

The Impact of Beef and Pork Advertising on US Meat Demand in the Presence of Food Safety Events

Nicholas E. Piggott

North Carolina State University

Chen Zhen

RTI International, RTP, NC

Robert H. Beach

RTI International, RTP, NC

Michael K. Wohlgenant

North Carolina State University

Research Objectives

- **Investigate the statistically and economic impacts of generic promotion and food safety in U.S meat demand simultaneously**
 - **build upon previous efforts in several areas**
 - **more recent data 1982(1)-2005(4)**
 - **more flexible lag structure for advertising and food safety employing the Polynomial Inverse Lag (PIL)**
- **Paper follows on from a recent evaluation of the pork check-off program**
- **The modeling approach has been made more sophisticated since completing the report and remains work in progress. The results to follow are the same as the final report to pork board.**

Previous Work on Generic Advertising and Food Safety

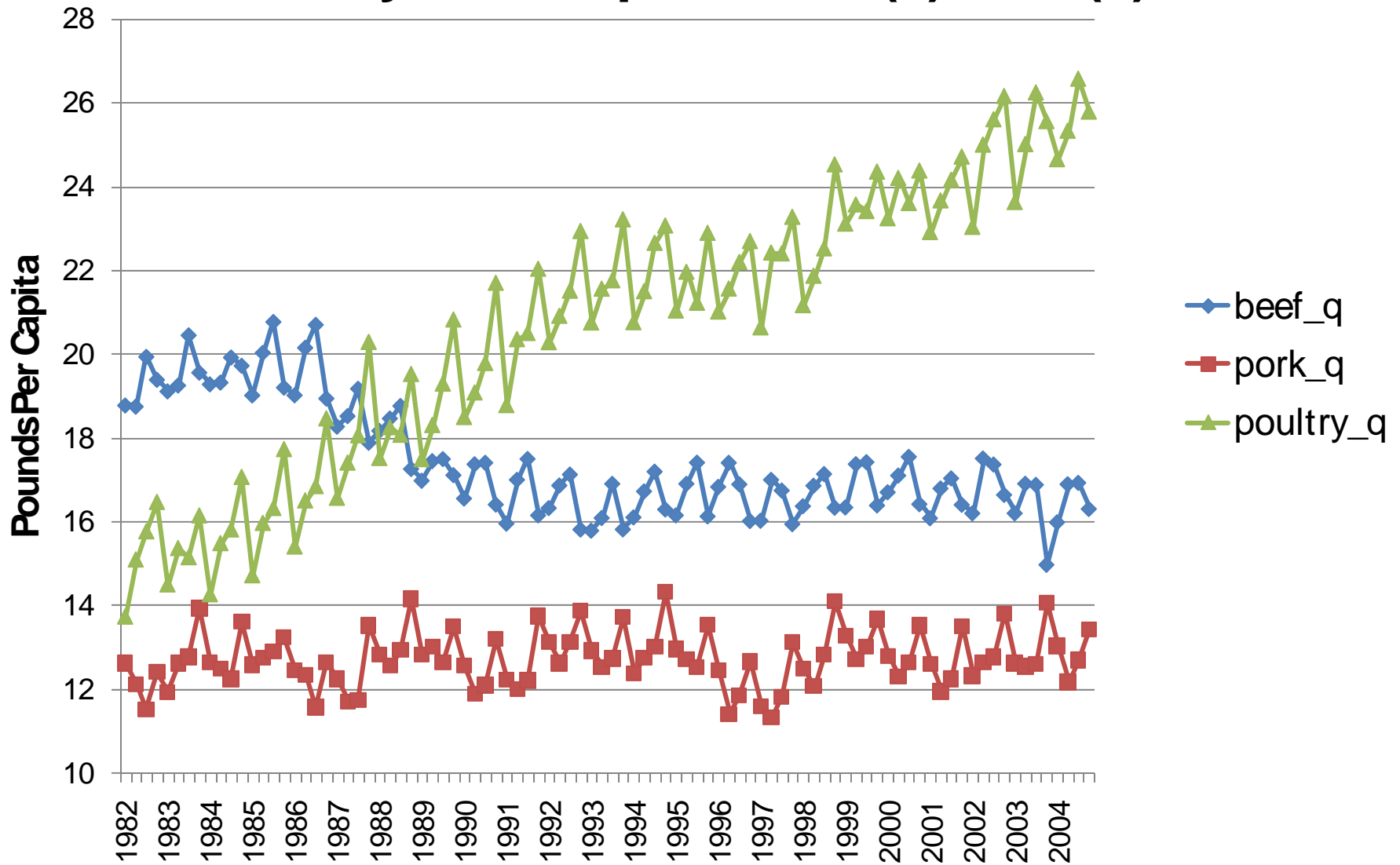
- **Brester and Schroeder (1995), Rotterdam, generic and branded beef and pork advertising**
- **Kinnucan et al (1997), Rotterdam, generic beef and pork advertising**
- **Burton and Young (1996), Almost Ideal Demand, British BSE newspaper count**
- **Piggott and Marsh (2004), Generalized Almost Ideal Demand, beef, pork and poultry safety news count**

