Does Negative Information Always Hurt Meat Demand? An Examination of Avian Influenza Information Impacts on U.S.

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Abstract: Consumers' consumption patterns could be affected by food safety information, however, it is more important to consider where the food safety issue occurs. If the food safety issue happens in other countries, in other words, it outbreaks out of the target market, negative information may be beneficial; in contrast, if the food safety issue occurs within the market, results may consistent with previous studies. Based on this assumption, this paper reinvestigates the impacts of AI media coverage and BSE cases on the demand of meat in U.S. market. Estimated results provide supports for our assumption, i.e., AI information has positive effect on poultry and turkey demands in short term, and BSE affect beef demand negatively.

Keywords: Avian influenza media coverage, AI human case, BSE announcements, AIDS model, meat demand

JEL code: Q1

1 Introduction

According to our knowledge from previous studies, e.g., Burton and Young (1997), Verbeke and Ward (2001), Piggott and Marsh (2004), Beach and Zhen (2008), etc., they conclude that information regarding food safety could affect consumers' consumption patterns, and negative information on food safety issues has significant effects on the allocation of consumer expenditures among meats. Their results may be reasonable because they consider the food safety information of a particular commodity item in a specific market. If the food safety issue happens outside of the target market, while information covering that food safety issue could reach worldwide, results could be different. In addition, if taking account of more than one food safety issues simultaneously, results may vary too.

Since the end of 2003, infection and disease of Avian Influenza (AI) spread widely to three continents, initially through East and Southeast Asia in 2003-2004, and then into Southern Russia, the Middle East, Europe, Africa and South Asia in 2005-2006 (Sims and Narrod, 2008; Sims, 2007). Fortunately, no human cases happened in the U.S. However, during the same period, there were three BSE announcements in U.S., i.e. 12/23/2003, 6/24/2004 and 3/13/2006. Apparently, the role of media coverage of AI should be reinvestigated under the new circumstances.

U.S. is a net supplier (exporter) of poultry meat accounting for more than one-third of global trade (Moore and Morgan, 2006) and U.S. is one of the AI-free counties to some extent, which could alter consumers' perceptions of the safety of domestic poultry meat. There is no doubt that AI information could affect meat demand, what we are really interested is, (1) to reveal the real relationship between media coverage of AI outbreaks outside of U.S. and the domestic U.S. meat demand; (2) to examine the difference between AI media coverage and BSE announcements in meat market.

There are some researches regarding to AI impacts on U.S. meat market, however, most of the studies focus on qualitative analysis (Pelzel et al., 2006; Senne, 2007; Taha 2007 and Leuck et al., 2004), and their results lack of theoretical support and ignore aftereffects on meat markets due to other food safety issue happening in the same period. Therefore, the purpose of this paper is to examine how AI information affects meat demand in U.S. by considering the BSE issue as well.

This paper is organized as follows. Section 2 summarized previous literature; Section 3 introduces models and methods; Section 4 provides data and their statistical descriptions; Section 5 presents estimation results and section 6 is the conclusion remarks.

2 Literature Review

The economic impact of food safety problems is a critical issue addressed in the literature with different focuses applying a variety of approaches. This review mainly focuses on approaches for the food scare indicators, impacts of food scares on consumer demand and the studies associated with AI, all of which are relevant to this study.

Basically, most of previous literatures employ the generalized Almost Ideal Demand System (AIDS) developed by Deaton and Muelbauer (1980). Food safety information index is imposed into the demand equation by either an indexing procedure for the volume of news, or indicator variables for the time of the event.

