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Long-Run Effects of BSE on Meat Consumption

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Abstract

This paper considers the long-run effects of BSE on meat consumption in the United Kingdom using data from the Expenditure and Food Survey. We estimate a dynamic AIDS demand system of household food consumption, with long-run effects captured via an adstock index of adverse media coverage. The results suggest that there are long-run impacts on meat consumption that extend well beyond the period of the scare. In addition, press articles with pictures have a greater, and more long-lasting effect, on long-run consumption than articles with words alone.

JEL Classification:

Keywords: Food health scares, Adstock, BSE, demand systems, meat demand.

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1 Introduction and Background

Recent outbreaks of BSE (bovine spongiform encephalopathy), ecoli 0157, foot and mouth disease, salmonella, hormone additives, and avarian bird flu have heightened concerns over the safety of eating meat. Unable to make their own objective assessments of the risks posed by such outbreaks, people rely heavily on information from government and media (Lobb 2005). Adverse press on meat safety are commonly known as "food scares".

The term "scare" is apt because peoples' perception of health risks is socially constructed, with psychological elements guiding responses rather than technical risk estimates, which tend to amplify peoples' perception of risk (see, for example, Henson 2001, Frewer 1999, Kasperson, Renn, Slovic, Brown, Emel, Globe, Kasperson, and Ratick 1988). Consumer reaction to reports of the BSE outbreak is a case in point. At the height of consumer backlash against British beef, Sir David Nash (President of the UK National Farmers' Union) demanded government to sanction mass cullings of aged cattle, not on the basis of scientific evidence, but to restore consumer confidence in British beef (*The Guardian* 27/3/1996).

The effect of meat scares on the demand for different meat groups (pork, lamb, beef and poultry) has been a topic of recent research. The approach used in most of these papers is to estimate a dynamic Almost Ideal Demand System (AIDS) model of meat demand with a demand shift variable to incorporate the effects of meat health scares. The demand shift variable is typically a measure of media coverage on the issue (see, for example Burton and Young 1996, Burton, Young, and Cromb 1999, Fousekis and Revell 2004, Piggott and Marsh 2004) or number of meat recalls (Marsh, Schroeder, and Mintert 2004). Of these, only Mangen and Burrell (2001) and Burton, Young, and Cromb (1999) take into account the long-term impacts from adverse media.

Mangen and Burrell (2001) and Peterson and Chen (2005) adopt a different approach to examine the effects of BSE. Both of these studies specify a time transition function within each demand equation that allows gradual shift of parameters over time in response to changes in market conditions, such as the BSE scare. A limitation of this approach is that it's hard to distinguish the effect of BSE from other external factors, such as advertising and taste changes, that may affect the demand for beef.

Regardless of the approach, these studies all implicitly assume that meat scares only affect the demand for *different* meat groups and that the total demand for meat is unchanged. In reality, if trust in the safety of all meats is eroded from a scare, consumers may opt for alternatives sources of protein such as fish, cereals and vegetables. Given that the spread of the disease was linked to unnatural feeding practices, it is possible that some people may have questioned the safety of all meat groups. If the trust in meat safety was irreparably eroded, impacts of BSE may be long-term. There is some anecdotal evidence of this in a survey from the European Commission (Lehuede 2004). In the report it is claimed that many 18 to 30 year-olds were deeply affected by the outbreak, which has led to persistent changes in their total meat consumption.

The primary objective of this study is to examine the long-term effect of adverse media coverage of the BSE outbreak on meat demand in the UK. As part of this analysis, different consumer reactions to newspaper pictures and text will be examined. Research in the marketing, media and psychology literature has for a long-time shown that pictures are more memorable than verbal or written cues (for a review of this literature, see Paivo 1969, Lutz and Lutz 1977). Pictures in newspapers impact on the reader's perception of the importance of a news item and hence draw them in to an article (Garcia and Stark 1991, Wanta 1992, Zillman, Knobloch, and Hong-Sik 2001) and also help foster a more in-depth consideration of the issue at hand (Lynn, Shavitt, and Ostrom 1985). Therefore this paper contributes to the existing literature in three ways. Unlike previous studies, the focus here is on meat demand in total, as opposed to its constituents (types of meat): as well as having a substitution effect within meat products, it is likely that adverse publicity for beef will have spill-over effects for all meat products. We will employ the well-developed *adstock* approach used in the marketing literature to evaluate the long-term effects of information (advertising) on response variables (typically demand) and to our knowledge, this research represents the first example of this methodology in the food scares literature. Finally, we make the important distinction between the potentially differing effects of visual *versus* written (print) media coverage.

2 Literature Review

During the 1980's studies of meat demand began to focus on the possibilities of attributing changes in consumption patterns of meat to changes in consumers' preferences and tastes.