Dataset 1982(1)-2004(4)

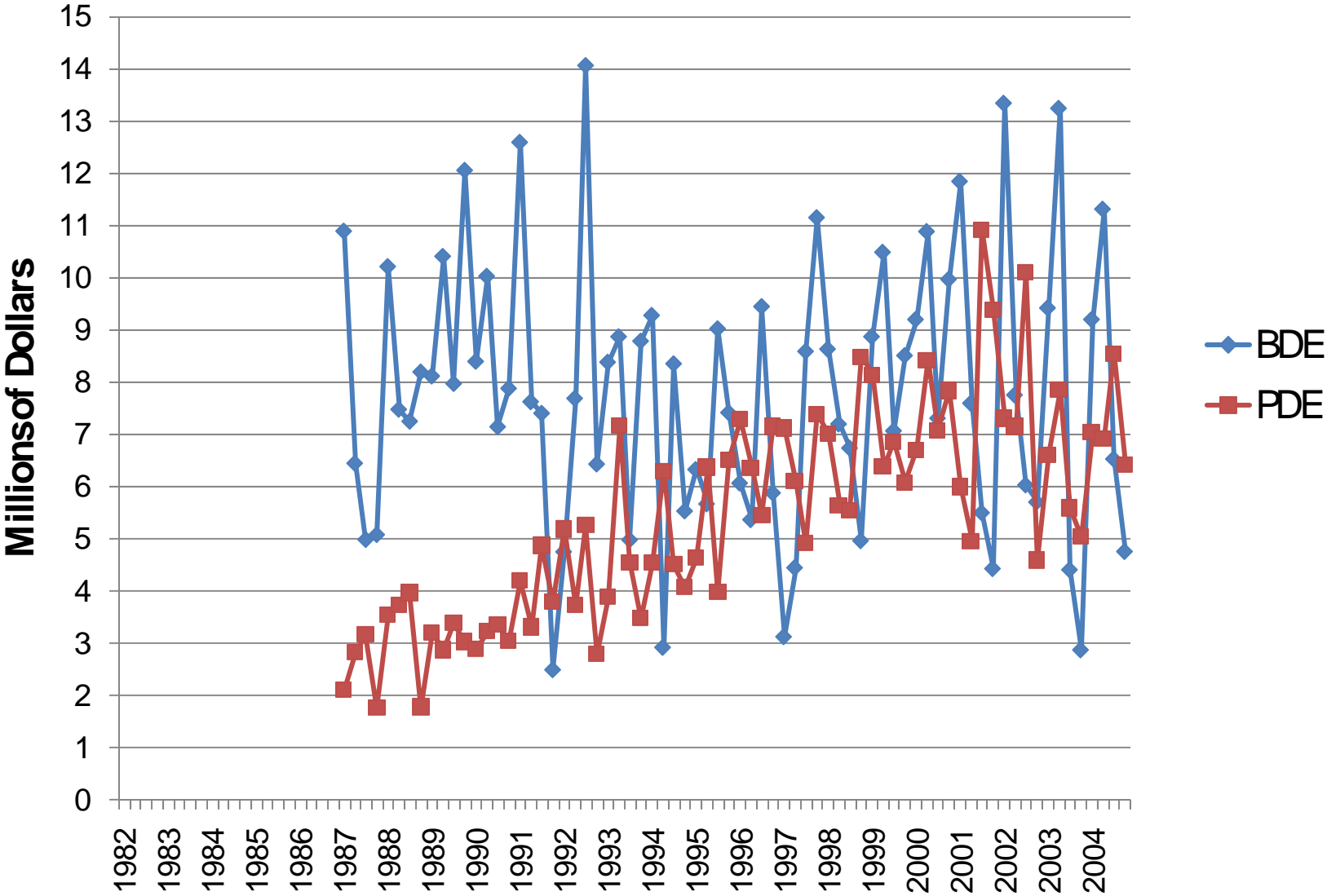
Table 1: Summary Statistics of Quarterly Data, 1982(1)-2004(4)

