Meat consumers' long-term response to perceived risks associated with BSE in Great Britain

Michael BURTON,
Trevor YOUNG,
Roy CROMB

Michael BURTON*, Trevor YOUNG**, Roy CROMB***

Les répercussions de l'ESB sur la consommation de viande à long terme en Grande-Bretagne

Résumé – L'objectif de cet article est de donner une preuve empirique de l'impact à long terme de l'ESB sur la consommation de viande en Grande-Bretagne.

Les deux premières études présentées reposent sur un système de demande dynamique. Elles portent sur 4 sortes de viande et utilisent la base de données trimestrielles "National Food Survey" pour la période allant du 1er trimestre 1961 au 4e trimestre 1995. Les résultats obtenus montrent de manière certaine qu'une fraction de la consommation de bœuf a été irrémédiablement perdue.

La seconde partie de ce travail empirique a été réalisée en collaboration avec la "Meat and Livestock Commission" (MMD, 1997). Utilisant les données de "Audits of Great Britain" de janvier 1988 à mars 1997, l'analyse aboutit globalement aux mêmes résultats quant à la variation dans la répartition du budget attribué à la consommation de viande sur le court terme. Elle souligne également les perte dues à l'ESB sur le marché du bœuf à long terme, mais l'effet paraît être moins important que celui suggéré par les deux premières études.

Mots-clés :
consommation de viande, sytème de demande, ESB, Grande-Bretagne

Meat consumers' long term response to perceived risks associated with BSE in Great Britain

Summary – The purpose of this paper is to review the empirical evidence of the scale of the long-term impact of BSE on meat consumption in Great-Britain.

The first two studies reviewed specified a dynamic demand system for 4 meats, using quarterly National Food Survey data for the period 1961:Q1 to 1995:Q4. The results suggest that as a consequence of BSE some portion of the beef market has been irretrievably lost and that this finding is robust.

The second body of empirical work reviewed here was undertaken on behalf of the Meat and Livestock Commission (MMD,1997). Using four-weekly data from Audits of Great Britain, for the period January 1988 to March 1997, the analysis gives broadly comparable short-run shifts in the meat expenditure shares due to BSE, and indicates that there has been a long-run loss in the market, but the effect is not as great as would have been implied by the earlier models.

Key-words :
BSE, beef demand, demand system, Great Britain

*   *Department of Agricultural and Resource Economics, University of Western Australia, Perth, WA 6907 Australia.*
     e-mail : mpburton@agric.uwa.edu.au
**   *Centre for Agricultural, Food and Resource Economics, School of Economic Studies, University of Manchester, Manchester, M13 9PL.*
     e-mail : trevor.young@man.ac.uk
*** *formerly MMD Limited, 2 Sekforde Court, 217-219 St John St., London EC1V 2LY.*

THE presence of BSE in the UK cattle herd has been taken by consumers as an indication that there is now a novel risk associated with consuming beef. This change in perception will cause a change in observed expenditure patterns, but economic theory has little to offer *ex ante* in terms of the predicted degree of that change, or its permanence, precisely because of the novelty. However, sufficient time has now passed since the first wave of media attention to BSE (starting in 1989), for us to quantify some of the effects empirically. The purpose of this paper is to review the empirical evidence of the scale of the long-term impact of BSE on meat consumption [1].

Two empirical approaches are examined. The first of these is found in the published work of Burton and Young (1996, 1997). The second draws heavily on a unpublished study undertaken by MMD Limited, on behalf of the Meat and Livestock Commission (MMD, 1997), but some developments have been made for this paper [2].

EMPIRICAL ANALYSIS I

In Burton and Young (1996, 1997) a dynamic demand system is estimated which takes account of i) the short-run and long-run effects of prices and income or total expenditure levels on consumer demand, ii) long-run trends in demand which might be attributed to non-economic factors, iii) some variables that represent media interest in the BSE issue, and which may help us to establish whether these variables have influenced demand in the long run. The data periods in both studies start in 1961 quarter 1, and they end in 1993 quarter 3, and 1995 quarter 4 respectively.

The basis of the demand model is the well-established Almost Ideal Demand System in which the market share of each product is expressed as a function of prices and a measure of real income or total expenditure. Burton and Young augment each intercept in the system by a polynomial of degree g in time (for the sake of parsimony, the use of trend has not been extended to other parameters in the model). The use of trends to capture structural shifts in meat demand, attributable to changes in tastes, is quite common (for example, Eales and Unnevehr, 1988, Martin

and Porter, 1985, and Moschini and Meilke, 1989). Although it does not permit an investigation of *why* the structural shift has occurred, the approach offers considerable flexibility in the representation of the temporal pattern of structural change (in this case, by choosing a high value of *g* and subsequently testing more restricted forms).

