

# **P3-2009**

## **The Impact of the Food Safety Information on U.S. Poultry Demand**

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### **Abstract**

The impact of poultry product recall events on consumer demand in the USA was tested empirically for the four major categories of poultry: broiler (young chicken), eggs, turkey and other chicken (mature or non-broiler chicken). FSIS recall and the MEDIA recall impacted only turkey, and demonstrated that consumers of turkey were a special behavior group in poultry consumers.

JEL Category: D-12, Consumer Economics-Empirical Analysis; I-18, Government Policy—Regulation—Public Health

### **Introduction**

Various outbreaks of food related diseases raise safety concerns in the United States dramatically in the past decades with respect to increased risk of being access to contaminated meat products. Human illness caused by food-borne contaminants is extremely harmful to society with cost estimates exceeding billions of US dollars annually (Roberts, 1989; USDA, 2001). Can the raised risk in the food market caused by contaminated meat products really impact the concerns of consumers and can it result in serious increased risk to the well-being and health of consumers? Recalls of contaminated meat products may impact directly the industry cost (Marsh, Schroeder and Mintert 2004). Various outbreaks have dramatically increased the previous studies linking recall events to consumer behavior in last two decades. Should we take the product recall into account when we want to forecast the poultry demand market? Does the product recall only impact the demand of the recalled product or it impact other products as well?

The first objective is to test whether actual FSIS product recall and media information covering meat recall events have influenced poultry demand significantly.

Second, by determining poultry product properties, the identified significant recall impacts on poultry consumers' behavior have been rationalized.

The first purpose of this study is fulfilled by empirically investigating impacts of poultry product recalls on US consumer demand. A previous study linking recall events to consumer behavior has been done by Marsh, Schroeder and Mintert (2004), observing US meat demand by using a Rotterdam model, and they find that Food Safety Inspection Service's meat recall events significantly impact demand but newspaper reports do not impact demand. Previous studies on recall show that specific studies on poultry products to recall events are limited to the scope of recall events. A work on extending recall to AI has been done by Ishida, Ishikawa and Fukushige (2006), which studies the impacts of the BSE and bird flu on consumers' demand in Japan using a AI demand system. In this work, the graduate shift pattern, using a dummy variable, indicates a gradual shift from the outbreak. They find that a bird flu outbreak impacts negatively on the market share for beef, while the outbreak of BSE raises the market demand for chicken. Moreover, they show that both impacts from BSE and bird flu do not continue consistently, which depends on the characteristics of disease.

The empirical results show that FSIS recall and the MEDIA recall undermine turkey demand. This demonstrates that consumers of turkey are a special behavior group in poultry consumers.

### Model Specification

Almost Ideal Demand System (AIDS)

AIDS is very flexible and, as it is the best form, it is used to estimate the static demand system. I use a linear approximate version of AIDS to estimate time series.

$$W_i = \sum_{j=1}^4 \gamma_{ij} \log(P_j) + \beta_i \log(x/P) + \sum_{j=1}^3 \theta_{ij} R_j \quad (1)$$

$\log(P) = \sum_{i=1}^4 W_i \log(P_i)$  is Stone price index constructed based on taking weighted average of individual prices with budget shares of each type of poultry as weights.  $i = 1, 2, 3, 4$  denote young chicken, eggs, turkey and other chicken respectively.

$W_i$ : Budget shares of demands for each type of poultry.

$P_i$ : Retail prices of poultry products.

$x$ : The total expenditure on four types of poultry product.

$R_1, R_2, R_3$ : Chicken and turkey FIFS recalls and media recalls.

Demand function properties require imposing symmetry  $\gamma_{ij} = \gamma_{ji}$ , homogeneity  $\sum_{j=1}^4 \gamma_{ij} = 0$  simultaneously and adding up restrictions  $\sum_{i=1}^4 \gamma_{ij} = 0$ ,  $\sum_{i=1}^4 \beta_i = 0$  are satisfied automatically.  $\sum_{i=1}^4 \theta_{ij} = 0$  meets the requirement of adding up of recalls across poultry products.

