Avian Influenza: outbreaks and the impact on UK consumer demand for poultry.

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Abstract

According to FAO (2008) the year 2006 was identified as the 'peak' of the highly pathogenic avian influenza (HPAI) H5N1 with 60 countries reporting outbreaks. The UK had its first confirmed AI outbreak in March 2006 and, to date, the country has experienced eleven AI outbreaks. Most countries reporting AI outbreaks had, as a result, experienced a highly negative impact on their poultry consumption. This paper sets out to examine how AI outbreaks affected UK consumer demand for poultry. Pilot data have been obtained on a four weekly basis from the Agriculture and Horticulture Development Board (AHDB) for the period May 2nd 2010 to March 1st 2015. By employing the Almost Ideal Demand System (AIDS) model, the preliminary results have indicated that during the examined period poultry meat had the highest demand in terms of monetary amounts accounting for 43 per cent of the market. Overall, the pilot data revealed that there is no evidence to support that the occurrence of an AI outbreak, either in the UK or elsewhere in the world, had affected consumption of poultry in the UK. This result complies with the FAS London statement that UK consumers have 'faith' in poultry.

Keywords AIDS model, Avian Influenza, Consumer demand, Food safety, Poultry sales and consumption

JEL code Q13

1. Introduction

The impact of an Avian Influenza (AI; Bird flu) outbreak could be experienced on all levels of the chain, from producers, processors to consumers (Rushton et al, 2005). The FAO (2015) has pointed out that uncontrolled outbreaks of AI could lead to grave consequences such as the death of birds through large scale infection or through culling which would subsequently result in loss of poultry producers' income; and the severe impact on human health by compromising food safety and security. Since the first confirmed human case reported in Vietnam, in December 2003 (Chang et al, 2010) more than 826 human cases have been confirmed of which 440 were fatal (WHO, 2015). As a result of the fear of a human pandemic reduction in poultry meat consumption could also be experienced (FAO, 2015).

In 2005, Asian nations (Cambodia, People's Republic of China, Indonesia, Japan, Lao's People's Democratic Republic, Republic of Korea, Malaysia, Pakistan, Vietnam, Thailand) had reported Bird flu outbreaks (Kraipornsak, 2010). Along with many human fatalities, a total of approximately 140 million birds died or were destroyed as a result of the disease and it was estimated that the overall GDP loss was as high as US$10 billion to US$15 billion (*ibid*). Poultry consumption was widely affected with chicken consumption in Thailand reportedly reduced by approximately 30 per cent (*ibid*).

In 2006, countries of the European continent reported Bird flu outbreaks (Taha, 2007). The impacts differed between countries. Some EU member countries like Greece and Italy experienced extreme drops of consumption levels (Valceschini, 2006) with both reporting up to 70 per cent of reduction of sales (USDA, 2006a; USDA, 2006b); while other EU member countries reported reductions of 20 per cent to 30 per cent, i.e. Belgium, Poland and Germany (Valcenschini, 2006). In Spain, despite no reported AI incident, the country's consumption levels decreased by 10 per cent (*ibid*). The only country in the EU that appeared to have stable poultry consumption levels was the UK (*ibid*; USDA, 2006c). However, the Foreign Agricultural Services (FAS) London point out that the 'faith' UK consumers had in poultry had to be tested after a confirmed AI case was reported within the UK(USDA, 2006c).

The aim of the present paper is to briefly inform how AI outbreaks have influenced consumer demand for poultry around the world and to examine, using a quantitative approach, whether AI outbreaks have affected UK domestic consumption of poultry. Hence, the paper is structured as follows: Section 2 discusses selected AI outbreaks in countries of the European continent including the UK; Section 3 presents consumer responses to AI outbreaks and the existing literature on UK consumer response to AI outbreaks; Section 4 provides the methodology and data used to empirically investigate UK consumer demand for poultry; Section 5 presents and discusses the results; and the paper ends with a brief conclusion.

2. Selected AI outbreaks including those occurred in the UK.

According to FAO (2008) the year 2006 was identified as the 'peak' of the highly pathogenic avian influenza (HPAI) H5N1 with 60 countries reporting outbreaks. The total number of confirmed human cases was 115 of which 79 were fatal (WHO, 2015).The following discussed countries (Greece, Italy, France, Turkey) all reported AI outbreaks within their territories and experienced reduction in poultry consumption. The UK had its first confirmed AI outbreak in March 2006 and, to date, the country has experienced eleven AI outbreaks.