Burton and Young (1996) use contemporary and cumulative numbers of BSE articles as the demand shifters for transitory and permanent quality shocks, respectively and find that negative publicity about British beef have reduced beef market share by 4.5% by the end of 1993. Mazzochi (2006) propose a stochastic, time-varying response parameter to assess the impact of food scare events. His findings indicate that BSE in 1996 is linked with a small negative reaction in beef demand, along with a positive impact on pork and poultry. Marsh et al. (2004) use two indexes, the total number of recalls and the total number of news media reports in a quarter to analyze the impact of meat and poultry product recalls on consumers' demand between 1994 and 1998. They find statistically significant but economically small effects of meat recalls on U.S. meat demand and the estimated own-effect elasticities of demand are -0.00052,-0.0010 and -0.0014 for beef, pork and poultry recalls, respectively.

In a related study, Piggott and Marsh (2004) use the Generalized AIDS model, which incorporates quarterly media indices for beef, pork, and poultry safety separately. They find that heightened public alert over food safety reduce per capita beef, pork, and poultry consumption by 2.21%, 0.99%, and 6.88%, respectively. Their work is continued by Beach et al. (2007) by updating food safety indices through 2005. With the expanded sample, they get the similar results that food safety information has a significant impact on consumer demand in the U.S.

By using weekly Nielsen meat sales data, Beach and Zhen (2008) present a methodology of the polynomial inverse lag (PIL) to analysis consumer response to media coverage of avian influenza. Their results show that the short term AI media index elasticities of fresh poultry, frozen poultry, beef and pork are -0.0031, -0.0071, 0.0209 and -0.0205, respectively.

However, research assessing food safety issue caused by AI is relatively little in the U.S, neither in discussing consumer preference for meat consumption nor in estimating the interact effect between AI information and BSE issues. Only recently, Ishida et al.(2010) investigate the impacts of BSE and AI on consumers' meat demand in Japan and find that the AI outbreak had no impact on the market share of beef which suggests BSE had a larger impact on consumers' meat demand than did AI.

Although there are a lot of studies have argued food safety information, they have not found a consistent way to measure and incorporate the food safety index into the demand equations. As one of the fundamental analyses, the approach used by Burton and Young (1996) is reasonable in two aspects. First, it takes account of cumulative effects of media coverage which could last for a long period; second, it considers the persistence of consumers' preference and so meat demand could recover if the related food safety issue becomes no health risk for meat consumption.

As our sample ends in November, 2009 when AI outbreaks becomes relenting, we use the same method following Burton and Young (1996) and define the food safety information index based on monthly article numbers and cumulative article numbers to see the short term and long term impacts of AI outbreaks on meat demand in U.S market. In addition, we include confirmed AI human case as well, which is published by the World Health Organization (WHO), to emphasize the serious of the AI disease which may aggravate the strength impacts of AI information.

3 Models and Methods

Following Deaton and Muellbauer (1980), Verbeke and Ward (2001) and Beach and Zhen (2008), the generalized Almost Ideal Demand System (AIDS) models with the incorporation of information index can be expressed as below,

$$w_i = \alpha_i + \sum_{k=1}^{2} \lambda_{ik} AI_k + \sum_{s=1}^{3} \rho_{is} D_s + \varphi_i HD + \theta_i bse + \sum_{j=1}^{m} \gamma_{ij} \ln p_j + \beta_i \ln(y/P) ...(1)$$

where w_i is the budget share of the i^{th} goods; AI_k means long term AI index if $k=1$ and short term if $k=2$; D_s is the seasonal dummy with $D=1$ if t falls into s season, otherwise 0; HD indicate the cumulative confirmed AI human death cases; bse is the dummy of confirmed BSE case with 1 means there is a BSE case, otherwise 0; p_j as the price of good j ; y is the total expenditure of meat and P is the price index that is defined as,

$$\ln P = \alpha_0 + \sum_{k=1}^{m} \alpha_k \ln p_k + 1/2 \sum_{k=1}^{m} \sum_{j=1}^{m} \gamma_{kj} \ln p_k \ln p_j ...(2)$$

where α, β , γ, λ, ρ, θ and φ are parameters to be estimated, which hold for restrictions including adding-up, homogeneity, symmetry for AIDS equations,