Variable	Average	Std Dev	Mnimum	Maximum
Beef Consumption (lbs/capita)	17.439	1.345	14.960	20.775
Pork Consumption (lbs/capita)	12.717	0.658	11.326	14.317
Poultry Consumption (lbs/capita)	20.654	3.375	13.710	26.566
Beef Price (\$/lb)	2.832	0.454	2.227	4.164
Pork Price (\$/lb)	2.203	0.333	1.678	2.877
Poultry Price (\$/lb)	0.939	0.104	0.722	1.112
Meat Expenditure (\$/capita)	96.697	14.242	75.369	135.212
Beef Expenditure Share	0.510	0.037	0.434	0.585
Pork Expenditure Share	0.289	0.015	0.259	0.322
Poultry Expenditure Share	0.201	0.028	0.134	0.244
Beef Advertsing (\$ millions)	6.064	3.944	0.000	14.043
Pork Advertising (\$ millions)	4.248	2.882	0.000	10.919
Beef Food Safety	229.554	262.525	3.000	1,283.000
Pork Food Safety	60.087	61.665	0.000	395.000
Poultry Food Safety	212.239	183.570	6.000	1,089.000

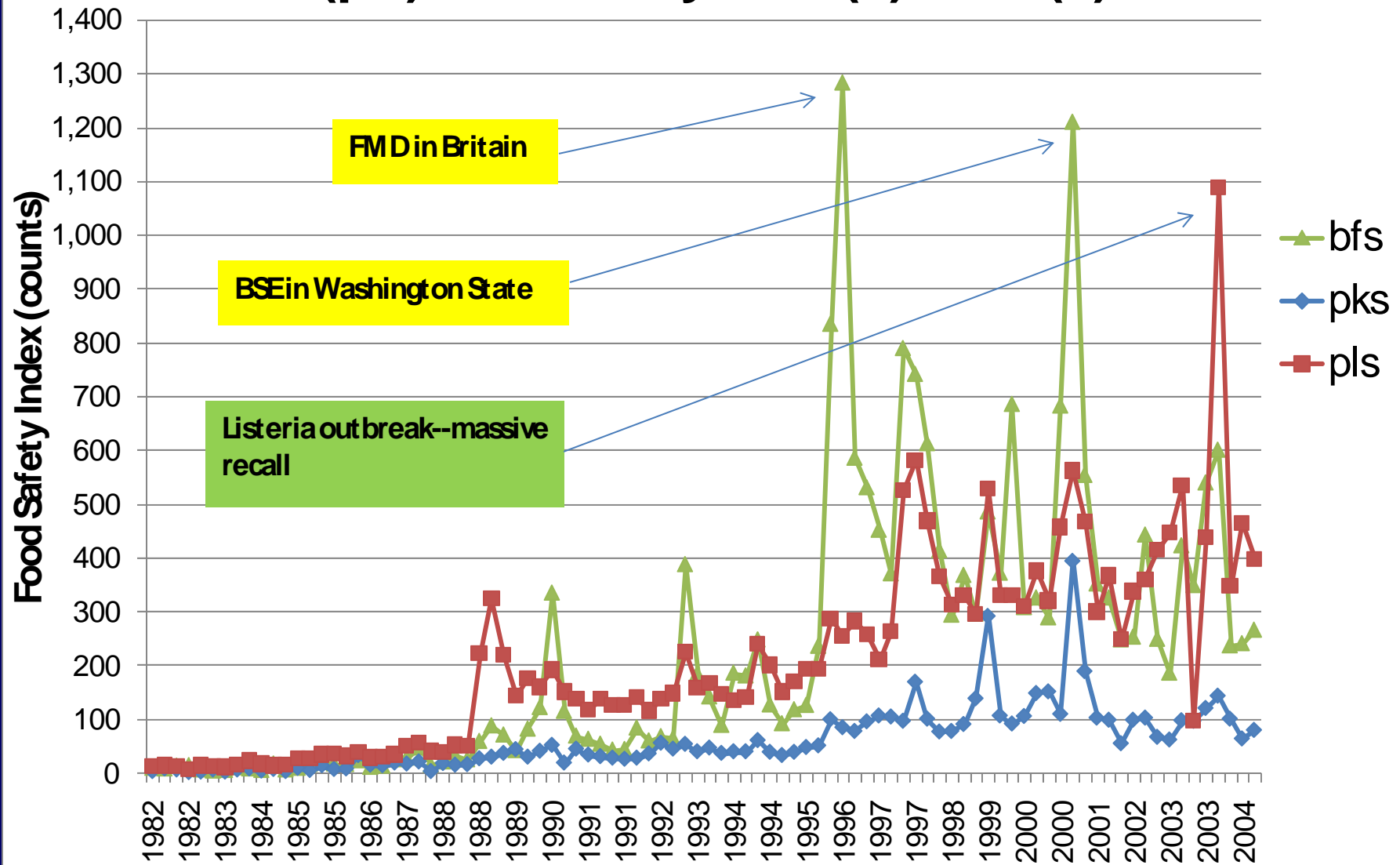
Quarterly U.S. Per Capita Beef, Pork, and Poultry Consumption 1982(1)-2004(4)



