probably a statement that women tend to be more careful about household consumption. Education is an interesting variable. The result may reflect the possibility that more educated respondents are less likely to take Agroterrorism threats at face value and are more discriminating in validating media, public, and other information on the terrorist threat. The negative relationship with increased income may simply reflect education levels and the earning capacity therein. As indicated in Table 3, the prediction success of the model is quite reasonable with 66% of respondents being correctly classified as either preferring or not preferring locally grown food in the presence of terrorist threat against the food system.

**Table 3: Predictive Accuracy of Logit Model**

		<i>Predicted</i>		
		0	1	Correct
<i>Actual</i>	0	130	23	130/153
	1	53	17	17/70

Number of correct predictions: 147

## **5. Conclusions**

Recent concerns about agroterrorism requires understanding how these threats affect consumer behaviour and markets. This study investigated the response of 304 New Jersey consumers to a survey question on their willingness to purchase local food over imported food. Thirty-three percent of respondents indicated that the threat of agroterrorism has caused them to think locally when it comes to their produce purchases. The results of a Logistic regression showed that there are some specific attributes common amongst those who show such a preference. Although empirical and theoretical investigations into consumer behaviors under conditions of terrorism risk are in their infancy, this paper provides some needed insight into such problems and the results are easily replicable.

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