To this day the existence of structural change, and the best method to measure it, is a subject of continual debate in the literature. Martin and Porter (1985) test for structural change in the demand for meat in Australia over the period 1962 to 1983. They posit that a systematic change in the aggregate pattern of demand for a good may arise for three reasons, through changes: in the composition of the population; in the underlying tastes and preferences of individual consumers; and in the nature and make-up of commodities available to consumers. Whilst there is some opposition to explicitly modelling structural change in demand systems (for example, Stigler and Becker (1977) argue that it would be more useful to treat individual preferences as constant and look for an economic explanation for any observed changes in demand) this has been a common approach of studies with analyses from a wide range of countries. Where structural change is more explicitly modelled, information on health issues, media coverage, advertising, and so on, can be incorporated into a demand system analysis in several ways:

- as a demand shifter (changes the intercept).
- As a scaling factor (where advertising changes elasticities). This is where advertising and/or health information variables, scale, or adjust, prices and total expenditure. (for example, this can occur where advertising creates product differentiation through persuasion).
- Through translating (in general only used for advertising variables) where fixed costs that are a function of advertising are included in the demand functions. These fixed costs are interpreted as psychological needs, or subsistence requirements, of products (where these needs are generated by the advertising).

It should be noted that these approaches are not mutually exclusive and can be used in conjunction with one another. There is a vast literature on these issues so it is necessary to be selective in what is presented here. We will consider a number of papers that look at advertising, health information and finally media indices to understand the factors that impact on the demand for food products.

2.1 Advertising

One approach to modeling structural change explicitly is to incorporate variables which capture the effects of advertising. In past studies, Piggott, Chalfont, Alston, and Griffith (1996) examined the impact on Australian meat demand of advertising and modelled advertising as a demand shifter with a weighted four period lag; Brester and Schroeder (1995) incorporated advertising (both generic and branded) as a demand shifter and a scaling factor and found that whilst branded meat advertising had a significant impact on demand for meat in the US, generic advertising had no such effect.

However, whilst many studies find that advertising can be a significant player in changing demand patterns, it is not the only driver of change. For example, Chang and Kinnucan (1991) in their study of the demand for butter and oils, found that a food health information index had a greater impact on demand than advertising: they concluded that the incorporation of such variables was highly important. Using a slightly different food health information index, Boetel and Liu (2003) also found this; Verbeke and Ward (2001) incorporated a media index in addition to advertising variables and found that the impact of negative TV press on meat demand was much greater than promotion and advertising effects. This paper is important to our investigation as it highlights the difference between negative publicity and positive publicity suggesting consumers tastes and preferences are formed as a response to their trust in the product's safety.

2.2 Health Concerns

A consistent hypothesis put forward to explain the considerable changes in the demand for meat over the past 30 years is that of health concerns. That is, the move away from beef, and the move towards chicken is often attributed to a greater understanding by consumers of the link between diets high in cholesterol and fat and heart disease. Brown and Schrader (1990) were the first to explicitly model such a change (although they were examining demand for shell eggs). To do this they constructed a measure of cholesterol information by searching through a medical database for American articles discussing cholesterol and heart disease. Articles were determined to provide either positive or negative information regarding the link between heart disease and cholesterol. To get the index the number of positive articles in a period were summed and subtracted from the number of negative articles (as such positive and negative articles were equally weighted; Brown and Schrader's (1990) tests found this to be appropriate). They found a strong relationship between egg consumption and information regarding cholesterol, such that per capita civilian shell egg consumption decreased by 16% to 25% by 1987 due to information on cholesterol. Their cholesterol index was then adapted by others and used in a wide range of demand studies. In terms of applying Brown and Schrader's (1990) index to meat demand studies, see Chang and Kinnucan (1991) and Kaabia, Angulo, and Gil (2001). Both these studies found that the health index was negatively related to beef consumption and positively related to poultry consumption.

Chern, Loehman, and Yen (1995) and Kim and Chern (1999) examined alternative health measures to be used in demand systems for fats and oils. Kim and Chern (1999) compared three models of the cholesterol information index: the standard version as developed by Brown and Schrader (1990) represented cumulatively and with a wider range of keywords; a cubic weighting function of the standard index; the standard index with a geometrically declining lag structure (with a monthly decay rate of 20%). They concluded that this final model performed the best and that the second model performed reasonably well and out-performed the standard cholesterol information index. These findings suggest that consumers have memory and base consumption decisions on past as well as present, information.

2.3 Media Indices

In a similar vein to food health information index, studies have also incorporated media indices which capture levels of positive and negative information in the media. One of the first examples of this approach is Smith, Van Ravenswaay, and Thompson (1988) where a media index was incorporated to examine the effect of a food contamination incident (the contamination of fresh fluid milk in Oahu, Hawaii with heptachlor in 1978) on the demand for milk. Articles in two major Honolulu newspapers were coded into negative coverage and positive coverage and each article weighted on a scale of 0 to 5 according to its prominence. The weighted codes were summed for each month to obtain measures of both negative and positive media coverage. However, only negative media coverage was included in the estimated model (as positive media coverage was not found to be significant).