Greece

In early 2006 six confirmed cases of H5N1 had occurred in Greece (USDA, 2006a).Greece is a country that produces approximately 180,000 MT of poultry meat per annum, meeting about 80 per cent of the domestic demand before experiencing AI (USDA, 2006a). Influenced by the outbreaks of AI in Turkey and Romania, in October 2005, Greek poultry consumption had already experienced a drop by approximately 55 per cent (*ibid*). Thereafter, the country reported AI within its own territory and the decline continued reportedly possibly as high as 70 per cent (*ibid*). The total economic damage, as estimated by both the Greek Ministry of Agriculture and the domestic poultry industry was over 50 million Euros (*ibid*).

Italy

As in the case of Greece, Italy experienced a drop of poultry consumption before the disease entered its own territory. Its annual poultry meat consumption, in 2005, had dropped by approximately 7 per cent as a result of the occurrence of AI in other European countries (USDA, 2006b). However, the report of AI in wild birds within Italy's territory resulted into further reduction in consumption levels. According to all major farmer organizations the economic impacts were profound (*ibid*). It was reported that poultry consumption had decreased by approximately 70 per cent from normal and that the industry was losing between 5 and 6 million Euros a day, resulting to a total cost of approximately 500 to 700 million Euros between October 2005 and February 2006 (*ibid*).

France

France reported H5N1 bird flu incidence in late February 2006 on a commercial poultry farm (USDA, 2006c). This resulted to an immediate and significant decline in the country's poultry consumption levels as high as 30 per cent (*ibid*).

Turkey

Bird flu outbreaks of the H5N1 strain was reported in the first instance in October 2005 and in December of the same year (Yalcin, 2006). Even though the first outbreak was quickly eradicated, the second had severe consequences as it resulted in human deaths and in panics among consumers (*ibid*). However, the impacts were short lived with the sector exhibiting initial signs of recovery by the end of February 2006 and resuming to normal levels by June 2006 (*ibid*).

Due to loss of consumer confidence the poultry meat market collapsed and sales dropped with prices recording steep reductions dropping below the cost of production (*ibid*). The estimated loss attributed to the decrease in production level was approximately 27 million YTL (approximately £6 million) while the losses due to decrease in market prices was approximately 102 million YTL (approximately £26 million) (*ibid*).

The finding of Yalcin (2006) revealed that AI outbreaks seemed to have different market impacts in different regions of Turkey. For instance, in Ankara (capital city of Turkey), broiler meat prices and sales volumes decreased by 32 per cent and 54 per cent respectively, whereas, in Erzurum (relatively small market in Eastern Turkey)the prices decreased by 12 per cent, while sales volumes increased by 78 per cent (*ibid*). Yalcin (2006) concluded that these findings imply that consumer perceptions about the risk of AI may not be the same in different regions of Turkey.

United Kingdom

Poultry meat is the leading meat consumed in the UK accounting for approximately 50 per cent of all meat eaten in the country (BritishPoultry, 2015). The poultry sector produces over 937 million commercial broilers, 35 million commercial layers, and 16 million turkeys (BPEX, 2015). It employs over 55,000 people across the country and has over 2,500 poultry farms and 30 food productions sites and slaughterhouses (BritishPoultry, 2015).

During the beginning of 2006 UK consumption of poultry meat remained unaffected despite the continued international media reports of AI in birds and humans across Europe (USDA, 2006d). However, the FAS London reported that this consumer 'faith' in poultry that had led to steady consumption levels could not be tested until a confirmed AI case was reported within the UK (USDA, 2006e). After February 2006, the UK reported 11 confirmed AI outbreaks. More specifically:

- *2006*

As the global spread of AI continued in 2006, the UK reported the disease within its territory. During 2006 there were 166 investigations carried out into suspect cases in the UK (Defra, 2006). There were, subsequently, two confirmed outbreaks of Bird flu. The first was the HPAI H5N1 strain, found in a dead wild swan in Fife, Scotland (ThePoultrySite, 2007). Investigations concluded that the swan had come from outside the UK (*ibid*). The second outbreak was identified as the Low Pathogenic Avian Influenza (LPAI) strain H7N3 at three commercial poultry holdings in Dereham, Norfolk (*ibid; Defra, 2006*). A total of 8,000 laying hens and 32,000 broiler breeders were destroyed (*ibid*).