$\sum_i \alpha_i = 1$, $\sum_i \beta_i = 0$, $\sum_i \lambda_{ik} = 0$, $\sum_i \varphi_i = 0$, $\sum_i \rho_{is} = 0$, $\sum_i \theta_i = 0$ adding-up restrictions;

$\sum_i \gamma_{ij} = 0$, homogeneity restrictions;

$\gamma_{ji} = \gamma_{ij}$, symmetry restrictions;

Since we use the nonlinear AIDS for estimation, it is much easier for us to carry out the price elasticities and income elasticities. Following Green and Alston (1990; 1991), the uncompensated own- and cross-price elasticities are calculated using the formula:

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i(\alpha_j + \sum_{k=1} \gamma_{kj} \ln p_k)}{w_i} ...(3)$$

The compensated own- and cross-price elasticities are derived as,

$$\varepsilon_{ij} = -\delta_{ij} + w_j + \frac{\gamma_{ij} - \beta_i(\alpha_j + \sum_{k=1} \gamma_{kj} \ln p_k - w_j)}{w_i} ...(4)$$

where δ_{ij} is the Kronecker delta with $\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$.

The expenditure elasticities are calculated as,

$$e_i = 1 + \frac{\beta_i}{w_i} ...(5)$$

As pointed by Elder (1997) that the Nonlinear Seemly Unrelated Regression (NLSUR) algorithm is more stable and robust with respect to poor initial values. Hahn (1994) also recommends estimating AIDS using its nonlinear form. Therefore, we use the NLSUR[1] to estimate both the short term and long term impacts of AI information.

4 Data Description

This paper includes four commodities, i.e., beef, pork, poultry and turkey and uses monthly data from January 1997 to November 2009. The total observation is 155. Monthly retail price and per capita consumption of beef, pork, chicken, and turkey were collected from RES/USDA DATA. Beef and pork prices are measured by the average retail value of retail weight equivalent, and turkey prices are measured by the retail value per pound of whole frozen birds. The chicken price is a composite price including whole bird, chicken breast, and chicken legs weighted by estimated total quantities demanded.

The per capita consumption of chicken and turkey are directly from the USDA Poultry Yearbook. Since the per capita consumption of beef and pork is not available in the USDA Red Meat Yearbook, we divide the total consumption of beef or pork, which is measured by the retail disappearance, by population that is collected from the Population Division of the US Census Bureau, to calculate the per capita consumption of beef or pork. In particular, we follow the formula below:

$$\frac{\lambda(\text{commercial meat production} + \text{net imports} + \text{beginning stocks - ending stocks})}{\text{population}},$$

where λ is the conversion factor used to convert livestock carcass to retail weight equivalent. We use $\lambda = 0.7$ for beef and $\lambda = 0.776$ for pork following USDA reports from 1997 to 2008.

AI information index are collected through using the LexisNexis Academic search engine to find news articles related to AI from up to 50 English-language newspapers worldwide. The numbers of news articles in each month is then used as a demand shifter in the model discussed above. The keywords searched are “avian influenza” or “bird flu” and the sample period for the media index is from January, 1997 to November, 2009. In addition, we also seared news articles associated with human case in the context of AI articles. As mentioned before, we also cumulate monthly short term AI index to get the long term AI index. Confirmed AI human cases are obtained from the WHO[2] from January, 28, 2004 to

[1] Set $\alpha_0 = 5$ in the NLSUR algorithm.
[2] It can be accessed through http://www.who.int/csr/disease/avian_influenza/country/en/

December, 30, 2009. Besides, a dummy variable indicating whether a BSE case is confirmed in each month in the U.S. is incorporated in the model as well.

