Economic Evidence of Willingness to Pay for the National Animal Identification System in the US

Moises A. Resende-Filho

Departamento de Análise Econômica, Universidade Federal de Juiz de Fora, Campus Universitário, Martelos, Juiz de Fora, MG 36033-220. Brazil moises.resende@ufjf.edu.br

Brian L. Buhr

Department of Applied Economics, University of Minnesota, 218C Classroom Office Building 1994 Buford Avenue, St. Paul, MN 55108-6040. USA bbuhr@umn.edu

Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

Economic Evidence of Willingness to Pay for the National Animal Identification System in the US

1. Introduction

Meat safety systems have been designed assuming that most of the risk of food-borne illness originates from bacterial contamination. Hence, meat and poultry inspections in the US have traditionally concentrated on detecting bacterial contamination in meat processing and packing plants and subsequent food preparation facilities (Bailey and Slade, 2004).

However, with the emergence of Bovine Spongiform Encephalopathy (BSE) and its linkage to new variant Creutzfeldt-Jakob disease (vCJD), the need for monitoring farm production has brought animal traceability systems to the forefront. Unlike bacterial contamination, BSE originates exclusively at the farm level and feeds made of meat and bones from contaminated cattle are the main vector of BSE transmission (Nardone, 2003). Further, BSE infected animals cannot be detected until symptoms appear (e.g. animal inability to stand or walk), nor can they be confirmed until brain tissue is tested.

As a result of this linkage throughout the supply chain, calls have increased for animal tracking in addition to quality control point specific strategies such as HACCP (Hazard Analysis and Critical Control Point) protocols. Possible benefits of animal tracking include improved access and stability for international trade (Brown et al., 2001). For example, upon discovery of the first case of BSE in a cow in Washington state in 2003, Japan immediately closed imports of beef products from the U.S. and only reopened it in December 2005 subject to improved testing and tracking of the U.S. beef supply. A national animal identification system (NAIS) would allow for backward tracing all premises where this animal has passed during its life. In theory, this would make it possible to find and to test cohort animals for BSE, minimizing the chance of a BSE infected animal entering the human food chain. As a side benefit, the implementation of a NAIS system would minimize the risk of products derived from animals with any other disease transmissible from animals to humans (zoonosis) entering the human food chain (Disney et al., 2001). Furthermore, a NAIS could give to the Food and Drug Administration (FDA) the necessary tools to more effectively ensure the compliance of feed manufacturers and farmers regarding the use of illegal drugs in meat products (Caporale et al., 2001).

As a result of the perceived potential benefits for animal tracking, in 2004 the USDA initiated the implementation of the voluntary NAIS. It is being implemented with three components: premises identification, animal identification and animal tracking. The stated goal is to have 100% of premises identified and 100% of new animals identified by January 2009. However, estimates of costs of implementation are limited to rudimentary evaluations. Estimated costs will include all aspects of increased record keeping, including tagging methods, possible software investments, possible investments in readers if technologies such as radio frequency identification tags become the preferred method of identification, increased handling of livestock and other associated costs. Estimates found range from approximately $8/head for small scale cattle operations to as little as $2/head for larger operations (Dhuyvetter and Blasi spreadsheet template on beefstockerusa.com). The per head decline indicates the economies of scale which likely exist given fixed investment in readers, handling facilities, and record keeping systems. The question this paper seeks to address is whether there is evidence that the increased costs apparent for implementation of the NAIS can possibly be paid by consumers willing to pay for perceived improvements in safety and more rapid intervention in the supply chain. If not, the implementation will represent an additional cost burden on the animal agriculture sector.

Previous research on consumer willingness to pay for meat product traceability (Hobbs (2003) and Dickinson and Bailey (2002)) found conflicting results. Both studies used market experiments to determine whether consumers were willing to pay for traceability attributes. Dickinson and Bailey found that the consumers were willing to pay for a combination of traceability and attributes desired by consumers, but that traceability alone with no other factor yielded the lowest willingness to pay by consumers. Hobbs also conducted laboratory experiments of Canadian consumers and found limited or no willingness to pay for traceability per se.