Given the high media attention afforded to BSE, it would seem appropriate to use some measure of the media's coverage of the issue as a proxy for the consumer's awareness of it. The measure chosen by Burton and Young is based on the number of UK newspaper articles which refer to BSE [3]. The index shows a very rapid rise in the number of articles during 1990: over the period 1989 to 1993 there are 1565 articles, of which 9% were published by the end of 1989, and 79% by the end of 1990. This measure is obviously crude, in that it does not distinguish between articles which are pessimistic about the effects of BSE on human health from those that are optimistic. Brown and Schader (1990), in their study of the effect of cholesterol information on egg consumption, use a slightly more sophisticated index, *viz.* the sum of medical articles supporting a link between cholesterol and heart disease minus the sum of articles questioning such a link. Nevertheless, such an aggregate measure of health information may be a poor proxy for consumers' specific health concerns and awareness. Yen *et al.* (1996), having access to data on individuals in a diet and health survey, are able to use a binary variable to indicate whether the individual knows of any links between cholesterol and health problems. The data used by Burton and Young precluded both of these approaches.

However, Burton and Young's approach does have the advantage that it captures the dynamics of the process of dissemination of information. In their model, an article on BSE is allowed to have two effects: i) an immediate but short-lived impact, such that beef consumption would return to its original level once media interest in BSE had passed, and ii) a permanent effect leading to a reduction in beef consumption in the long run. It has particular advantages over the alternative of simply including dummy variables to capture the effect of the media exposure of the BSE issue. The dummy variable approach has been used elsewhere (for example, Tansel (1993) used dummy variables to capture the effects of health warnings and anti-smoking campaigns on cigarette consumption) but it raises some methodological problems: given its discrete, step nature, a dummy variable does not lend itself to describing a process which is continuous and evolving, such as media coverage; a dummy variable would not indicate the intensity of media coverage over time; and the temptation to use a dummy that corresponds to an obvious perturbation in the data may bias the identification of transitory effects [4].

---

[3] These data were provided by Jacquie Reilly of the Glasgow Media Studies Group, Department of Sociology, University of Glasgow.

[4] Moschini and Moro (1996) provide a short review of approaches to explicit modelling of structural change which introduce variables representing taste shifters.

A static version of the AIDS model, augmented for seasonal variation, trend and media effects, would take the form:

$$w_{it} = \sum_{f=1}^{g} \alpha_{if}\, t^f + \sum_{k=1}^{4} d_{ik}\, D_{kt} + \varepsilon_i^c\, bse_t^c + \sum_{j}^{n} \beta_{ij}\, lnP_{jt} + \beta_{i0}\, ln\, M_t \quad i = 1, ..., n$$

where
w_i = share of good i in total meat expenditure,
P_j = price of good j; $j = 1,.., n$
M = real total meat expenditure, defined as *TE/P* where
TE = total meat expenditure, and *P*, the deflator, is computed as:

$$lnP = \sum_{k=1}^{n} \overline{w}_k\, ln\, (P_k)$$

$\overline{w}_k$ = mean expenditure share of good k; k= 1,.., n
bse = no. of articles on BSE per quarter,
bse^c = cumulative total no. of articles on *bse*.
D_k = dummy variable, 1 in quarter k, 0 otherwise,
t = time trend.

The dynamic AIDS system used by Burton and Young takes the form of an error correction model (Anderson and Blundell, 1982) in which the expression above is an equilibrium condition:

$$w_{it} - w_{it-1} = \lambda \left(\sum_{f=1}^{g} \alpha_{if}\, t^f + \sum_{k=1}^{4} d_{ik}\, D_{kt-1} + \varepsilon_i^c\, bse_{t-1}^c + \sum_{j}^{n} \beta_{ij}\, ln\, P_{jt-1} + \beta_{i0}\, ln\, (M_{t-1}) \right.$$

$$\left. - w_{it-1} \right) + D_{lt}(d_{i1} - d_{i4}) + D_{2t}(d_{i2} - d_{i1}) + D_{3t}(d_{i3} - d_{i2}) + D_{4t}(d_{i4} - d_{i3})$$

$$+ \varepsilon_i\, bse_t + \sum_{j}^{n} \delta_{ij}\, ln\,(P_{jt} / P_{jt-1}) + \delta_{i0}\, ln\,(M_t / M_{t-1}) \qquad i = 1, ..., n$$

Changes in the expenditure share can be attributed to two aspects: the degree to which the share is out of equilibrium and period-to-period changes in the exogenous variables. For example, the immediate impact of a change in price j will manifest itself in a change in share via the coefficient δ_{ij}, but the long-run equilibrium impact will be determined by the change in the equilibrium condition *i.e.* via β_{ij}. The transition path will be determined by a combination of the initial shock, the change in equilibrium, and the adjustment parameter λ. The "general restrictions" of homogeneity and symmetry may hold in the short run and/or long run or not at all.