Retail prices of beef, pork, poultry and turkey are presented in Figure 1. It can be seen that beef and pork price have the trend of increasing while turkey price seems declining. Price of poultry is unstable during 2004 and 2009. However, trends become insignificant in Figure 2 when considering the budget share of each meat. It looks that pork and poultry have the close budget share, so as their directions of changes. Probably, pork is a complementary good of poultry in U.S. meat market. And the pattern of beef budget share shows that beef is a substitute good of poultry. Based on Figure 2, it is impossible to tell the relationship between poultry and turkey, however, we know that turkey is treated as one of poultry product in super market. Since turkey takes a very small proportion of meat consumption, it is too small to become a substitute of poultry consumption.

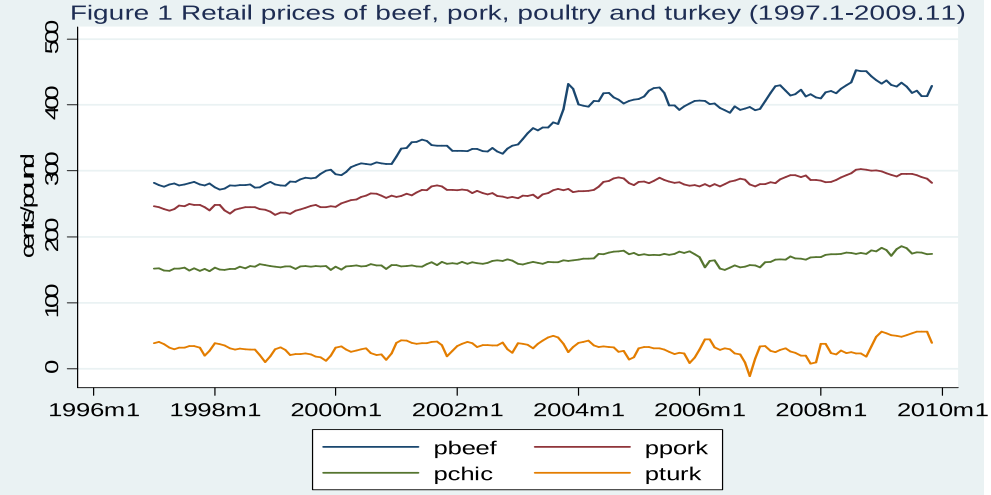

Figure 1 Retail prices of beef, pork, poultry and turkey (1997.1-2009.11)

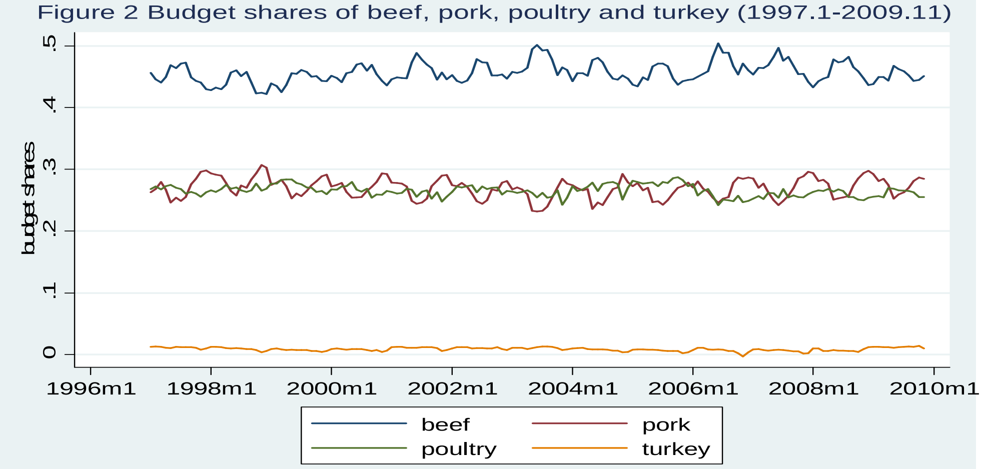

Figure 2 Budget shares of beef, pork, poultry and turkey (1997.1-2009.11)

Figure 3 shows the media coverage of AI index and AI human index. Not surprisingly, AI human index and AI index are following the some trend, which first peaked in 1997 when there was a first AI human death case confirmed in Hong Kong, China and then in 2005-2006 when AI outbreaks spread widely from Asia to other African and European countries. Because of the similarity, we use human index hereafter in our analysis.