An alternative approach to analyzing consumer willingness to pay is by using an event study methodology. Using this method actual food safety events are included in analysis methods to determine if market prices have been impacted by the events. For example, Thomsen and McKenzie (2001) measured the impact of product recalls on share prices for food companies affected. Other studies have tried to associate

3

detected structural changes in commodity price time series with food safety crisis events. Carter and Smith (2004) combined 'market experiments' and econometric methods to develop a procedure capable of detecting and measuring the price impact of the U.S. corn supply contamination with genetically modified Starlink corn. However both studies examined specific events rather than broader ongoing events related to food safety as would be the case with an NAIS in place. However, Piggott and Marsh (2004) apply a Generalized AIDS model that incorporates pre-committed quantities and varying intercepts for the expenditure share equations accounting for food safety events' impact on demand for each meat commodity over time. This structure will be adapted to the current situation, but focusing on news events regarding BSE and drug residues rather than broader food safety events. Following is a description of the model originally developed by Piggott and Marsh. Then the procedure of collecting news and market information on BSE and drug residue events is described followed by the results interpreted in light of the implementation of the NAIS.

2. The Demand Model

The Generalized Almost Ideal (GAI) model is recommended by Alston et al. (2001) as a manner for flexibly and parsimoniously incorporating demand shifters in the Almost Ideal Demand System (AIDS) model. According to them, the use of the GAI model allows for obtaining invariant estimates to changes in the units of measurement of quantities and prices, even when demand shifters are used.

2.1. The GAI model

The GAI model originates from a generalized expenditure function given as:

$$E(\mathbf{p}, u) = \sum_{i=1}^{n} p_i c_i + E^*(\mathbf{p}, u) \tag{1}$$

where, p_i is the price of good i, c_i is the pre-committed quantity with good i, $\mathbf{p} \in \mathfrak{R}_{++}^{n}$ is the vector of prices for a group of N commodities, $\sum_{i=1}^{n} p_i c_i$ stands for the pre-committed expenditure on the N goods, and $E^*(\mathbf{p}, u)$ denotes the supernumerary (beyond pre-committed) expenditure.

Applying Shephard's lemma to (1) and using dual identities yields the generalized Marshallian demand function as:

4

$$q_i = c_i + q_i^*(\mathbf{p}, x^*) \quad \forall\, i \tag{2}$$

where, $q_i^*(\mathbf{p}, x^*)$ is the Marshallian demand function for good i, $x^* = x - \sum_{i=1}^{n} p_i c_i$ is the supernumerary

expenditure, and x is the total expenditure on the N goods.

Pre-multiplying (2) by p_i / x yields the generalized Marshallian budget share equations as

$$w_i = \frac{p_i c_i}{x} + \frac{x^*}{x} w_i^*(\mathbf{p}, x^*) \quad \forall\, i \tag{3}$$

Finally, the GAI model is obtained by making $w_i^*(\mathbf{p}, x^*)$ be the AIDS budget share equation given as:

$$w_i^*(\mathbf{p}, x^*) = \alpha_i + \sum_{j=1}^{n} \gamma_{i,j} \ln p_j + \beta_i (\ln x^* - \ln a(\mathbf{p})) \quad \forall\, i \tag{4}$$

where, $\ln a(\mathbf{p})$ is the Translog price index given as:

$$\ln a(\mathbf{p}) = a_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{i,j} \ln p_i \ln p_j \tag{5}$$

2.2. Introducing Demand Shifters in the GAI Model

Demand shifters are incorporated in the GAI model to account for time trend, seasonal patterns and food

safety indices for meat. As proposed by Piggott and Marsh (2004), these demand shifters are introduced by

modifying pre-committed quantities, redefining c_i's to be:

$$c_i = c_{i,0} + \tau_i t + \sum_{k=1}^{3} \theta_{i,k} D_k + \sum_{m=0}^{L} \phi_{i,m} bf_{t-m} + \pi_{i,m} pk_{t-m} + \kappa_{i,m} py_{t-m} \quad \forall\, i \tag{6}$$

where t is a linear time trend, D_k are dummy variables accounting for seasonal patterns in quarterly meat

demand, bf_{t-m} are indices accounting for beef safety, pk_{t-m} are indices accounting for pork safety, and py_{t-m}

are indices accounting for poultry safety.