- *2007*

During 2007 there were three confirmed outbreaks of AI due to H5 or H7 subtypes (Defra, 2007a). These included the following:

*HPAI H5N1 outbreak in Upper Holton, Suffolk in February 2007.*A total of 153,000 turkeys were destroyed. According to market analysts Nielsen it cost the British poultry industry £9.4m in lost sales over a 12 week period (Owen, 2014).

*LPAI H7N2 outbreak in North Wales and North-West England in May 2007.*On 7th May 2007 two farms, one near Corwy (North Wales) and one in St Helens (North west England) reported illness and mortality in birds they had previously bought at the Chelford Market (Defra, 2007b). Both farms had confirmed cases of H7N2 (*ibid*). Forty two farm birds and two peacocks were destroyed.

HPAI H5N1 outbreak on two poultry premises in Norfolk in November 2007. This outbreak appeared to be unrelated to the earlier outbreak. A total of 90,000 birds were destroyed (52,000 ducks, 5,000 geese and 33,000 turkeys).

- *2008*

In 2008 two AI outbreaks occurred; one in January in Dorset with six wild birds testing positiveofH5N1 and the other in June in Oxfordshire with a free range layer flock testing positive of HPAI H7N7 (Defra, 2008). The first incidence remained limited within the wild bird population (*ibid*) while the latter resulted in the destruction of 21,000 laying hens and pheasants.

- *2014*

After a five year period, a confirmed case of HPAI H5N8 was reported in an indoor holding with 6,000 breeding ducks in North Yorkshire in November 2014 (ECDC, 2014). A possibility of this incidence being linked to the outbreaks that had occurred during the same period in Germany and the Netherlands has been suggested (*ibid*).

- *2015*

In 2015 the UK had experienced two outbreaks: one in a Hampshire chicken farm in February and one in a Lancaster poultry farm in July. Both were identified as H7N7 cases (Defra, 2015; Quinn, 2015) with the formal identified as LPAI and the latter as HPAI. A total of 10,000 birds were destroyed in February and according to Harrold (2015) 170,000 birds were culled in July.

- 2016

In January a LPAI H5N1 was confirmed in a single poultry farm in Dunfermline, Scotland. It was reported that 40,000 birds were destroyed.

The following Table 1 provides a summary of all the UK outbreaks that have occurred indicating the date, the virus strain, the location and the number of birds destroyed or having died due to the disease.

Table 1: List of AI outbreaks that have occurred in the UK

Date	Avian Influenza Strain	Location	Outbreak magnitude
March 2006	H5N1	Cellardyke, Fife, Scotland	1 wild whooper swan
April 2006	H7N3	Dereham, Norfolk, England	8000 laying hens, 32000 broiler breeders
February 2007	H5N1	Holton, Suffolk, England	153000 turkeys
May 2007	H7N3	Conwy, Wales	45 farm birds, 2 peacocks
November 2007	H5N1	Suffolk, England	52000 ducks, 5000 geese, 33000 turkeys
January 2008	H5N1	Dorset, England	6 wild mute swans
June 2008	H7N7	Oxfordshire, England	21000 laying hens and pheasants
November 2014	H5N8	East Yorkshire, England	6000 duck breeding farm
February 2015	H7N7	Hampshire, England	10000 birds
July 2015	H7N7	Lancaster, England	170000 birds
January 2016	H5N1	Dunfermline, Scotland	40000 birds

Source: Own compilation

3. Consumer response to AI outbreaks

The literature has revealed that AI outbreaks do affect consumer poultry consumption. Ishida et al (2006) investigated the effect of AI on Japanese poultry consumption. By employing the Almost Ideal Demand Systems (AIDS) model, they revealed that the Japanese market experienced gradual shifts in the demand structure due to AI outbreaks and that the AI outbreak had a negative impact on poultry and beef meat. Furthermore, their study also revealed that an AI outbreak had positive effects on demand for pork and fishery products, which are considered substitutes to poultry.