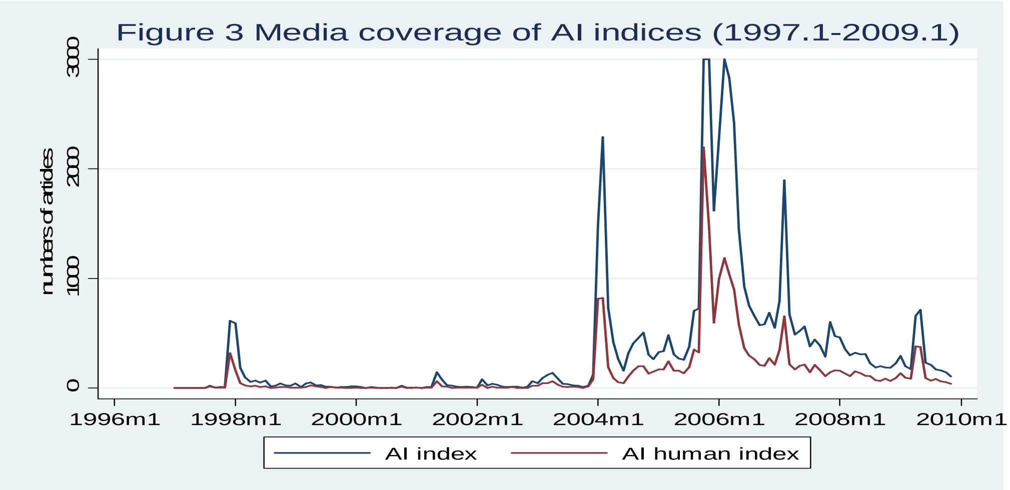

Figure 3 Media coverage of AI indices (1997.1-2009.1)

According to Beach and Zhen (2008), an advantage of media indices based on the number of outbreaks is that provide a continuous measure of consumer exposure to information regarding AI. Even if a country has not yet experienced an outbreak, consumers may respond to information on AI. More generally, consumers are likely to respond not only to domestic outbreaks but to any information that affects their perceived risk of poultry consumption and these responses become even stronger along with increased confirmed AI human death cases which were released by WHO (see Figure 4).

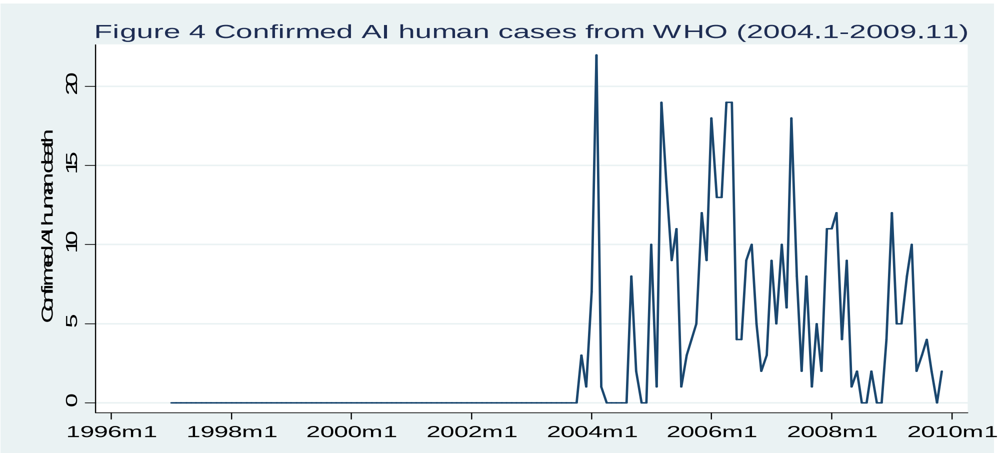

Figure 4 Confirmed AI human cases from WHO (2004.1-2009.11)

Table 1 gives statistic descriptions of our sample. The budget share of turkey is relatively small since turkey is a special poultry product which is only consumed during Thanksgiving[3]. However, we do not combine poultry and turkey together not only because it is difficult to weight but also their relationships with beef and pork are different.