In addition to initial impact of the event occurring, the duration of time that the event remains affecting

the demand is unknown. Hence, in equation 6 the length of L or the departure from the linear time trend is a

variable to be estimated.

2.3. Homogeneity, Symmetry and Adding-up Constraints

Following Fisher, Fleissig and Serletis (2001) and Piggott and Marsh (2004), the parameters of equations to be estimated have been restricted to satisfy adding-up (budget shares must sum one), homogeneity of degree zero in prices and expenditure (absence of monetary illusion), and symmetry of the Slutsky substitution matrix. These restrictions are imposed via equations (7), (8) and (9).

$$\sum_{j=1}^{n} \gamma_{i,j} = 0 \quad \forall i \tag{7}$$

$$\gamma_{i,j} = \gamma_{j,i} \quad \forall i, j \tag{8}$$

$$\sum_{i=1}^{n} \alpha_i = 1, \ \sum_{i=1}^{n} \beta_i = 0, \text{ and } \sum_{i=1}^{n} \gamma_{i,j} = 0 \ \forall j \tag{9}$$

Finally, as the budget shares sum to unity the error covariance matrix will be singular. Therefore, the equation for poultry is deleted from the system to solve this problem.

2.4. Autocorrelation Corrections

Autocorrelation corrections are introduced in the GAI model by transforming the original GAI model to:

$$W_t = R W_{t-1} + \Upsilon_t C_t - R \Upsilon_{t-1} C_{t-1} + \frac{x_t^*}{x_t} W_t^*(\mathbf{p}_t, x_t^*) - R \frac{x_{t-1}^*}{x_{t-1}} W_{t-1}^*(\mathbf{p}_{t-1}, x_{t-1}^*) \tag{10}$$

Where $W_t \equiv \begin{pmatrix} w_{b,t} \\ w_{p,t} \end{pmatrix}$, $R \equiv \begin{pmatrix} \rho_{b,b} & \rho_{b,p} \\ \rho_{p,b} & \rho_{p,p} \end{pmatrix}$, $\Upsilon_t \equiv \begin{pmatrix} \frac{p_{b,t}}{x_t} & 0 \\ 0 & \frac{p_{p,t}}{x_t} \end{pmatrix}$, $C_t \equiv \begin{pmatrix} c_{b,t} \\ c_{p,t} \end{pmatrix}$ with subscripts b, p and c denoting

respectively beef, pork and poultry; $W_t^*(\mathbf{p}_t, x_t^*) \equiv \begin{pmatrix} w_{b,t}^*(\mathbf{p}_t, x_t^*) \\ w_{b,t}^*(\mathbf{p}_t, x_t^*) \end{pmatrix}$; $w_{i,t}$ are observed shares, $p_{i,t}$ are observed

prices at time t; $c_{i,t}$ are pre-committed quantities as given by (6) and $w_{i,t}^*(\mathbf{p}_t, x_t^*)$ are the AIDS budget equations as given by (4) using the supernumerary expenditure $x^* = x - \sum_{i=1}^{n} p_i c_i$.

Models have been estimated employing a Null R matrix (N-R^{matrix}) wherein all elements are zeros, a Diagonal R matrix (D-R^{matrix}) in which its elements must be equal across the main diagonal and all off main diagonal elements are zeros, and a Full R matrix (F-R^{matrix}) wherein every element may assume any Real value.

3. Data and Estimation Procedure

Models were estimated using Full Information Maximum Likelihood (FIML) algorithms available in the software EViews. FIML's estimators are asymptotically efficient for linear and nonlinear simultaneous models under the assumption that contemporaneous errors are jointly normally distributed (Quantitative Micro Software, 2004).