Following on from this approach, Verbeke and Ward (2001) created an index of TV news reports on meat issues (the number of negative segments minus the number of positive segments). Rather than incorporate lagged values, the index was expressed as a function of the current value and past values (going 5 periods back) and these values were all weighted. They found that food safety information had a moderate impact on beef demand, but that information regarding cholesterol had a much greater impact.

2.4 Media Information Indices and BSE

Burton and Young (1996) examined demand for meat in the UK after the BSE crisis. In their analysis the media index was simply a count of the number of articles relating to BSE in the UK press over the sample period. Their use of a media index differed from previous literature in that the index was entered into the demand equations in two ways: as the number of articles per quarter (captures short-run effects) and the cumulative number of articles (capturing long-run effects). The impact of media on consumption of beef over this period was found to be significant; however, when dynamic effects were incorporated these were not significant. Importantly the data for this study did not extend to the period in March 1996 where it was first officially announced that CJD was linked to BSE and could affect humans.

Burton, Young, and Cromb (1999) conducted another study with data which included this crucial period. However, they modelled their media index slightly differently to that in Burton and Young (1996). The index was included in the demand equations as the number of articles per quarter (capturing short-run effects), the cumulative number of articles (to capture long-run effects) and a stock measure of articles with a 68% rate of depreciation over each 4 week period. They found that the impact of the March 1996 BSE announcement had a significant impact on the short-term consumption of beef (reducing beef's market share by 13%). However, the long term impact for this data period was found to be similar to that found in their previous studies (where the long-run impact of the BSE scare is said to be a 5% reduction in budget share). In addition, the authors found no evidence of a decrease in aggregate demand for meat over this period due to BSE.

Chang and Kinnucan (1991) investigate the impacts of health information and advertising on the demand for butter. They discuss how the source and quality of information can impact on consumers' actions. They highlight findings in the literature that negative information may have a greater impact on consumer behaviour. They also discuss how that source and type of information may have differing impacts on how consumers react to information. In general, personal and neutral information are thought to have a greater influence on consumer actions relative to non-personal and market-oriented information. Yen, Jensen, and Wang (1996) also note that aggregate measures of health information may be poor proxies for consumers' specific health concerns due to the fact that individuals differ in the extent they are exposed to media sources and in their cognitive skills to process this information.

Chern, Loehman, and Yen (1995) also discuss how information is diffused and the issues around modelling such a process. They cite a working paper by Putler (1987) who modelled an information diffusion process as an S-shaped function. He attributed this to the fact that not everyone has the same access to information sources and as such there may be a lag before the impact of information is fully seen in consumption decisions.

Herrmann, Warland, and Sterngold (1997) conducted a cross section analysis to examine what affects individuals awareness of a food safety scare (they use the Alar apple crisis as their case study). They also investigate the factors behind whether an individual changes their consumer behaviour in response to observed information. They discuss how the early models of the effects of media and communication assumed that messages were received without fail and then interpreted correctly (hypodermic models). However, they point to another model, the transactional model, as better capturing the way information is diffused and absorbed. The transactional model assumes that the effect of any communication depends on both its content and on the ability of the audience to process such a communication (this incorporates the recipient's previous knowledge, interest in the message content and attitude towards the message source). Thus, this suggests that media coverage of an event will not affect all individual's preferences in the same way due to the differing levels of effectiveness of this message given the above factors.

Here we will adopt an *adstock* approach to try and capture the impact of the BSE food scare on the consumption of total meat. This methodology allows the data to determine how past information impacts on current decisions. As such it is more flexible than the approaches taken to date in the existing literature. Instead of imposing a lag structure on the data we allow this to be determined endogenously within the modeling framework. The next section will discuss this methodology in detail.

Note that a thorough understanding of the long term impact of such health scares is also important to a number of countries who are large beef producers and currently have disease free herds as it allows them an estimated value of protecting their livestock. For example, Australia is the largest beef exporter in the world. In 1999, there were 22.7 million beef cattle, producing 2 million tonnes with a gross value of AU$4.4 million. To date, Australia has been unaffected by the growing number of major health scares currently plaguing many European and South American countries. Equivalent scares in Australia would be devastating to the world's beef supply and hence research into the impact of scares on the behaviour of consumers is of paramount importance. Moreover in this paper we look at the impact on total meat consumption rather than just beef consumption. Thus we are looking for broader impacts on consumption patterns than have been studied in the existing literature.

3 The analytical framework

To estimate the effect of the scare on a number of food groups, a dynamic AIDS model is used. It is assumed that consumers have already made decisions about how much to spend on home-prepared food (as opposed to expenditure on other household items including food prepared outside the home) and allocate their expenditure on home-prepared food across five broad food groups: meat, fish; bread and cereals; vegetables; and other foods. The basic functional form for the dynamic AIDS model is given in equation (1) below.

$$w_{it} = a_i + \sum_{j=1}^{n} \theta_{ij} w_{j,t-1} + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(y_t/P_t\right), \quad i,j = 1,2,...,n \tag{1}$$

w_{it} is the budget share of food (commodity) of group i $(1,\ldots,n)$ in time period t $(t = 1,\ldots,T)$; p_{jt} the prices of commodity group j; y_t is total expenditure on home-prepared food in period t; and P_t is a log-linear analogue of the Paasche price index, defined as $ln(P_t) = \sum_{i=1}^{n} w_{it} \ln(p_{it}/p_{i0})$, where 0 is the base period.[1] Economic theory