Kraipornsak (2010) examined the effect of AI on chicken consumption in Thailand. According to this study, chicken consumption declined due to the disease by 29 per cent in the first year of prevalence. However, the effect appeared to be temporary and was not found to be statistically significant beyond the first year of occurrence. The author suggests that more knowledge and better information resumed consumer confidence.

Mu et al (2013) investigated the impact of AI media coverage on meat demand in the USA. Their AIDS model revealed that AI outbreaks that occur closer to home have a greater impact in the short run than those occurring overseas. However, in the long run all outbreaks negatively influence consumption patterns. More specifically their study showed that AI media coverage induced an increase in pork budget share and the reports of confirmed human fatalities in other countries increased beef expenditure and reduced chicken expenditure.

Beach and Zhen (2008) examined the effect of AI media coverage on Italian poultry consumer purchases. By employing the AIDS model and the generalized method of moments (GMM) their analysis revealed that an increase in media coverage, whether specifically mentioning Italy or not, led to negative effects on poultry consumption and positive effects on beef and pork consumption. It appeared that fresh poultry sales were more responsive to media coverage in comparison to frozen poultry sales. The authors supported that consumers had greater concern about fresh products with respect to food safety. They also found that Italian specific media coverage had a negative effect in the group expenditure on meats.

Lui et al (2009) investigated the potential effect an AI outbreak could have on the demand for chicken and egg products in Taiwan by surveying primary shoppers and general consumers. Their survey revealed that in the case of an AI outbreak 43 per cent of primary shoppers would stop eating chicken while only 28.23 per cent of general consumers stated that they would stop eating chicken. Overall, their study indicated that risk perception about AI, knowledge of AI and some socio-economic conditions such as gender, age and education are important factors.

Figuie and Fournier (2008) examined Hanoi consumer reaction to AI. Their survey revealed that 74 per cent of respondents had stopped eating poultry due to the AI crisis but quickly resumed consumption. According to the authors the decrease in demand was such that traders were forced to stop selling poultry. However, consumption resumed within four months but consumers declared they did not eat the same quantities as prior to the outbreak.

Akben et al (2008) examined consumer responses to the Turkish AI outbreak between October 2005 and April 2006. Their findings revealed that consumers that had knowledge on how the virus was transmitted had lower concerns about food safety compared to consumers that had lack of knowledge. Their study also revealed that media coverage increased the level of concern.

Until the beginning of 2006 the UK had not experienced any AI outbreaks and consumer confidence appeared to not be influenced by the international media from AI outbreaks elsewhere in the world. However, FAS London commented that this confidence could not be examined until an outbreak occurred within the UK territory (USDA, 2006e). Since, eleven outbreaks have occurred but to the author's knowledge no quantitative study has been undertaken to examine whether any AI outbreaks have affected domestic poultry consumption.

Rowe et al (2008) examined the UK public's reactions during the first H5N1 outbreak on a turkey farm site by analysing people's opinions posted on the BBC website. Their study provided qualitative evidence that the AI outbreak had a negative impact on their turkey consumption. This was also backed by the statistics reporting that the turkey farm had a 40 per cent reduction in their sales (Rowe et al, 2008) and that sales for fresh turkey had reduced by 29 per cent for a 12 week period and for frozen turkey had dropped by 33 per cent compared to previous year's figures (*ibid*). Rowe et al (2008) commented that consumers turned to substitute meat such as chicken.

De Krom and Mol (2010) conducted qualitative in-store interviews to UK consumers purchasing poultry products right after the UK outbreaks. From consumers interviewed at market vendors, only two consumers out of 22 interviewed had changed their poultry consumption habits (*ibid*). The first consumer ceased consuming chicken meat altogether for a two week period but resumed after gaining confidence that British meat '*is the best in the world'* and only consumed British poultry (*ibid*). The second consumer stopped feeding her children with poultry products of a specific reported farm while the rest of the interviewees did not reveal any alteration in their consumption behaviour (*ibid*). From consumers interviewed at supermarkets, ten out of 30 interviewees changed their consumer behaviour (*ibid*). The majority, 9 of them, either lowered or stopped their poultry consumption while one increased his consumption taking advantage of the discounted prices (*ibid*).