The systems of demand equations were estimated using quarterly data from 1982(1) to 2001(1), providing a total of 77 observations. Limiting the sample period from 1982(1) to 2001(1) reduces the chances of having to deal with structural breaks since it is known that beef experienced a sharp decline in consumption during this time. The length of the time series was found to be sufficient for obtaining models' estimates with desirable properties in statistical and economic terms. Time series for per capita meat quantities and retail prices are from the United States Department of Agriculture, Economic Research Service (USDA/ERS). Per capita quantities are measured on a retail weight basis (pounds) for beef, pork, chicken and turkey. Prices are in dollars per pound for choice retail beef value, pork retail value, chicken as whole fryers retail price and turkey as average U.S. retail prices for whole frozen birds. As proposed by Piggott and Marsh (2004) the time series for poultry quantity is constructed by summing quarterly chicken and turkey quantities in pounds. Further, the time series for poultry price has been constructed summing chicken and turkey price series weighted by their respective quantities and divided by the poultry quantity series.

3.1 Meat Safety Indices

Indices have been computed by summing the number of references to meat safety found in the top fifty English language news articles in circulation in the US over the entire sample period. The academic version of the Lexis-Nexis search tool available at http://web.lexis-nexis.com.floyd.lib.umn.edu/universe/ has been used. The search was conducted so that indices for beef, pork and poultry were estimated independently. References on food safety issues related with each type of meat are separately taken and then summed to generate quarterly series of beef, pork and poultry indices over the entire sample period.

7

To account for meat safety issues related and not related to the NAIS, two sets of indices have been created. First, in order to account for meat safety issues that are seemingly not related with the NAIS, a search has been conducted with these keywords: *food safety* or *contamination* or *product recall* or *outbreak* or *salmonella* or *listeria* or *E. coli* or *trichinae* or *staphylococcus* or *foodborne*. This search is narrowed to separately collect beef, pork and poultry information by conducting a search within the previously obtained results with these additional keywords: (a) *beef* or *hamburger*, (b) *pork* or *ham*, and (c) *chicken* or *turkey* or *poultry*. Second, accounting for food safety issues that were the original intent of putting the NAIS in place (seemingly related), a search was conducted for these keywords: *zoonosis* or *BSE* or *mad cow* or *residues*. Then the same steps taken to produce the three series of indices for beef, pork and poultry of seemingly non-related with the NAIS were also undertaken.

Finally, a third set of aggregate food safety indices for each type of meat were obtained by summing the series of indices that were seemingly related and seemingly unrelated with the NAIS. These three series of general food safety indices were used to estimate the models and to run all the following set of specification tests.

4. Hypothesis Testing and Model Selection

4.1 Testing for Autocorrelation

According to Cashin (1991), asymptotic test statistics such as the Likelihood Ratio (LR) tend to over-reject restrictions imposed on demand systems in finite samples. Therefore, Cashin suggests instead the use of the adjusted likelihood ratio test corrected for small sample as proposed by Bewley (1986: pp.125). The adjusted likelihood test statistic follows an asymptotic Chi-squared distribution with degrees of freedom equal to the number of added variables, under the null hypothesis that the additional set of regressors is not jointly significant. The adjusted likelihood ratio test statistic is:

$$LR^s = ((M * T - k^u) / M * T) * 2 * (LL^U - LL^R) \tag{11}$$

where LR^s denotes the adjusted likelihood test statistic, M is the number of estimated equations, T is the sample size, k^u is the number of parameters in the unrestricted model, LL^U and LL^R are maximized log-likelihood values respectively for unrestricted and restricted models.

Table 1.
Hypothesis Test for Significance of Food Safety Indices and Autocorrelation Corrections

	Lag Lengths for Food Safety				Autocorrelation Corrections		
	H_0: No-FS	H_0: L=0	H_0: L=1		H_0: N-R^{matrix}	H_0: D-R^{matrix}	H_0: N-R^{matrix}
Model	H_a: L=0	H_a: L=1	H_a: L=2	*Model*	H_a: D-R^{matrix}	H_a: F-R^{matrix}	H_a: F-R^{matrix}
N-R^{matrix}	36.751*	7.258	13.186	No-FS	16.379*	6.205	22.206*
D-R^{matrix}	21.652*	7.062	16.244	L=0	0.448	1.965	2.402
F-R^{matrix}	17.315*	5.581	21.408	L=1	0.282	0.523	0.798
				L=2	3.444	6.117	9.461
Df	9	9	9		1	3	4
$\chi^2_{0.05,df}$	16.919	16.919	16.919		3.841	7.815	9.488

Note: *denotes the rejection of H_0 at the 5% level, L stands for the lag length of food safety indices included in models, No-FS indicates a model estimated without food safety indices.