Table 1 Descriptive Statistics of Data

Description	Mean	Std. Dev.	Min	Max
Short term AI media index	144.8065	287.2269	0	2198
Long term AI media index	6915.755	8310.442	0	22445
Confirmed AI human death cases	111.8194	156.0667	0	444
Price of beef (cents/pound)	359.6839	57.66245	272	452.6
Price of pork (cents/pound)	269.4155	18.4899	233.4	302.6
Price of poultry (cents/pound)	162.7394	9.4366	147.91	185.68
Price of turkey (cents/pound)	31.16548	10.79041	-11.26	56.3
Budget share of beef	0.456344	0.016477	0.422194	0.50396
Budget share of pork	0.269666	0.016099	0.232217	0.306901
Budget share of poultry	0.26524	0.009258	0.242299	0.286986
Total expenditure	5756.53	714.4254	4324.144	7416.384
Budget share of turkey	0.00875	0.002907	-0.00308	0.013717

Note: the total observation is 155.

5 Estimation Results

Estimated parameters for each equation are presented in Table 2, where results for the fourth equation are retrieved by using constraints of adding-up, homogeneity and symmetry as discussed above.

Obviously, short term and long term AI information have totally different effects on meat demand. In short term, poultry and turkey demands are increasing as increased numbers of news articles related to AI. If negative information could affect meat demand adversely, here is counterexample. As AI outbreaks happened outside of U.S., poultry demand in world market is reduced due to the potential heal risks of poultry consumption. Considering U.S. is the major poultry exporter, supply of poultry in world market does not change as much as changes of demand. Hence, poultry price is declining. In the short term, consumers in U.S. benefit of reduced poultry price, the marginal increase of poultry demand could be 0.000792% and it is significant at the 1% level. And turkey demand could increase by 0.0000476% at the significant level of 10%. If beef is the substitute for poultry in the short term, AI information has significant (at the 1% level) and negative effect on beef demand (-1E-05) and there is no significant on pork demand.

[3] It also gives us a good reason to include winter seasonal dummy and use summer as the base.

However, in the long term, the story is opposite. When AI outbreaks become more serious, more people died because of AI disease and they have expanded to more countries in Africa and Europe continents rather than in Asia. More importantly, there has been considerable speculation about the mode of entry of H5N1 HPAI[4] virus into unaffected countries, especially concerning the relative role of trade in poultry and movement of free-flying wild birds (Sims and Narrod, 2008). U.S. consumers have become increasingly concerned that AI disease poses a "serious health risk", so demand of poultry and turkey are declining by 0.000179% and 0.0000199%, respectively, both are significant at the 5% level. Meanwhile, beef demand is increasing by 0.000449% at the 1% level.

The announcements of BSE cases in U.S. indeed affect demands of meat although coefficients are very small. It reduces beef demand by 0.025% while increases pork, poultry and turkey demands by 0.0161%, 0.0078% and 0.00106%, respectively, all of which are significant at least at the 5% level. These results provide the evidence that negative information could affect meat demand negatively only if the related food safety issue happens inside of the market.

Poultry demand is enhanced if the AI information becomes stronger. Once there are more people died because of AI disease, consumers become more cautious about their consumption behaviors even through there is no human case occurred in U.S. Poultry demand is declining by 0.684% and it is statistically significant at the 10% level. For other meats, effects are insignificant.