Based on mean values of the variables from the summary statistics, income, compensated price and recall elasticity can be calculated in both demand systems as

follows:

In AIDS model income elasticity can be obtained by

$$e_i = 1 + \frac{\beta_i}{w_i} \quad (2)$$

Uncompensated price elasticity is expressed in the following way:

$$e_{ij} = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i w_j}{w_i} \quad (3)$$

$\delta_{ij} = 1$ , if  $i = j$ , and  $\delta_{ij} = 0$ , if  $i \neq j$ . Compensated price elasticity can be expressed in uncompensated price elasticity and income elasticity in the following way:

$$e_{ij}^* = e_{ij} + e_i w_j \quad (4)$$

The demand shifter elasticity is defined as:

$$e_{ir} = \theta_{ij} * r_i w_i \quad (5)$$

## Data

Without specification, information on product recalls is constructed in a similar way to Marsh, Schroeder and Mintert(2004).

Poultry quantity and price series are reported by the United States Department of Agriculture Economic Research Service (USDA ERS) Poultry Yearbook (Updated 8/2006).

The data are grouped into four major sections: broiler (young chicken), eggs, turkey and other chicken (mature or non-broiler chicken).

The price of other consumption goods is deflated from the Total Meat Consumer Price Index (CPI). The CPI for all urban consumers, is used to adjust for inflation over time, which represents the US city average price of all items, as reported by the United States Department of Commerce Bureau of Labor Statistics (BLS).

A description and summary statistics of data used in estimation of the poultry demand model are reported in Tables 1 and 2. Per capita young chicken consumption is ranked the highest of the four types of poultry products, averaging 6.67 lbs/capita/month; Per capita consumption of eggs ranks the second, averaging 6.2 lbs/capita/month, which is followed by turkey with an average consumption of 1.45 lbs/capita/month. Over time, per capita poultry consumption does not declined significantly, whereas per capita poultry consumption does fluctuate steadily. Consumption of turkey is more stable than either young chicken or egg consumption, generally oscillating between 1.06 and 2.56 lbs/ capita/month over the 5-year period. Retail prices of other chicken average the highest among the competing types of meat at 37.02 cents/lb expressed in 2000 US dollars. Young chicken and egg prices have similar mean values round 22 cents/lb and turkey price is averaged at 20.52 cents/lb.

Number of table in Yearbook	Name of variable	Unit	Description
82	Young Chicken	lbs/capita	Monthly per capita consumption, retail weight basis.
124	Other Chicken	lbs/capita	Monthly per capita consumption.
147	Turkey	lbs/capita	Monthly per capita consumption.
43	Egg	lbs/capita	Monthly per capita consumption shell egg equivalent.
92	Young Chicken Price	cents/lb	Or named broilers, live-weight equivalent price.
128	Other Chicken Price	cents/lb	Or named roasters and hens, wholesale price in Chicago, ready-to-cook.
166	Turkey Price	cents/lb	U.S. retailer to consumer price spread.
63	Egg Price	cents/lb	U.S. retailer to consumer price spread.
93	Total meat	CPI	Consumer Price Index 1982-84=100.

Table 1: Description of Variables Used to Estimate Poultry Demand from 2000 to 2004

Summary statistics of data	Average	Std. Dev.	Minimum	Maximum
Young Chicken (lbs/capita)	6.67	0.50	5.76	7.43
Other Chicken (lbs/capita)	.1	0.04	0.01	0.15
Turkey (lbs/capita)	1.45	0.31	1.06	2.56
Egg (lbs/capita)	6.20	0.41	5.2	6.9
Young Chicken Price (cents/lb)	22.28	2.87	16.93	28.23
Other Chicken Price (cents/lb)	37.02	1.84	33.6	42.09
Turkey Price (cents/lb)	20.52	4.92	7.58	29.57
Egg Price(cents/lb)	22.11	8.86	.17	41.6
Poultry FIFS Chicken Recalls	1.45	1.32	0	5
Poultry FIFS Turkey Recalls	.33	.60	0	2
Poultry Media Recalls	2	4.10	0	27