According to the three adjusted log-likelihood tests conducted for the group of models estimated with no food safety indices (No-FS, Table 1) it was found that D-R$^{matrix} \succ$ N-R^{matrix}, D-R$^{matrix} \succ$ F-R^{matrix}, and F-R$^{matrix} \succ$ N-R^{matrix}. As a consequence of these results, the final order of preferences for the autocorrelation corrections is given as D-R$^{matrix} \succ$ F-R$^{matrix} \succ$ N-R^{matrix}. In other words, to use a Diagonal R matrix will be enough to correct for autocorrelation for models estimated without food safety indices.

For the group of models estimated only with contemporaneous food safety indices included (L=0), with food safety indices included up to 1 lag (L=1), and with food safety indices included up to 2 lag (L=2), it has been found that N-R$^{matrix} \succ$ D-R^{matrix}, D-R$^{matrix} \succ$ F-R^{matrix}, and N-R$^{matrix} \succ$ F-R^{matrix}. Therefore the order of preferences for autocorrelation corrections is to use N-R$^{matrix} \succ$ D-R$^{matrix} \succ$ F-R^{matrix}. In other words, there is no need for autocorrelation corrections for models estimated with food safety indices regardless of the lag length employed.

5.2 Testing for the Appropriate Lag Length for Food Safety Indices

According to the results in Table 1 the following inferences can be made. First, food safety indices should be present in the model specification since H_0: No-FS is rejected against H_a: L=0 within all classes of

models estimated using N-R ^{matrix}, D-R ^{matrix} and F-R ^{matrix}. Second, it is enough to use only contemporaneous food safety indices (L=0). The reason for this is that H_0: L=0 is not rejected against H_a: L=1 and H_0: L=1 is not rejected against H_a: L=2 for all group of models. Therefore the order of preferences for the lag length for food safety indices in the models is given as L=0 $\succ$ No-FS and L=0 $\succ$ L=1 $\succ$ L=2.

5.3 The Preferred Model

Testing for appropriate lag length for food safety indices indicated that it is enough to include only contemporaneous (L=0) food safety indices in models. Moreover, autocorrelation testing within the group of models estimated only with contemporaneous food safety indices indicated that no autocorrelation correction is needed for models within this group. As a consequence, the preferred model needs no autocorrelation correction (to use N-R ^{matrix}) and should be estimated including food safety indices without any lag (L=0). Table 2 presents the estimates obtained for the preferred model.

Table 2.
Estimates for the Model with Food Safety Indices with no Lag and Estimated Using a Null R^{matrix}

Parameter		Parameter		Parameter	
$c_{b,0}$	15.7782* (1.05457)	$\theta_{p,3}$	-1.0692* (0.1356)	$\kappa_{p,0}$	0.0010 (0.0016)
$c_{p,0}$	7.4786* (1.9218)	$\theta_{c,1}$	-2.4501* (0.1910)	$\kappa_{c,0}$	-0.0022 (0.0021)
$c_{c,0}$	9.4922* (4.0252)	$\theta_{c,2}$	-1.7476* (0.2124)	α_0	19.1853 (19.2062)
τ_b	0.02862* (0.0121)	$\theta_{c,3}$	-1.2350* (0.1900)	α_b	8.9891 (8.7512)
τ_p	0.0681* (0.0125)	$\phi_{b,0}$	-0.0010 (0.0006)	α_p	-3.0070 (3.4646)
τ_c	0.1610* (0.0163)	$\phi_{p,0}$	-0.0017* (0.0005)	γ_{bb}	7.3441 (5.5160)
$\theta_{b,1}$	0.0209 (0.2001)	$\phi_{c,0}$	-0.0003 (0.0007)	γ_{bp}	-2.5417 (2.1816)
$\theta_{b,2}$	0.6060* (0.1173)	$\pi_{b,0}$	-0.0020 (0.0050)	γ_{pp}	0.8594 (0.8382)
$\theta_{b,3}$	1.0357* (0.1029)	$\pi_{p,0}$	-0.0035 (0.0047)	β_b	0.5700* (0.1601)
$\theta_{p,1}$	-1.0150* (0.1215)	$\pi_{c,0}$	-0.0010 (0.0050)	β_p	-0.2159* (0.0605)
$\theta_{p,2}$	-1.4737* (0.1302)	$\kappa_{b,0}$	-4.61E-05 (0.0012)		
Log Likelihood	663.076	**R^2 beef**	0.9892	**R^2 pork**	0.9237