This version has a restricted dynamic specification with the adjustment coefficient, λ, being the same in each share equation. In steady state, the model reduces to the orthodox AIDS specification.

In the empirical analysis four meat categories are identified : (carcase) beef and veal ; lamb ; pork and bacon ; and poultry. The data collected by the National Food Survey (NFS) of household food expenditure in Great Britain, conducted by the Ministry of Agriculture, Fisheries and Food (MAFF), are used. Burton and Young (1996) examined NFS quarterly meat price and expenditure data for the period 1961 : Q1 to 1993 : Q3. Burton and Young (1997) extended the data set to 1995 : Q4. In both cases a large number of alternative specifications were estimated [5], in order to investigate the significance of linear, quadratic and cubic trend effects (g = 1, 2 or 3), the transitory and equilibrium BSE media variables, both singularly and in combination, and general restrictions of homogeneity and symmetry.

It is important to note a number of deficiencies of the NFS data which should be borne in mind when interpreting the empirical results. Firstly, the data exclude food consumed outside the home, an omission which has grown in significance over time. Secondly, unit values are recorded, not actual market prices, and as a number of authors, notably Deaton (1988), have argued, unit values reflect quality as well as genuine price variation and so in effect are choice variables. Their use in empirical demand analysis introduces potential problems of identification, simultaneity bias and interpretation. Finally, the estimated consumer responses are conditional upon there being no substitution within meat types – so, for example, it is assumed that consumers do not switch from lower to higher quality of beef cuts as a response to concerns about BSE.

Ideally the demand system would be specified at a lower level of aggregation (e.g. specific cuts of meat). In this way the problem would be reduced (although strictly it would still exist if there were any heterogeneity of quality within the product definition) and the impact of BSE on the composition of beef demand could be identified, which may be important if consumers perceive there to be a differential risks. Unfortunately, the data do not exist at a sufficient degree of disaggregation, at a quarterly periodicity, and this route is not open.

The results reported in Burton and Young's 1996 paper turned out to be very robust when the data period was extended to the end of 1995. The preferred model (based on log likelihood ratio (LR) in both cases has homogeneity and symmetry in the long run, cubic trend effects and a significant impact for BSE in both the short run and long run (an alter-

---

[5] The model is estimated by FIML using the computer program TSP 4.2a. In a multistage budgeting model, such as this, it is possible that the aggregate expenditure variable should be considered as endogenous, and should be instrumented (Deaton and Muellbauer, 1980). The original work reviewed here did not consider this, but some subsequent re-estimation using instruments for total meat expenditure did not lead to any significant changes in parameter estimates, neither for prices, expenditure nor the BSE variables. The non-IV estimates are reported here to conform with the previously published papers.

native test procedure based on the Akaike's information criterion (AIC) leads to the same choice of preferred model specification).

Table 1 presents the estimated (uncompensated) demand elasticities for the preferred model. These results confirm that meat consumers are relatively responsive to changes in prices when determining the allocation meat expenditure between the four groups. In particular, the own-price elasticities are all relatively high, but particularly those of beef and lamb, where for example, a 10 % increase in prices would cause a 15 % and 16 % decline in consumption respectively. The cross-price elasticities also reveal that beef and lamb consumption are particularly sensitive to changes in their respective prices. This may give some indication that consumers view the two goods as relatively good substitutes, and hence beef consumption may be threatened by a food scare such as BSE.

Table 1.
Long-run Elasticities

	Beef Price	Lamb Price	Pigmeat Price	Poultry Price	Total Expenditure
Beef	-1.522	0.219	0.058	-0.036	1.282
	0.102	*0.073*	*0.064*	*0.078*	*0.155*
Lamb	0.475	-1.602	-0.010	-0.107	1.245
	0.161	*0.233*	*0.153*	*0.166*	*0.166*
Pigmeat	0.249	0.080	-1.041	-0.022	0.734
	0.069	*0.069*	*0.084*	*0.079*	*0.351*
Poultry	0.125	-0.036	-0.030	-0.709	0.650
	0.226	*0.178*	*0.177*	*0.319*	*0.132*

Source: Burton and Young, 1997.
Standard errors are reported in italics.