[1] For identification, one of the lagged budget shares is omitted in estimation.

suggests the following restrictions

$$\sum_{i=1}^{n} a_i = 1, \sum_{i=1}^{n} \theta_{ij} = 0, \sum_{i=1}^{n} \gamma_{ij} = 0, \sum_{i=1}^{n} \beta_i = 0, \; \forall j \tag{2}$$

$$\sum_{j=1}^{n} \gamma_{ij} = 0, \; \forall i \text{ (homogeneity)} \tag{3}$$

$$\gamma_{ij} = \gamma_{ji} \; \forall i, j \text{ (symmetry).} \tag{4}$$

A geometric distributed lag (GDL) model of adverse media coverage was incorporated into the dynamic AIDS demand system to allow for shifts in expenditure shares due to meat scares (in this application we look at the impact of the BSE food scare). As noted above the existing literature suggests that negative media coverage impacts on consumer behaviour but positive coverage has little effect (although positive advertising can be effective). For this reason we include only adverse media coverage in our model but it is also fair to say that there was little, if any, positive media coverage of the BSE crisis. The GDL model is equivalent to the *adstock model* in the marketing literature (Broadbent 1979) which is commonly used to evaluate the long-run effectiveness of advertising campaigns. In essence, we are making the modelling assumption that a food scare can be thought of simply as adverse advertising (see, for example Havlena and Graham 2005).

Adopting the direct estimation technique of the GDL (Fry, Broadbent, and Dixon 1999), the final model is:

$$w_{it} = a_i + \sum_{j=1}^{n} \theta_{ij} w_{j,t-1} + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jt} + \beta_i \ln (y_t/P_t) + \delta_i A_t + \rho_i \lambda^t, \quad i, j = 1, 2, ..., n \tag{5}$$

$$\text{where} \;\; A_t = A_t + \lambda A_{t-1} + ... + \lambda^{t-1} A_1. \tag{6}$$

Note that the final term of equation (5), $\rho_i \lambda^t$, arises from the application of the requisite *Koyck* transformation, and that the parameter ρ_i can be interpreted as the difference between the expected value of w_i and a_i in the period preceding the first sample observation (Johnston 1984). Note also, that in omitting one $w_{j,t-1}$ for identification, the remaining θ_{ij}'s are interpreted *relative* to this omitted one ("Other Food").

The advantage of using this approach to examine long-term effects, over using a lagged cumulative effect (Burton and Young 1996), is that it allows the impression of information received in the past to fade through time at a rate that is endogenously determined. If information from past periods is evaluated on equal terms as information from the current period, then λ will equal 1. At the other extreme, if information from the past is discounted completely, λ will be 0. Once information is evaluated, its effect on the response variable is estimated as δ. That is, following the marketing literature, we allow the total effect of scares (as opposed to advertising in the former) at time t to be the result of the current level of the scare *and* the accumulation of all past scares with weights that decline over time and that are endogenously determined. It is this endogenous determination that significantly differentiates our approach to those that have been utilised in the existing literature.

The *adstock* variable A_t is a geometrically declining index of the area devoted to BSE articles on the front page of *The Times* newspaper. We chose to look at the week day papers only (*i.e.*, Monday - Saturday) *The Sunday Times* mostly reviews the week's news such that its inclusion would cause a double counting of the number of stories in any given week. Moreover, it is evident that front page coverage will have a bigger impact on the reader than stories inside the paper. We also chose to look at only a single paper to prevent us from double counting the same story across multiple papers and hence artificially inflating the level of coverage recorded by our index. Finally, *The Times* was chosen for its reputation for quality news reporting: it is the UK's oldest national newspaper with the largest readership for a (traditional) broadsheet newspaper.

As an alternative, it would have been possible to look at a popular tabloid paper such as the *Sun* or the *Daily Mirror*, however, readership surveys suggest that their readers tends to be skewed towards young (aged 15-44) males whereas, the Times has an even distribution across both genders and all age groups and as such is more likely to be representative of the media information absorbed by the population in general.[2]

To evaluate the effect of pictures *versus* text, two systems of equations were estimated: one with the *adstock* variable measuring the area devoted to pictures; and the other measuring area devoted to text. Thus we use area of newspaper coverage, rather than the

[2]Source: the national readers survey, see http://www.nrs.co.uk.

standard approach of using a count of the numbers of articles (see, for example Burton and Young 1996, Burton, Young, and Cromb 1999, Fousekis and Revell 2004, Piggott and Marsh 2004). The area covered is a better measure of the intensity of media coverage because it takes into account the total newspaper space devoted to the issue regardless of the number of articles. An index based only on article numbers may be misleading because small pieces, which can be missed by the reader, are given the same weighting as large articles that may include pictures and feature in a prominent position. Finally, it should be noted that we look only at the front page of the newspaper in the hope of capturing only lead stories and headline news in the belief that it is this kind of reporting that has the most impact on consumption behaviour.