Note: numbers in parentheses are the estimated standard errors. * denote a coefficient statistically significantly different form zero at the 5% level by the z-test.

Results in Table 2 show that the intercept estimates of modified pre-committed quantities respectively for beef, pork and poultry ($c_{b,0}, c_{p,0}, c_{c,0}$) are all nonnegative as a priori expected. They are also individually

statistically different from zero by the z-test at 5%. Time trend coefficients (τ_i $\forall i$) are all statistically

significantly different from zero. With the exception of the coefficient for the first quarter Dummy for beef $\theta_{b,1}$,

all remaining seasonal coefficients ($\theta_{i,1}, \theta_{i,2}, \theta_{i,3}$ $\forall i$) are statistically different from zero by the z-test at 5% of

significance across models.

As a priori expected, own-food safety estimated coefficients for beef ($\phi_{b,0}$), pork ($\pi_{p,0}$), and poultry

($\kappa_{c,0}$) are all negative indicating that meat safety references in the news depress pre-committed quantities.

Interestingly, for beef and pork the cross-commodity food safety coefficient estimates were all negative,

indicating that beef and pork food safety references in the news adversely impact the pre-committed quantities

of all other meat commodities (spillover effect). Except for $\phi_{p,0}$, all the other food safety coefficients do not

individually statistically differ from zero by the z-test at 5%. Despite this, food safety indices are kept in the

model because they are jointly statistically different from zero according to the specification tests conducted to

find the appropriate lag length for food safety indices. Finally, the preferred model shows very high coefficient

of determination (R^2) for the estimated equations for beef and pork, indicating that they fit the data well.

6. On the Economic Value of the NAIS

Based on the estimated model it is now possible to simulate the consumer derived economic value from

the implementation of NAIS. The model was estimated including the aggregate index of food safety. This

value was constructed as a composite of news articles on topics identified above and is the simple sum of all

articles. Therefore, a higher or lower number of articles will alter the impact of the estimate on the endogenous

variable in the estimated equations and allow for a calculation of the economic impact of NAIS with a bit more

calculation including total revenue values.   The following three scenarios were constructed using this logic.

Baseline Scenario - The baseline scenario assumes that the NAIS has not been implemented in the sample

period and therefore that consumers have reduced their consumption by the full extent of any media reporting of

food safety issues identified in the search of news articles. Results for this scenario are obtained by first

plugging the time series for all exogenous variables into the preferred model. The predicted budget share series

for beef, pork and poultry are then multiplied by the total population in the US and by the per capita expenditure allocated with meat consumption. Finally, the predicted revenue series are converted into Dollar of the third quarter of 2005 using the CPI for all goods obtained at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet.

Scenario 1 – Scenario 1 assumes that the NAIS has been implemented for beef and dairy cattle through the entire sample period. In order to model this scenario, the series of food safety index seemingly not related with the NAIS for beef is used in place of the aggregate food safety index for beef. Thus, plugging the series of food safety index seemingly not related with the NAIS for beef and all other series of explanatory variables into the preferred model produce the predicted budget shares series for each type of meat. This assumes of course that consumers are no longer concerned with issues of BSE because we assume that they are confident all animals will be found, tracked and removed from the food chain when the NAIS is in place. Predicted budget shares are multiplied by the total expenditure series and by the total population in the US, and finally deflated using the CPI for all goods so that the predicted total revenue series are converted into dollars for the third quarter of 2005.