Mazzocchi et al (2007) developed a log-log model investigating factors that affected consumer response to information on AI outbreaks. Their study however was carried out before an AI outbreak occurred in the UK and their results are comparative between Italy and the UK. Their analysis revealed that UK consumers had stronger preferences towards chicken in comparison to their Italian counterparts. The adverse impact of AI media coverage was much stronger in Italy than the UK and the starting level of risk perception was higher in Italy than the UK indicating that poultry consumption was likely to suffer more in Italy than the UK.

Finally, Gstraunthaler and Day (2008) investigated the level of AI knowledge and the factors influencing poultry consumption behaviour of higher education students in the wake of the first H5N1 outbreak in the UK. The results revealed that 98.4 per cent of the respondents believed AI could lead to potential health concerns but the majority indicated it as being of 'moderate' concern (Gstraunthaler and Day, 2008). In terms of consumption behaviour, the majority indicated they would not change their behaviour with only 39.5 per cent stating they would adopt some risk reducing strategy (*ibid*).

4. Material and Methods

Methodology

The examination of consumer behaviour of consuming highly perishable goods, such as meat, is benefited by the employment of demand models (Holt and Balagtas, 2009; Mu et al, 2013). The literature on applied demand analysis reveals that the Almost Ideal Demand System (AIDS) is a popular method (Taljaard et al, 2004; Ishida et al, 2006; Wadud, 2006; Chang et al, 2010). It appears to be dominating in the literature of consumer demand for animal food products with several studies employing this method (Bharumshah and Mohamed, 1993; Ishida et al, 2006; Wadud, 2006; Motallebi and Rendell, 2013; Mu et al, 2013).

The AIDS was developed by Deaton and Muellbauer (1980). According to Motallebi and Pendell (2013) studies in the literature (see Taljaard et al, 2006; Paraguas and Kamil, 2005) have delved into the comparison of models, notably the comparison between AIDS and the

Rotterdam model and have concluded that the AIDS model fits the data better and, hence, is viewed as more favourable (see Taljaard et al, 2004).

The AIDS model expresses a consumer cost minimization problem through an expenditure function (Deaton and Muellbauer, 1980) which defines the lowest expenditure level needed in order to achieve a specific utility level at specific prices (Verbeke and Ward, 2001). Demand functions, in the form of budget shares, are then derived by the logarithmic differentiation of the expenditure function with respect to prices (*ibid*).

If we denote the amount of goods in the system by q, and the price of each good i as p_i, then x_i could represent the consumption of good i and S_i could be the budget share of good i. Hence the budget shares could be represented by a linear function of logarithmic p and logarithimic X (Ishida et al, 2006; Wadud, 2006):

$$S_i = a_i + \sum_{j=1}^{q} \gamma_{ij} \ln p_j + \beta_i \ln \frac{X}{P} \qquad \text{i=1,2,…,q}$$

Where a_i, β_i, γ_{ij} are parameters, where the slope coefficients β_i, γ_{ij} indicate the expenditure and price effects on the demand for the q goods (Fujii, et al, 1985) and X denotes the total expenditure which is given by:

$$X = \sum_{i=1}^{q} p_i x_i$$

lnP is the translog price index given by:

$$\ln P = \alpha_0 + \sum_{i=1}^{q} a_i \ln p_i + \frac{1}{2} \sum_{i}^{q} \sum_{j}^{q} \gamma_{ij} \ln p_i \ln p_j$$

In practice, α_0 is difficult to estimate and therefore many have suggested (see Poi, 2012) its value to be set lower than the lowest value of the logarithm of the household income ($\ln m$).