We chose to model separately the impact of text and pictures for a number of reasons. Firstly, the existing literature tells us that visual images through TV have a big impact on behaviour and the existing literature which looks at the impact of TV media and printed media has found significant impacts in both cases, but of differing size. Secondly, the BSE crisis was quite unique in the quantity and intensity of the graphical images that where reported in both the TV and newspaper coverage. This gives us an unique opportunity to see if the visual image presented in the press had a different impact to the written text and headline impacts.

Thus two adstock variables are generated: one based on the area of the paper devoted to pictures; and one based on the area devoted to text. Ideally, these two variables would be included together in the one system to estimate their independent effects. However, because these two indices are highly correlated, their effects had to be estimated in separate systems.[3]

Both demand systems (one looking at the impact of text and the second looking at the impact of pictures) were estimated using seemingly unrelated regression (SUR) approach for different values of λ. Following the marketing literature (see, for example Fry, Broadbent, and Dixon 1999) the optimal value of λ was found via a grid-search procedure (in 0.01 increments in the 0-1 interval) as that which maximised the explanatory power of the meat equation.

[3] As a consequence the estimated *adstock* coefficeints will include the effects of their opposing format, which means that these effects should only be considered in relative terms.

4 The Data

The focus of this paper is on the food scare caused by the outbreak of BSE in the United Kingdom which occurred roughly between March 1996 (when the link between BSE and CJD was established) up to the end of 2000. Hence our data covers the time from 1988 to 2004. Extending the period beyond 2001, when the issue had vanished from the newspapers, allows for longer-term impacts on consumption to be examined. Whilst there where other food scares reported during this time period most were very minor compared to the BSE crisis and hence we do not include them in our index. One scare that was perhaps large enough to affect consumer behaviour was the outbreak of foot and mouth disease. This occurred from February 2001 until the end of the year and whilst reporting and coverage was large throughout that year it died out quickly afterwards. Hence given that we use annual data here, we only have one observation corresponding to the foot and mouth scare and hence it does not make statistical sense to try to measure the impact of this with these data.

Expenditure data are from the Expenditure and Food Survey (EFS): an annual survey of around 7,000 households from across the UK (source: Office of National Statistics - ONS).[4] The data relate to annual average weekly expenditure per household.[5] Price data collected are based on the Retail Price Index (ONS), which is generated from around 120,000 separate price quotations each month. The monthly price index was transformed into an annual index to match the same time period as the expenditure time-series. For some of the food groups in this study (such as bread and cereals, vegetables, other foods and other meats) a price index had to be generated by aggregating prices from several commodities. In these cases, the expenditure shares were used as weights.

Figure 1 graphs the constructed scare index based on newspaper coverage of the BSE scare, disaggregated by text and pictures. We can see that the index reflects the important dates in the BSE story. In January 1990 the first reports of BSE in the domestic beef herd began to appear but the consensus was that the disease had such a long gestation period that there was no danger from beef consumption. In March 1996 the first links where

[4] Initially the data was collected on an annual basis according to calendar years but from April 1993 it was collected annually according to financial years *i.e.*, April - March.

[5] See: http://www.statistics.gov.uk for more detailed information.

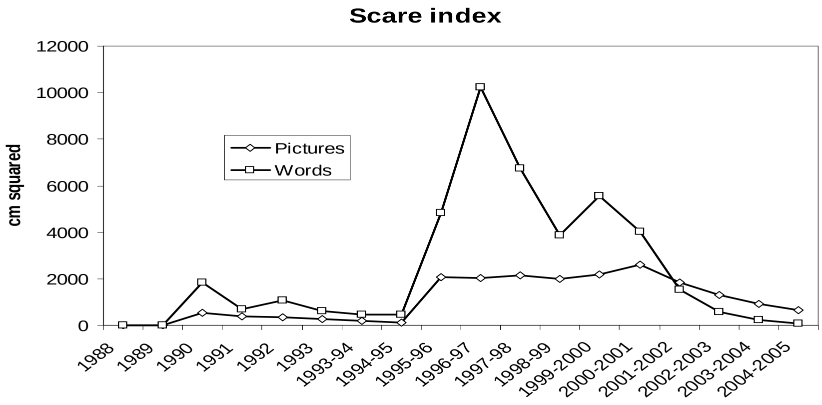


Figure 1: Scare Indices for Pictures and Text

made between BSE and CJD and this story ran in various forms until the end of 2001, from whence there is very little media attention given to BSE. The index for text coverage clearly mirrors these important dates, however, the index for picture space devoted to the issues surrounding BSE are less reflective. The area denoted to pictures clearly increases in the mid 1990's and drops off after 2001 but is fairly flat throughout the late 1990's at the height of the scare. One possible explanation is that there is a limit to how much of the front page the editors of the newspaper were willing to allocate to pictures as opposed to text given the nature of the media chosen to compile the index. That is, there may be an upper bound to this index which was reached at the height of the crisis and is reflected in the flatness of the index following its upwards step-like rise in the mid 1990's until the end of the scare and the downwards ratchet in the early 2000's .