Scenario 2 - Scenario 2 assumes that the NAIS has been implemented for both beef and pork. In order to model Scenario 2, the series of food safety index seemingly not related with the NAIS for beef and pork are used in place of the aggregate food safety indices for these two types of meat. Thus, plugging these series and all other series of explanatory variables into the preferred model produce the predicted budget shares series for each type of meat. Predicted budget share series are multiplied by the total expenditure series and by the series of total population in the US and finally deflated by the CPI for all goods so that the predicted total revenue series are converted into dollars for the third quarter of 2005.

Summary statistics of the two scenario alternatives are presented in Table 3. In Scenario 1, (NAIS implemented only in cattle) beef and pork sectors would have respectively experienced an average increase in their total revenue of $4.01 million and $4.60 million per quarter. The increase in pork is a result, as described earlier, of the significant and negative effect that beef food safety issues had on pork (the coefficient $\phi_{p,0}$). This is a counterintuitive result, but may plausibly show that consumers do not adequately distinguish between beef

and pork related food safety events. In other words a negative event in beef spills over to pork as 'meat' in the eyes of the consumer. In contrast, the poultry sector which seems to benefit by consumers switching to poultry when a food safety event occurs in beef would have lost revenue on average of $8.606 million per quarter.

Table 3.
Predicted Changes in the Total Revenue for Beef, Pork and Poultry Sectors under Three Alternative Scenarios (1982:1 – 2001:1)

	Total Revenue Difference in Million of Dollars as of September/2005					
	Scenario 1- Scenario 0			Scenario 2- Scenario 0		
	Beef	Pork	Poultry	Beef	Pork	Poultry
Minimum	-158.19	-55.63	-248.77	-172.69	-73.41	-308.60
Maximum	304.40	129.91	28.29	382.01	141.91	30.78
Std. Dev.	45.11	21.96	33.03	55.61	24.67	41.20
Total	308.00	354.50	-663.50	414.03	389.18	-803.20
Average	4.01	4.60	-8.62	5.38	5.05	-10.43

If the NAIS were in place during the sample period for beef and for pork (Scenario 2), these sectors would respectively increase their total revenues by $5.38 and $5.05 million per quarter. Note that pork also has a positive spillover on beef as beef had on pork. The magnitude is not directly comparable between scenario 2 and scenario 1 because the number of articles affecting beef and pork together and separately are different (some may have included both beef and pork while others may have been just beef or just pork). In this case the poultry sector would have lost an average of $10.43 in revenue per quarter.

The total revenue effect is recognized as a gross measure of the economic value of the NAIS since the costs of producing, processing and transporting additional product were not taken into account. Also, how these changes in the total revenue at the retail level will be passed through to the producer level is not considered, so it is possible that even if consumers are willing to pay this value may not be passed back fully to producers. However, these figures may serve as a starting point for the meat industry to discuss how the benefits and costs with the NAIS will be shared among segments within each meat supply chain, and also on how much the US government will potentially need to contribute to the NAIS.   For instance, preliminary estimates for the costs of the NAIS in the US are $550 million for a five year period (Gray, 2004). Using this figure one may calculate that the NAIS will create an additional cost of $27.5 million per quarter for the beef and pork sectors. Thus, it is

straightforward to see that $27.5 million per quarter is far higher than $10.417, the sum of the expected increase in total revenues for the beef and pork sector. Using this same figure, one will see that it would take 13.2 years for these sectors to recover the cost incurred with 5 years of the NAIS. Therefore, if the defense of the NAIS is based on its effect on the demand side of the market for meats it is expected that the US Federal government will need to pay for a great part of the costs with the NAIS; otherwise the NAIS is likely to be economically unfeasible in the US.

7. Summary

The implementation of the NAIS in the U.S. is proceeding with proposed 100% coverage by 2009. However, relatively little information exists regarding the prospective costs or benefits to the identification system. This paper developed a method for analyzing expected benefits to the meat animal sector from improved confidence consumers may have in the meat supply with an animal identification process in place. A generalized meat demand system is estimated and food safety indexes are created from news reports to estimate the impacts of food safety events on meat consumption. This information is then used to evaluate the estimated increased revenues from the NAIS program. Results show that there is a significant cost to food safety in terms of less meat consumed in aggregate. Therefore, an improvement in tracking animals and instilling confidence will result in positive benefits to the meat sector and in particular beef and pork because NAIS is not yet proposed for the poultry sector. However, the domestic U.S. positive returns are not great enough to offset the total estimated costs of NAIS implementation. This study does not include estimates of the potential for increased value of exports which is an important consideration given that export bans have resulted from previous cases of BSE. It is likely that many of the costs will be borne by the farm production level, and it is also not estimated how these additional values paid by consumers at the retail level will be allocated back to the farm level. This includes potential issues of imperfect price transmission from retail to farm level as well as simply identifying the increased revenue share contributed by farmers if NAIS is implemented.