Quarterly Beef (BDE) and Pork (PDE) Advertising 1982(1)-2004(4)



Quarterly beef (bfs), pork (pks), and poultry (pls) food safety 1982(1)-2004(4)



Using Polynomial Inverse Lags (Mitchell and Speaker) to Transform Promotion and Food Safety Expenditures

True model:

$$Y_t = b + \sum_{i=0}^{\infty} w_i X_{t-i} + e_t$$

where Y_t = sales of commodity being promoted at t
 X_t = promotion expenditure or food safety index at t

Estimable model:

$$Y_t = b + \sum_{j=2}^n a_j Z_{jt} + R_t + e_t$$

where

$$Z_{jt} = \sum_{i=0}^{t-1} \frac{X_{t-i}}{(i+1)^j}, \quad j = 2, \dots, n,$$

n = highest degree of polynomial for the lag

The Generalized Almost Ideal Demand (Bollino)

$$w_i = \left(\frac{p_i c_i}{M} \right) + \left(\frac{M^*}{M} \right) \left(\alpha_i + \sum_j^N \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{M^*}{P} \right) \right) + e_i$$

$$\ln P = \delta + \sum_{j=1}^N \alpha_j \ln p_j + \frac{1}{2} \sum_{k=1}^N \sum_{j=1}^N \gamma_{kj} \ln p_k \ln p_j$$

where

p_i

c_i = price of good i

M^* = pre-committed quantity of good i

M = supernumerary expenditure

= total expenditure

Including Promotion and Food Safety Variables into the Demand System

Translating procedure (Pollak and Wales):

$$\begin{aligned}c_i = & c_{i0} + \kappa_{i1}qd1 + \kappa_{i2}qd2 + \kappa_{i3}qd3 + \varphi_i D0205 + \tau_i T \\ & + \phi_{i,b}bfs_t + \phi_{i,p}pks_t + \phi_{i,c}pys_t \\ & + \sum_{j=2}^n \omega_{i,j,b} ZBDE_{jt} + \sum_{j=2}^n \omega_{i,j,p} ZPDE_{jt}\end{aligned}$$

where

$qd1, qd2, qd3$ = quarterly dummies

T = time trend

bfs, pks, pys = beef, pork, and poultry food safety, respectively

$ZBDE, ZPDE$ = polynomial inverse lag transformation of beef and pork promotion expenditures, respectively