Economic theory suggests that the following restrictions must be satisfied:

Adding up: $\sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \sum_i \beta_i = 0$

Homogeneity: $\sum_j \gamma_{ij} = 0$

Symmetry: $\gamma_{ij} = \gamma_{ji}$, i≠j

In addition, demographics may be incorporated in the system using Ray's (1983) scaling technique. If z represents a vector of k characteristics and $e^R(p,u)$ represents the expenditure function of a reference household, then Ray's method forms the expenditure function as follows:

$$e(p,z,u) = m_o(p,z,u)x\, e^R(p,u)$$

With the expenditure function being scaled by $m_o(p,z,u)$ (Poi, 2012).This can be further explained as:

$$m_o(p,z,u) = \overline{m}_o(z)x\, \varphi\,(p,z,u)$$

Where $\overline{m}_o(z)$ estimates the increase in household expenditure depending on z without controlling for consumption pattern changes and is defined as $\overline{m}_o(z) = 1 + \rho' z$ (Poi, 2012). The second term $\varphi\,(p,z,u)$ controls for changes in the goods consumed and the relative prices and according to Poi (2012) can be parameterized as follows:

$$ln\varphi\,(p,z,u) = \frac{\prod_j^q {p_j}^{\beta_j}(\prod_{j=1}^q {p_j}^{\eta' z} - 1)}{\frac{1}{u}}$$

This approach adds an additional adding- up requirement, that of:

$\sum_{j=1}^q \eta_{rj} = 0$, for r= 1,...,n.

The estimations of the AIDS equations have no straightforward economic interpretation but are the basis for the formation of elasticities (Wadud, 2006). There are two types: the Hicksian (compensated) and the Marshallian (uncompensated) elasticities.

The Hicksian price (compensated) elasticity, which is compensated for the effect of a change in the relative income on demand as it only contains price effects (Taljaard, et al, 2004) is derived by the Slutsky equation ($\epsilon_{ij}^H = \epsilon_{ij}^M + \mu_i S_j$) and is given by the following:

$$\epsilon_{ij}^{H} = -\delta + \frac{\gamma_{ij}}{S_i} - S_j$$

The Marshallian price (uncompensated) elasticity, which contains income and price effects (Taljaard et al, 2004) is given by the following:

$$\epsilon_{ij}^{M} = -\delta + \frac{\gamma_{ij}}{S_i} - (\frac{\beta_i}{S_i})S_j$$

Where δ is the Kronecker delta.

In addition the Marshallian expenditure elasticity is given by the following:

$$\mu_i = 1 + \frac{\beta_i}{S_i}$$

Data

Demand is estimated for pork, beef, lamb and poultry. We obtained four weekly rather than monthly data on the retail quantity in tonnes sold and retail value in £ million sold in the UK of the aforementioned animal products from the Agriculture and Horticulture Development Board (AHDB) for the period May 2nd 2010 to March 1st 2015. Retail prices were difficult to obtain, specifically for poultry as there are no published prices due to the highly consolidated and vertically integrated nature of the supply chain (Howarth, April 10th 2015, personal communication). Hence, average prices were used.

If we denote the four weekly average price of good i as p_i, the purchased four weekly quantity of good i as x_i and the value of the four weekly quantity of good i as v_i, then the four weekly average price of good i could be calculated as follows:

$$p_i = \frac{v_i}{x_i}$$

Thereafter, we are able to calculate the market share, S_i, of each type of meat as follows:

$$S_i = \frac{p_i x_i}{\sum_{j=1}^{q} p_j x_j} \qquad \text{for all i,j = 1, 2,…, q}$$

In order to capture any effect the occurrence of an AI poultry outbreak may have on the consumption of poultry, two animal disease indices were constructed; an AI dummy variable indicating whether an AI poultry case occurred within the UK territory and an AI dummy variable indicating whether an AI poultry case occurred elsewhere in the world. These were inserted into the model as demographic characteristics as they can be defined as periods consumers are aware of AI outbreaks, either domestically or internationally. This paper has assumed that each AI outbreak was followed by media coverage making consumers aware.

Data on whether an AI poultry outbreak occurred either within the UK territory or elsewhere in the world was taken from the OIE[1] website. This site provides an up to date list of all notifications of HPAI types H5 and H7 in OIE member countries since 2003. More specifically, it lists the country of occurrence, the type of HPAI and the date of notification as well as follow-up reports.

For the AI dummy indicating whether an AI outbreak occurred within the UK territory only one outbreak, on 17th November 2014, has been listed during the data set period; while for the AI dummy indicating whether an AI outbreak occurred elsewhere in the world there are many notifications listed.