Table 2: Summary Statistics of Monthly Data Used to Estimate Poultry Demand from 2000 to 2004(Prices are Inflation Adjusted US Dollars (Deflated by Total Meat CPI, 1982-84=100))

Quantity of wrt. prices of	young chicken	egg	turkey	other chicken
young chicken	-.13	.17	.07	-1.25
egg	.15	-.33	.18	3.91
turkey	.01	.04	-.35	.81
other chicken	-.03	.38	.70	-3.47
Income	1.37	1.37	1.36	-29.09

Table 3: Compensated Price and Income Elasticity - AIDS

### Model Estimation and Discussion

The ordinary least squares estimates of the coefficients for each variable is testing whether variables have autocorrelation. The goodness of fit is measured with adjusted R-square, which yields 99.9%, 99.92%, 98.25% and 90.42% for young chicken, eggs, turkey and other chicken respectively. Durbin-Watson test at 5% shows that there are no autocorrelation in the estimation of demand of turkey, no autocorrelation in young chicken, eggs, and other chicken. The critical value for D-W(8,60) has a lower bound 1.335 and an upper bound 1.85. I can conclude that there are no autocorrelation in other chicken and turkey demand equations.

When I estimate parameters of four equations extended from the intensive form in equation 1 by imposing symmetry  $\gamma_{ij} = \gamma_{ji}$ , homogeneity  $\sum_{j=1}^4 \gamma_{ij} = 0$  simultaneously and adding up restrictions  $\sum_{i=1}^4 \gamma_{ij} = 0, \sum_{i=1}^4 \beta_i = 0$  are satisfied automatically.  $\sum_{i=1}^4 \theta_{ij} = 0$  meets the requirement of adding up of recalls across poultry products. That is, I estimate four equations using an iterative nonlinear seemingly unrelated regression (ITSUR), with restrictions on parameters being imposed. By using ITSUR the efficiency of the estimates is improved, which can be reflected in the reduction of standard errors of the variable coefficients in each estimation.

Other chicken log prices in each chicken budget share (othc lnp4) are calculated by imposing homogeneity  $\sum_{j=1}^4 \gamma_{ij} = 0$  in each equation. The expenditure in the other chicken equation (expd lnxp) is calculated by imposing adding up restriction across equations  $\sum_{i=1}^4 \beta_i = 0$ . The log prices of young chicken, eggs, and turkey in the other chicken budget share equation are obtained by imposing the automatically satisfied adding up restriction across equations  $\sum_{i=1}^4 \gamma_{ij} = 0$ . Lastly, the coefficients of recalls in other chicken budget share are obtained by squeezing out from the first three equations with  $\sum_{i=1}^4 \theta_{ij} = 0$  the requirement of adding up being imposed.

As the estimates in Table 4 show, the estimates of parameters  $\beta_i$  and  $\gamma_{ij}$  are significant at 1% level for all  $i, j$ . The coefficient of FSIS recall shifter  $\theta_{32}$  is significant at 10% level in the turkey demand equation. The coefficients of media recall shifter  $\theta_{21}$  and  $\theta_{31}$  are significant at 5% level for the products of eggs and turkey.

The goodness of fit in Table 4 of the ITSUR model is measured with the adjusted R-square, which yield 85.26%, 79.55 % and 60.80% for young chicken, eggs and turkey respectively.