The food expenditure share data modelled in this paper are shown in Figure 2. It can be seen that the expenditure share of meat is around 25% of food expenditure at the start of the period shown but falls to approximately 18% following the BSE food scare. The majority of this fall in consumption occurs during 2001, but there is clearly a downward trend throughout the time period observed. One might attribute this to the additional impact of the foot and mouth scare (but as noted above, we only have one data point in our date which accounts for the outbreak of foot and mouth and we are reluctant to draw inferences from a single data-point).

We are therefore concerned with explaining the overall downward trend in meat con-

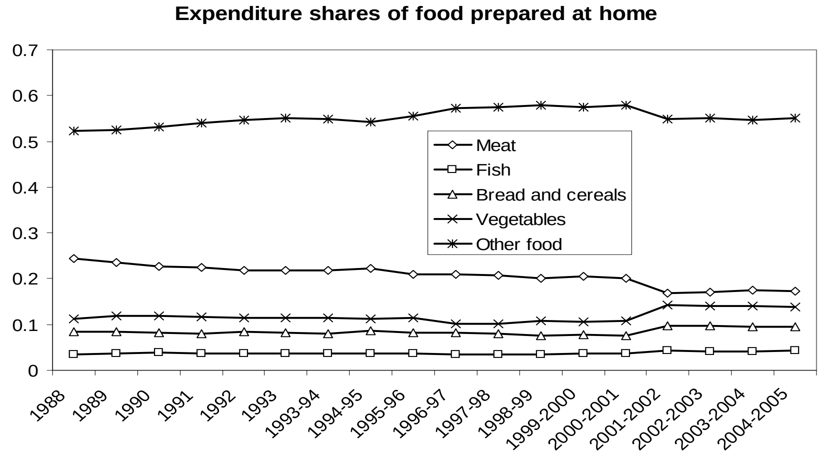


Figure 2: Expenditures Shares

sumption over this period. It is also evident from Figure 2 that as the share of meat consumption has fallen, the expenditure share of fruit and vegetables and bread and cereals has risen, but the share of fish has remained virtually unchanged over the period under consideration, perhaps in contrast to popular belief. Finally, it is worth noting that, consumption patterns appear to change slowly through time. Individuals do not radically alter their consumption (year-to-year) but there are nevertheless interesting changes occurring over the long term in peoples dietary intake.

5 Results

The results of the two systems are presented in Tables 1 and 2, where the former contains the results appertaining to the *adstock* variable in text, and the latter in pictures. The first thing to note is that the results are generally consistent across the two specifications. Where differences in the coefficients do arise the variable is insignificant in one or other of the models and so imprecisely estimated. The coefficients on last period's consumption (budget shares) are interesting: both meat and bread and cereals are positive; whereas fish and vegetables are negative (although fish is insignificant in both models). Note that given that we are estimating a system based on budget shares if the budget share for one commodity group increases then by construction this must result in a fall in the budget shares for one or more of the remaining commodity groups. Overall, the separate equations appear to fit the data very well, with $\bar{R}^2$'s ranging from 92% to 99%. Note that as noted, the parameter ρ_i can be interpreted as the difference between the expected value of w_i and a_i in the period preceding the first sample observation (Johnston 1984) and that all of these are statistically significant.

The impact of price and income is highlighted more clearly in Table 3 which reports (short-run) own-price and income (expenditure) elasticities calculated at the mean budget shares over the period. Although the focus of this paper is on the impact of health scare information on individuals' consumption decisions, we note that these estimated elasticities are, in general, as expected and in line with results typically found in the literature.[6]

We turn now to the impact of health scare information on individuals' consumption decisions using an *adstock* modelling approach. The coefficients presented in Table 1 suggest that total front page *text* coverage of BSE had a strongly significant negative effect on the demand for meat $(\delta_{meat} = -0.135, t - statistic \approx 17)$. That is, the greater the (cumulative) amount of text devoted to BSE issues, the greater will be the reduction in the budget share allocated to meat. However, it also had a significant negative spill over effect into consumption shares of other animal (fish) food products $(\delta_{fish} = -0.040, t \approx 3)$; a small positive effect on vegetables ($\delta_{veg} = 0.095, t \approx 4$); and no effect on bread and cereals.

Interestingly, the results in Table 2 suggests that demand for meat was much more responsive with respect to *pictures* (as compared to words), with $\delta_{meat} = -0.312$ ($t \approx 6$); once more there was also a significant spill-over effect into fish $(\delta_{fish} = -0.109, t \approx 2)$; but here a small negative impact on bread and cereals and no effect on vegetables.