5. Results and Discussion

In this study, UK meat consumption is assumed to be between pork, beef, lamb and poultry. During the period May 2nd 2010 and March 1st 2015, it is revealed that poultry meat had the highest demand in terms of monetary amounts accounting for 43 per cent of the market. The second popular meat type was that of beef with a market share of 32 per cent. The least popular meat type appears to be lamb with a market share of 10 per cent. The market shares for the four different types of meat are given in Table 2.

Table 2: Summary statistics of meat shares

Share	Mean	Standard Deviations
Pork	0.144	0.012
Beef	0.324	0.017
Lamb	0.103	0.011
Poultry	0.430	0.021

[1]http://www.oie.int/animal-health-in-the-world/update-on-avian-influenza/2015/ Accessed August 6th, 2015.

The estimated parameters of the AIDS for meat demand in the UK are presented in Table 3. The estimated parameters do not have a straightforward interpretation but are the basis of the elasticity estimation. The output was estimated by using the econometric package Stata 14 (www.stata.com, 2015). The quadratic AIDS model was also performed in order to verify whether the original AIDS model was the appropriate one. In the quadratic AIDS model λ_i=0 for all i hence indicating that the original AIDS model was appropriate. In addition, inspections reveal that the estimated parameters comply with the adding-up and homogeneity conditions.

Table 3: Parameter estimates of AI demand system

VARIABLES	Coefficients	Std. Error	95% Conf. Interval
alpha_1	0.10***	(0.01)	0.087 0.118
alpha_2	0.29***	(0.02)	0.246 0.309
alpha_3	0.11***	(0.01)	0.096 0 .134
alpha_4	0.50***	(0.02)	0.464 0.545
beta_1	-0.04***	(0.01)	-0.068 -0.021
beta_2	0.08***	(0.02)	0.037 0.132
beta_3	-0.01	(0.01)	-0.037 0.009
beta_4	-0.02	(0.02)	-0.075 0.024
gamma_1_1	0.10***	(0.01)	0.071 0.128
gamma_2_1	-0.05***	(0.01)	-0.067 -0.025
gamma_3_1	0.06***	(0.01)	0.038 0.075
gamma_4_1	-0.11***	(0.02)	-0.143 -0.076
gamma_2_2	0.13***	(0.02)	0.088 0.183
gamma_3_2	0.06***	(0.01)	0.035 0.088
gamma_4_2	-0.15***	(0.03)	-0.209 -0.092
gamma_3_3	-0.09***	(0.01)	-0.119 -0.061
gamma_4_3	-0.03	(0.02)	-0.075 0.019
gamma_4_4	0.29***	(0.05)	0.185 0.391
eta_AI in World_1	-0.01	(0.01)	-0.026 0.032
eta_ AI in World_2	0.03	(0.03)	-0.101 0.020
eta_ AI in World_3	0.01	(0.01)	-0.014 0.085
eta_ AI in World_4	-0.03	(0.02)	-0.090 0.093
eta_AI in UK_1	0.003	(0.01)	-0.035 0.014
eta_AI in UK_2	-0.04	(0.03)	-0.021 0.081
eta_AI in UK_3	0.03	(0.02)	-0.008 0.020
eta_AI in UK_4	0.002	(0.05)	-0.061 0.009
rho_ AI in World	-0.14	(0.10)	-0.329 0.049
rho_AI in UK	0	(0)	

By performing the Wald test the null hypothesis of no significance on determining expenditure patterns of the dummy variables 'AI in the UK' and 'AI in the rest of the world' can be tested. If that hypothesis holds then according to Poi (2012) all elements on the eta matrix corresponding to 'AI in the UK' and 'AI in World' and the corresponding rho vector must jointly be zero. The output of the Wald test, given in Table 4, does not allow us to reject the null hypothesis indicating that the occurrence of AI outbreaks either domestically or internationally does not significantly affect UK poultry consumption.