14

References

Alston, J.M., J.A. Chalfant, and N.E. Piggott, "Incorporating Demand Shifters in the Almost Ideal Demand System," *Economics Letters* 70 (2001), 73-8.

Bailey, D., and J. Slade. "Factors Influencing Support for a National Animal Identification System for Cattle in the United States." Denver, CO ed. Denver, CO: American Agricultural Economics Association Annual Meetings, August 1-4, 2004.

Bewley, R. *Allocation Models: Specification, Estimation, and Applications*. Cambridge, MA: Ballinger, 1986.

Brown, P., R.G. Will, R. Bradley, D.M. Asher, and L. Detwiler. "Bovine Spongiform Encephalopathy and Variant Creutzfeldt-Jakob Disease: Background, Evolution, and Current Concerns," *Emerging Infectious Diseases* 7 (2001), 6.

Carter, C.A. and A. Smith. "The Market Effect of a Food Scare: The Case of Genetically Modified Starlink Corn." http://www.agecon.davis.edu/facultypages/smith/workingpapers/starlink_aug17.pdf. August 2004.

Cashin, P. "A Model of the Disaggregated Demand for Meat in Australia," *Australian Journal of Agricultural Economics* 35 (1991), 263-83.

Caporale, V., A. Giovannini, C. Di Francesco, and P. Calistri. "Importance of the traceability of animals and animal products in epidemiology." Rev. Sci. Tech. Off. Int. Epiz. 2 (2001):372-8.

Dickinson, D.L., and D. Bailey. "Meat Traceability: Are U.S. Consumers Willing to Pay for It?" *Journal of Agricultural and Resource Economics* 27 (2002), 348-64.

Disney, W.T., J.W. Green, K.W. Forsythe, J.F. Wiemers, and S. Weber. "Benefit-Cost Analysis of Animal Identification for Disease Prevention and Control." Rev. Sci. Tech. Off. Int. Epiz. 2 (2001):385-405.

Fisher, D., A.R. Fleissig, and A. Serletis. "An Empirical Comparison of Flexible Demand System Functional Forms," *Journal of Applied Econometrics* 16 (2001), 59-80.

Gray, C.W. "The National Animal Identification System: Basics, Blueprint, Timelines, and Processes," U.S. Livestock Identification Systems: Risk Management and Market Opportunities. H. Doyle, ed., pp. 1-1-1-11. Tucson, AZ: Western Extension Marketing Committee, 2004.

Hobbs, J.E. "Consumer Demand for Traceability." Working Article 03-1 ed. Saskatoon, Saskatchewan, Canada: International Agricultural Trade Research Consortium, April 2003.

Nardone, A. "Impact of BSE on Livestock Production System" *Veterinary Research Communications* 27 Suppl. 1 (2003), 39-52.

Piggott, N.E., and T.L. Marsh. "Does Food Safety Information Impact U.S. Meat Demand?" *American Journal of Agricultural Economics* 86 (2004), 154-74.

Quantitative Micro Software, *EViews 5 User's Guide* (Irvine, CA: Quantitative Micro Software, LLC, 2004).

Thomsen, M.R. and A.M. McKenzie. "Market Incentives for Safe Foods: An Examination of Shareholder Losses from Meat and Poultry Recalls." *American Journal of Agricultural Economics.* 83(2001): 526-38.

USDA, Economic Research Service. "Red Meat Yearbook". http://usda.mannlib.cornell.edu/data-sets/livestock/94006/.

USDA, Economic Research Service. "Poultry Yearbook". http://usda.mannlib.cornell.edu/data-sets/livestock/89007/.