Thus, overall Tables 1 and 2 suggest a similar pattern for the impact of both pictures and text in the media: coverage of the BSE health scare had a significant negative impact on meat, fish and bread/cereals consumption and a positive impact on the consumption of vegetables (although the effects for the latter, as expected, were much weaker). However, there was clear evidence that the impact of media pictures seems to outweigh that of text. Moreover the results suggest that it is not just today's media coverage that impacts on today's consumption but also past coverage. To illustrate these effects over time Figure

[6]Further information regarding these, including long-run and cross-price elasticities and standard errors are available from the authors on request.

Table 1: Estimated coefficients for the Dynamic AIDS model of food demand, Adstock is area devoted to text

	Meat		Fish	
Constant	0.311	(0.032)**	0.200	0.049)**
Lagged meat share	0.741	(0.032)**	0.007	0.049)
Lagged fish share	-1.493	(0.081)**	-0.189	(0.125)
Lagged veg. share	1.673	(0.045)**	0.022	(0.070)
Lagged bread share	-1.611	(0.019)**	0.162	(0.029)**
Log price of meat	0.023	(0.005)**	0.045	(0.007)**
Log price of fish	-0.091	(0.002)**	0.001	(0.003)
Log price of veg.	-0.014	(0.002)**	0.007	(0.003)**
Log price of bread	-0.012	(0.007)*	-0.027	(0.011)**
Log real income	-0.185	(0.004)**	0.014	(0.006)**
A_t	-0.135	(0.008)**	-0.040	(0.012)**
λ^t	-0.034	(0.004)**	-0.025	(0.006)**
$\bar{R}^2$	0.999		0.950	
	Vegetables		Bread and cereals	
Constant	1.031	(0.104)**	0.125	(0.028)**
Lagged meat share	-1.094	(0.105)**	-0.096	(0.028)**
Lagged fish share	2.189	(0.268)**	-0.713	(0.073)**
Lagged veg. share	-1.940	(0.150)**	-0.087	(0.040)**
Lagged bread share	1.498	(0.062)**	1.037	(0.017)**
Log price of meat	0.079	(0.015)**	-0.001	(0.004)*
Log price of fish	0.097	(0.007)**	0.006	(0.002)**
Log price of veg.	0.039	(0.006)**	0.000	(0.002)
Log price of bread	0.129	(0.023)**	-0.005	(0.006)
Log real income	0.026	(0.012)**	0.001	(0.003)
A_t	0.095	(0.027)**	-0.003	(0.007)
λ^t	0.031	(0.012)**	-0.021	0.003)**
$\bar{R}^2$	0.990		0.997	
λ	0.380			

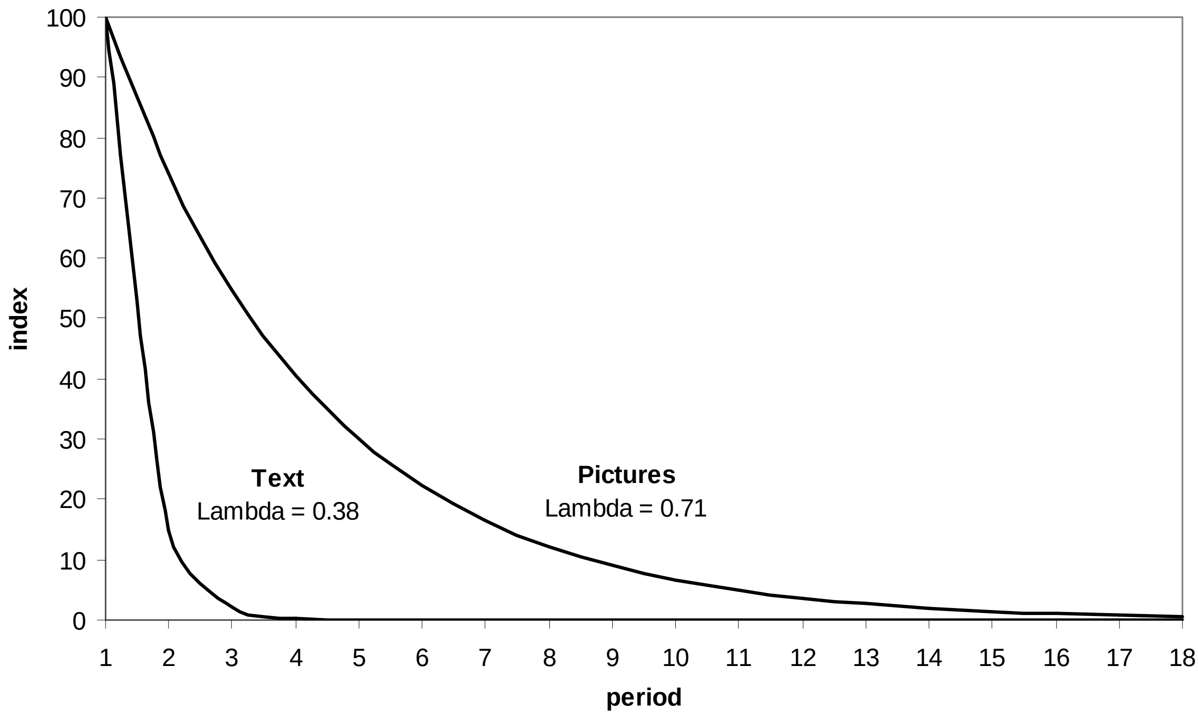
Table 2: Estimated coefficients for the Dynamic AIDS model of food demand, Adstock is area devoted to pictures