Most seasonal effects are statistically significant and satisfied our expectations. For example, demands of beef, pork, and poultry are decreasing in winter while they are increasing in spring when summer is the base. In fall, people consume more pork and turkey by 0.3489% and 0.03009%, respectively, and less poultry (-0.511%) compared to summer. Fall season includes September, October and November, and November is the time for preparing the Thanksgiving. Only in this season, turkey becomes the substitute for poultry. Since the budget share of turkey is very small, the estimated parameter in very small and significant at the 10% level.

[4] It means the highly pathogenic avian influenza and H5N1 is a subtype of the AI virus,

Table 2 Estimated Results from NLSUR

	beef	pork	poultry	turkey
α_i	0.442054***	0.196933***	0.340097***	0.0209157***
	(0.034165)	(0.033345)	(0.021319)	(0.002445)
λ_{1i}	4.49E-06***	-2.50E-06**	-1.79E-06**	-1.99E-07**
	(1.08E-06)	(1.08E-06)	(7.60E-07)	(8.13E-08)
λ_{2i}	-1E-05***	1.80E-06	7.92E-06***	4.76e-07*
	(3.66E-06)	(3.52E-06)	(2.19E-06)	(2.53E-07)
θ_i	-0.00025***	0.000161***	0.000078**	0.0000106**
	(5.48E-05)	(5.51E-05)	(3.81E-05)	(4.12E-06)
φ_i	-0.00159	0.008662	-0.00684*	-0.0002382
	(0.006498)	(0.006174)	(0.003796)	(0.000445)
ρ_{1i}	-0.03039***	-0.01876***	-0.02346***	-0.0000794
	(0.002629)	(0.002467)	(0.002449)	(0.000181)
ρ_{2i}	0.03106***	0.015335***	0.028268***	-0.0000611
	(0.002502)	(0.002352)	(0.002346)	(0.00017)
ρ_{3i}	-0.00059	0.003489**	-0.00511***	0.0003009*
	(0.001553)	(0.001457)	(0.001467)	(0.000175)
γ_{1i}	0.062785***	-0.05839***	-0.00092	-0.0034819***
	(0.012711)	(0.012054)	(0.007187)	(0.000827)
γ_{2i}	-0.05839***	0.141942***	-0.08278***	-0.000778
	(0.012054)	(0.020058)	(0.015646)	(0.001344)
γ_{3i}	-0.00092	-0.08278***	0.086394***	-0.002697**
	(0.007187)	(0.015646)	(0.015154)	(0.001183)
γ_{4i}	-0.0034819***	-0.00078	-0.002697**	0.006172***
	(0.000827)	(0.001344)	(0.001183)	(0.001546)
β_i	-0.00256	-0.01391	0.018037*	-0.001573
	(0.018143)	(0.017197)	(0.010596)	(0.001242)

Note: *, **, *** indicate significant at the 10%, 5% and 1% level; Standard deviations are presented in parentheses; the total observation number is 155 in each equation.

Using equations of (3), (4) and (5), Table 3 shows the uncompensated and compensated own- and cross price, expenditure and AI index and BSE elasticities. As expected, all uncompensated and compensated own-price elasticities are negative. The uncompensated own-price elasticities for beef, pork, poultry and turkey are -0.85979, -0.46208, -0.69484 and -0.29405, respectively, which is similar to the results in Jin et al., (2010) where they use monthly data from 1982 to 2006.

All expenditure elasticities are positive. Only poultry has expenditure elasticity larger than one which indicates that poultry are the luxury good for U.S. consumers. All other expenditure elasticities are less one meaning they are normal goods. These results are consistent with results in Table 2, where the parameter of poultry is bigger than zero ($\beta > 0$) and for other meat, they are less than zero ($\beta < 0$).