Hypothesis Tests--Advertising

Model	$H_0 : \text{No Adv}^a$	$H_0 : n = 2$	$H_0 : n = 3$
	$H_a : n = 2$	$H_a : n = 3$	$H_a : n = 4$
$N - R^{matrix}$	24.13^c	18.12	8.04
$D - R^{matrix}$	19.53	15.88	5.61
$F - R^{matrix}$	18.56	16.04	5.32
df ^b	6	6	6
$\chi_{0.05,df}^d$	12.59	12.59	12.59

No Adv denotes a model with no generic promotion variables included.

df denotes degree of freedom.

Bold numbers indicate statistical significance at 5% level.

Critical value for chi-square distribution at 5% level.

Hypothesis Tests--Autocorrelation

Model	$H_0 : N - R^{\text{matrix}}$	$H_0 : N - R^{\text{matrix}}$	$H_0 : D - R^{\text{matrix}}$
	$H_a : D - R^{\text{matrix}}$	$H_a : F - R^{\text{matrix}}$	$H_a : F - R^{\text{matrix}}$
<i>No Ads</i>	11.78	14.88	3.10
<i>n = 2</i>	7.18	9.31	2.13
<i>n = 3</i>	4.93	7.23	2.29
<i>n = 4</i>	2.50	4.50	1.99
Degree of freedom	1	4	3
$\chi_{0.05,df}$	3.84	9.49	7.82

Estimated Effects of Generic Promotion and Food Safety on Pre-committed Quantities

variable	beef	pork	poultry
constant	14.1665** (1.1223)	7.3004** (1.3069)	7.1534* (3.6867)
beef food safety	-0.0014** (0.0003)	-0.0016** (0.0003)	-0.0019** (0.0004)
pork food safety	-0.0023 (0.0013)	-0.0017 (0.0012)	-0.0017 (0.0018)
poultry food safety	-0.0003 (0.0002)	-0.0007 (0.0004)	-0.0015* (0.0007)
2 nd degree PIL beef promotion	-2E-7 (1.281E-7)	-1.36E-7 (9.379E-8)	-3.23E-7** (1.18E-7)
3 rd degree PIL beef promotion	2.497E-7 (1.306E-7)	1.897E-7 (9.905E-8)	3.709E-7** (1.26E-7)
2 nd degree PIL pork promotion	1.824E-7 (1.691E-7)	5.273E-7** (1.855E-7)	8.562E-7** (3.067E-7)
3 rd degree PIL pork promotion	-2.68E-7 (1.718E-7)	-5.94E-7** (1.962E-7)	-9.06E-7** (3.233E-7)

Estimated Price, Expenditure, Food Safety, and Promotion Elasticities

	beef quantity	pork quantity	poultry quantity
Marshallian Price Elasticities			
beef price	-0.7835	-0.2610	-0.0598
pork price	-0.1222	-0.6526	-0.1785
poultry price	-0.1051	-0.2196	-0.4190
Expenditure Elasticities			
Expenditure	1.0108	1.1333	0.6573
Food Safety Elasticities			
beef food safety	-0.0011	-0.0019	0.0048
pork food safety	-0.0024	0.0014	0.0036
poultry food safety	0.0027	-0.0005	-0.0055
Long-Run Generic Promotion Elasticities			
generic beef promotion	-0.0013	0.0119	-0.0137
generic pork promotion	-0.0287	0.0207	0.0380

Conclusion

- Beef and pork advertising are jointly statistically significantly different from zero
 - 3rd degree polynomial lag provides the best fit
- Pork advertising increased pork and poultry consumption at the expense of beef demand
- Beef advertising only had a statistically significant on cross-commodity impacts—negative impact on poultry consumption
- Beef and poultry food safety information is found to have negative own-effects using the updated sample
 - Beef food safety information is found to adversely affect pork and poultry demand using the updated sample
- No statistically significant impact impacts from pork food safety

Working version of paper

www.ag-econ.ncsu.edu/faculty/piggott/piggott.html