Table 4: Wald test output

AI in the UK		**Constraints dropped**
Ch2(3)	3.88	constraint 3 and constraint 5
Prob>chi2	0.27	
AI in the rest of the World		
ch2(4)	5.35	constraint 3
Prob>chi2	0.25	

The estimation of the Marshallian (uncompensated) own-price elasticities are given in table 5 and expenditure elasticities are given in table 6. The own-price elasticities are found to be negative as expected a priori. In absolute terms the value of elasticity found to be lowest for pork followed by poultry, beef and lamb. The demand for pork, beef and poultry appear to be inelastic while the demand for lamb is elastic as in absolute values its own price elasticity is greater than the unit. Of the four meat types the most expensive is beef, followed by lamb and poultry. Pork is revealed to be the cheapest meat in the market. These results confirm our expectations that the least expensive meat type will have the lowest own price elasticity. The analysis reveals that poultry, pork and lamb are normal goods as their expenditure elasticity is below one and beef is indicated as a luxury good as it has an above unit expenditure elasticity; a result that is consistent with the literature (see Beach and Zhen, 2008).

The cross price elasticities do not show substitutability for all meat types as only lamb appears to have positive cross price elasticities with respect to pork and beef. According to the uncompensated elasticities lamb and pork are highly substitutable. All other meat types have negative cross price elasticities revealing that these goods are more likely to be complements even if relationship is rather weak. The strongest complementary relationship is revealed between poultry and pork.

Table 5: Uncompensated elasticities

	Pork	Beef	Lamb	Poultry
Pork	-0.266	-0.189	0.424	-0.613
Beef	-0.181	-0.699	0.158	-0.597
Lamb	0.559	0.633	-1.864	-0.233
Poultry	-0.243	-0.315	-0.055	-0.288

Table 6: Expenditure elasticities

Pork	Beef	Lamb	Poultry
0.644	1.319	0.905	0.902

The values of the Hicksian (compensated) elasticities are given in Table 7. All own price elasticities are negative as expected except for poultry. In absolute terms the value of elasticity found to be lowest for poultry followed by pork, beef and lamb. Again, the demand for lamb appears to be elastic as in absolute values its own price elasticity is greater than the unit.

Table 7: Compensated elasticities

	Pork	Beef	Lamb	Poultry
Pork	-0.174	0.020	0.490	-0.337
Beef	0.009	-0.272	0.294	-0.031
Lamb	0.690	0.926	-1.771	0.155
Poultry	-0.113	-0.023	0.037	0.099

The estimated cross price elasticities reveal substitutability between beef, pork and lamb as they have positive cross price elasticities. The strongest substitutability appears to be between lamb and pork. Poultry has a positive cross price elasticity with lamb, revealing they are substitutes and negative cross price elasticities with pork and beef revealing a complementary relationship, with the strongest relationship being that between poultry and pork.

Overall, according to our analysis, during the examined period, poultry meat had the highest demand in terms of monetary amounts accounting for 43 per cent of the market. The AIDS parameters estimations did not reveal an association between poultry consumption and AI occurrence both within the UK territory and elsewhere in the world. Therefore the results of this study support previous statements by the USDA (2006d) that UK consumers are unaffected by the occurrence of AI in other countries. Furthermore, it has tested the FAS London statement that this consumer confidence could not be examined until an outbreak occurred within the UK territory (USDA, 2006e). The analysis of the available data has revealed that there is no evidence that the occurrence of AI within the UK territory had affected consumer demand for poultry. However, it must be noted that the studied outbreak was very small in magnitude and rapidly confined. Therefore this result must be further tested and outcomes of this paper must be taken with caution.

Further caution must be taken due to the limitations of this study. The examined data on poultry were aggregated and did not distinguish between species of poultry, i.e. chicken, turkey and duck; nor did it distinguish between fresh and frozen poultry. As revealed in Beach and Zhen (2008) consumer response may be different depending on whether poultry products are frozen or fresh. An additional limitation is the issue of multicollinearity. Prices may be correlated with the instance of an AI (i.e. producers may reduce prices as a response to an AI outbreak) and thus further examination of prices need to be taken.

6. Conclusion

The results of this pilot study supports that the occurrence of an AI outbreak, either in the UK or elsewhere in the world, had not affected consumer consumption of poultry in the UK and complies with the USDA (2006c) report that UK consumers had 'faith' in poultry despite the AI outbreaks in European countries. They had also point out that the observed steady consumption levels had to be tested after a confirmed AI case was reported within the UK and this pilot study has confirmed that steady consumption levels were observed and in the case of a confirmed AI outbreak in the UK. However, the results serve as preliminary findings on which future investigations will be based. As such these results must be taken with caution.

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