Table 3 Uncompensated and Compensated Own-price, Cross price, Expenditure and Other Index Elasticities

	beef	pork	poultry	turkey
	Uncompensated own- and cross-elasticities			
beef	**-0.85979**	-0.12669	-0.00032	-0.00761
pork	-0.19241	**-0.46208**	-0.29138	-0.00276
poultry	-0.03527	-0.32733	**-0.69484**	-0.01039
turkey	-0.31386	-0.04887	-0.25388	**-0.29405**
	Compensated own- and cross-elasticities			
beef	**-0.40345**	0.141458	0.263432	0.00109
pork	0.240398	**-0.19241**	-0.03982	0.005531
poultry	0.452108	-0.03933	**-0.4296**	-0.00105
turkey	0.060449	0.172323	-0.03632	**-0.2853**
	Expenditure, AI information, AI human case and BSE elasticities			
expenditure	0.99439	0.948418	1.068002	0.820233
long term AI information	0.004252	-0.003	**-0.00132**	-0.00085
short term AI information	-0.95003	0.21676	**0.585716**	0.204349
AI human death cases	-0.02434	0.168102	**-0.08152**	-0.01648
BSE	**-6.6E-07**	5.41E-07	1.61E-07	1.27E-07

Note: for point estimation, we use the mean value of variables, some of them are listed in Table1; the total observation number is 155 in each equation

Consistent with our estimation results, short term AI information have positive effects on poultry, turkey and pork while it has negative effect on beef. However, situation is reversed in long term. Consumers are more price-responsive in the short run than in the long run because of inventory behavior (Beach and Zhen, 2008). So the long term AI index elasticities are 0.004252, -0.003, -0.00132 and -0.00085 for beef, pork, poultry and turkey, respectively.

Additionally, the severity of AI disease reminds people that there is high possibility to get sick if eating poultry and they don't believe domestic poultry is safer than that from outside of U.S. Although price could be cheaper than before, consumption of poultry declines along with more reported confirmed AI human cases. Since BSE cases are announced in U.S., it affects meat consumption immediately. The elasticities of BSE case are -6.6E-07**,** 5.41E-07, 1.61E-07 and 1.27E-07 for beef, pork, poultry and turkey, respectively.

Based on the results of short term AI information and BSE case, it is worth noting that impacts of food safety issues mostly depend on where they occur. If they are happening in the same market where consumption takes place, there is no doubt that negative information could alter consumers' behavior adversely. However, if food safety issue only occurs outside the target market, former conclusion should be reexamined. Nevertheless, both cases are analyzed in this paper and our arguments are supported by estimated results.

6 Conclusion Remarks

In demand analysis, the prevalent opinion is information regarding food safety could affect consumers' consumption patterns, and negative information on food safety issues reduce demand for the item which relates to it. However, it is not always the case. By imposing AI media coverage, AI human death cases and BSE cases, this paper examine their impacts on meat demand in U.S market from January, 1997 to November, 2009 to investigate the demand changes under such condition. From the generalized AIDS model, results in Table 3 confirm our expectation that negative information is not always hurt meat consumption and it is more case dependent.

As AI outbreaks happen in countries other than U.S., and U.S.is the second-largest exporter of poultry meat (USDA, 2009), the media coverage of AI behaves oppositely in short term and long term. In short term, AI information significantly increases demand for poultry and turkey, although magnitudes are small. However, in long term, consumers become responsive to the health risk of poultry meat, and it becomes worse when more AI human cases are confirmed by the WHO. On the other hand, there are three BSE announcements in U.S. which provides signal that beef contains a high potential health risk, so it is not surprising that beef demand declines corresponding to BSE cases.

Generally, under the AI media coverage, poultry and turkey demand could increase by 0.0000476% and 0.000792%, respectively in short term. In contrast, they could be reduced by 0.000179% and 0.0000199%, respectively in long term. Our estimated elasticities also support these results.

In a policy perspective, understanding how consumers respond to food safety information is very important for developing appropriate risk communication strategies (Beach and Zhen, 2008) and it is more significant to decompose effects into a specific circumstance. If not doing this, results may be overestimated or underestimated and policies which are based on those results could be biased.

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