Quantity of wrt. number of recall of	young chicken	egg	turkey	other chicken
FSIS chicken	.01	-.02	.04	.02
FSIS turkey	-.01	.00	<b>.03</b>	.09
NS Median	-.00	<b>.02</b>	<b>-.03</b>	-.31

Table 4: Recall Elasticity - AIDS

In the AIDS model, the elasticity is calculated at the mean values of explanatory variables. Their exact mean values are in Table 2. Compensated price elasticity and income elasticity evaluated at the means are reported in Table 3, which show that:

The compensated price elasticity seems that the symmetry is violated in magnitude but holds in sign. The compensated cross price elasticity is positive between young chicken and eggs, turkey, which suggests substitute. There is no exception in any type of poultry that the cross price elasticity is consistent in their signs. Theoretically they should coincide both in sign and magnitude. Own price elasticity is negative for each type of poultry, which means each increase in own price causes a decline in per capita poultry consumption and turkey gives the most elastic response. More than unity, income elasticity shows that each type of poultry product except other chicken is a luxury good.

Table 4 reports the current period FSIS and Media recall elasticity. Poultry recalls have positive effects on retail young chicken and turkey demand. The turkey FSIS turkey recall elasticity is 0.03 in AIDS. However, the Media recalls have negative effects on retail turkey elasticity -.03. Media recalls have positive impacts on eggs with elasticity .02 in AIDS. After the comparison of the magnitude of elasticity with the FSIS recall, it shows that the media has less magnitude than FSIS elasticity. The above analysis show that the consumers' demand is influenced less by media than FSIS recall information.

With the exception of turkey Media recall elasticity, overall the estimated FSIS and Media recall demand shifter elasticity is not consistent with prior literature and expectation.

MEDIA recall affects turkey negatively, but affects young chicken and eggs positively. FSIS recall impacts the demand of turkey positively.

Future study needs to investigate the impact from recall in the long run. Though at present no impact has been found in the long run, there is still a probability that food safety information will retain on the market.

## Conclusion

This study has assessed the impacts of poultry product recall events on US consumer demand. Both FSIS meat recall events and a measure of media (newspaper articles) reporting meat recalls have been examined. Statistical evidence suggests individual FSIS and Media recall indices for poultry aggregated monthly significantly affect

demand for recalled poultry products.

From 2000 to 2004, poultry product recall events have had a positive impact on demand for turkey (10% significant level in AIDS and significant at 5% level in OLS) and no significant impact on other types of poultry products, which is consistent in estimations. Furthermore, MEDIA recall indices influence turkey negatively and eggs positively at 5% significance level. Poultry FSIS recall information impacts demand for poultry negatively in current periods only in an insignificant way.

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## Appendix SAS<sup>®</sup> Codes

AIDS model:

```
DATA pp;
INFILE "f:90515.txt" dsd dlm='09'x;;
INPUT t q1 q4 q3 q2 p1 p4 p3 p2 x y1 y4 y3 y2 r1 r2 p1r1 p3r2 pc xstar qd ns rc;
w1=(p1*q1)/x;
w2=(p2*q2)/x;
w3=(p3*q3)/x;
w4=(p4*q4)/x;
lnx=log(x);
lnp1=log(p1);
lnp2=log(p2);
lnp3=log(p3);
lnp4=log(p4);
lnp=w1*lnp1+w2*lnp2+w3*lnp3+w4*lnp4;
lnxp=lnx-lnp;
run;
```

```
PROC model data=pp;
endogenous w1 w2 w3;
parms k11 k12 k13 k21 k22 k23 k31 k32 k33 beta1 beta2 beta3 gamma11 gamma12 gamma13
gamma22 gamma23 gamma33;
w1=k11*ns+k12*r1+k13*r2+ gamma11*lnp1+gamma12*lnp2+gamma13*lnp3
-(gamma11+gamma12+gamma13)*lnp4+beta1*lnxp;
w2=k21*ns+k22*r1+k23*r2+gamma12*lnp1+gamma22*lnp2+gamma23*lnp3
-(gamma12+gamma22+gamma23)*lnp4+beta2*lnxp;
w3=k31*ns+k32*r1+k33*r2+gamma13*lnp1+gamma23*lnp2+gamma33*lnp3
-(gamma13+gamma23+gamma33)*lnp4+beta3*lnxp;
fit w1 w2 w3 /itsur;
RUN;
```



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