	Meat		Fish	
Constant	0.537	(0.101)**	0.288	(0.070)**
Lagged meat share	0.447	(0.064)**	-0.079	(0.045)*
Lagged fish share	-0.544	(0.198)**	0.164	(0.138)
Lagged veg. share	1.100	(0.106)**	-0.185	(0.074)**
Lagged bread share	-1.529	(0.047)**	0.179	(0.033)**
Log price of meat	0.023	(0.014)	0.046	(0.010)**
Log price of fish	-0.056	(0.005)**	0.014	(0.003)**
Log price of veg.	-0.006	(0.005)	0.008	(0.003)**
Log price of bread	0.020	(0.019)	-0.019	(0.013)
Log real income	-0.201	(0.01)**	0.009	(0.007)
A_t	-0.312	(0.068)**	-0.109	(0.047)**
λ^t	-0.012	(0.006)*	-0.010	(0.004)**
$\bar{R}^2$	0.997		0.924	
	Vegetables		**Bread and cereals**	
Constant	0.879	(0.155)**	0.204	(0.039)**
Lagged meat share	-0.863	(0.099)**	-0.078	(0.025)**
Lagged fish share	1.575	(0.304)**	-0.549	(0.077)**
Lagged veg. share	-1.569	(0.163)**	-0.176	(0.042)**
Lagged bread share	1.420	(0.073)**	1.015	(0.019)**
Log price of meat	0.082	(0.022)**	0.006	(0.006)
Log price of fish	0.072	(0.007)**	0.013	(0.002)**
Log price of veg.	0.031	(0.008)**	-0.005	(0.002)**
Log price of bread	0.085	(0.029)**	-0.021	(0.007)**
Log real income	0.043	(0.015)**	0.000	(0.004)
A_t	0.125	(0.104)	-0.082	(0.026)**
λ^t	0.010	(0.009)	-0.013	(0.002)**
$\bar{R}^2$	0.985		0.996	
λ	0.710			

Table 3: Estimated Price and Income Elasticities

	Own-Price		Income (expenditure)	
	Text	Pictures	Text	Pictures
Meat	-0.704	-0.688	0.107	0.030
Fish	-0.988	-0.640	1.369	1.237
Veg.	-1.060	-1.248	1.012	1.000
Bread	-0.696	-0.780	1.220	1.364

Figure 3: Adstock Index Through Time for Text and Pictures when $A_1 = 100$



3 plots the estimated decay functions based on the optimal value of λ for each of the two *adstock* variables. From these it is clear that people discount the past quite quickly with regard to the scare index based solely on the amount of text devoted to the scare. However, interestingly. the effect of pictures has a much more enduring effect on peoples' consumption patterns, such that images seen several periods ago still have a significant impact on current consumption patterns. Thus in conjunction these results suggest that not only do pictures have a bigger immediate negative effect on meat consumption, but also that these effects tend to last for much longer.

6 Conclusion

Widespread food health scares, such as the BSE outbreak in the U.K., undoubtedly affect demand for these (and related) food products. The extent to which this demand is affected is predominantly determined by peoples' perception of the risks involved, which in turn is predominantly a result of information supplied from government and the media. Such "adverse advertising" is likely to have a strong, indeed the strongest, contemporaneous effect on consumer demand. However, as is well-known in the advertising literature, such media exposure also has an effect which will last, but diminish, over time.

For these reasons in this paper we follow the advertising literature, in adopting an *adstock* approach. Here the negative effect of media exposure to food scares (in particular, BSE) is modelled as having its strongest impact contemporaneously, but also having a lasting effect into the future with geometrically declining weights, where the rate of decline is endogenously determined by the data. Indeed, we believe that the *adstock* approach is ideally suited to modelling such health scares and allows us to examine the long-term effects of these.

To allow for the fact that consumers are likely to react quite differently to front page text and front page pictures; research in the marketing, media and psychology literature has suggested that pictures are more memorable than verbal or written cues; we consider two *adstock* variables: one based on text and the other on pictures. Finally, unlike previous studies that have considered the effect of health scares on demand for meat, the focus here is on meat demand in total, as opposed to its constituents (types of meat). That is, as well as having a substitution effect within meat products, it is likely that adverse publicity for beef will have spill-over effects for all meat products.

The results with regard to price and income elasticities were broadly in line with prior expectations and those found in the literature. Also in line with previous evidence, our results suggest that (media) picture effects dominate the text ones, both with regard to the magnitude of effect and the length of their impact. Based on our model estimates, we would predict that BSE has had a significant effect on total meat demand. Over the 16 years examined in this paper (1990-2005) it is estimated that meat consumption due to the BSE scare was reduced, on average, by around 70 pounds per head per year (in £2006).

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