Turning to the issue of the effect of BSE, Burton and Young estimate that media concern about the issue caused a "transitory" loss of 5.4 percentage points in the market share of beef (*i.e.* from approximately 30.8 % to 25.4 % of the expenditure on meat) in the second quarter of 1990, the quarter in which most articles referring to BSE were published (see Table 2). This, however, turns out to be an overreaction. The estimated long-run effect is rather less but still substantial: with a *sustained* decline of some 4.8 percentage points in the share of beef (so by 1995 the market share for beef was 25.9 %) given the media attention to BSE. This is indeed bad news for the beef producers, but lamb and pigmeat producers benefit from the shift in consumer preferences (their market shares rising by 3.1 and 1.6 percentage points respectively).

There is, however, relatively little effect on poultry, suggesting that the effects that have been identified are not part of the general movement away from red and towards white meat, but a specific concern with beef. It is interesting to note that the shifts in demand that are attributed to BSE mirror the relationships between the meats revealed by the elasticities in Table 1.

	Maximum SR effect - 1990:2	Maximum LR effect - 1995:4
Beef	-5.4 % (-5.7)	-4.8 % (-4.5)
Lamb	0.7 % (0.7)	3.1 % (2.8)
Pigmeat	2.2 % (2.0)	1.6 % (1.6)
Poultry	2.5 % (2.4)	0.1 % (0.1)

Table 2. Estimated Maximum Effects of BSE on Expenditure Shares

Source: Burton and Young, 1997.
Figures in parentheses refer to estimates in Burton and Young (1996).

One criticism of the specification used by Burton and Young is that there is no depreciation in the long-run impact of the media, *i.e.* the model predicts that the loss of beef share will be sustained indefinitely even if there is no further media coverage of the issue. This issue was explored in Burton and Young's 1997 paper.

Given a general media index,

$$bse_t^c = \sum_{i=0}^{30} v_i \, bse_{t-i}$$

the form of the cumulative media index used previously is defined when $v_i = 1$ for all *i*. An alternative is to let the weights decline geometrically over time, *i.e.* $v_i = q^i$, which gives:

$$bse_t^c = bse_t + \theta \, bse_{t-1}^c \qquad 0 < \theta \le 1$$

Setting $q = 1$ gives the previous model. By selecting alternative values of *q*, different measures of the "stock" of the media effect are generated. A grid search has been conducted with *q* varying from 0.6 to 1, in steps of 0.01, and the model (2) re-estimated using each of these variables. The specification with the largest log-likelihood was identified at $q = 1$, confirming that the results presented in the text are appropriate.

A further alternative that was considered was to allow the weights to follow a third degree polynomial distribution, $v_i = c_0 + c_1 i + c_2 i^2 + c_3 i^3$, where c_0, c_1, etc. are parameters to be estimated. This allows some flexibility in the way that the depreciation in the media stock may occur, and also has the advantage that the original model is contained within it, when $c_0 = 1$ and $c_1 = c_2 = c_3 = 0$. Using the usual transformation of variables (see Pindyck and Rubinfeld 1981, pp. 238-239) this restriction was tested and accepted on the basis of a LR test, suggesting that for the period considered, the best representation of the stock of media effect is one which does not depreciate over time.

EMPIRICAL ANALYSIS II

In this section, we present the amended results of a study undertaken by MMD Limited for the Meat and Livestock Commission. The general approach is similar to that outlined above, although the data and the specific model are different.

The meat expenditure data were 4-weekly estimates of frozen and fresh purchases of beef, lamb, pork and poultry, derived from Audits of Great Britain survey data [6]. The AGB survey covers approximately 10,000 households. As in the Burton and Young studies, unit values are used to represent prices paid. Figure 1 reports the BSE press mentions for the period 1988 to 1997. The index of newspaper articles is also on a 4-weekly basis, and was collected independently from the data used in the previous studies (and hence is not the same), although it shows a very similar evolution of total media interest over the period. A large number of alternative specifications were explored, but the preferred equation took the form:

$$w_{it} = \sum_{f=0}^{1} \alpha_{if}\, t^f + \sum_{k=1}^{11} d_{ik}\, DUM_{kt} + \sum_{l=1}^{3} \varepsilon_{il}\, bse_{lt} + \sum_{m=1}^{4} \eta_{im}\, \mathrm{ADV}_{mt} + \sum_{j}^{n} \beta_{ij}\, ln\, P_{jt}$$

$$+ \beta_{i0}\, ln\, M_t \qquad\qquad\qquad\qquad i = 1, ..., n$$

The use of 4-weekly data presents some difficulties in modelling the seasonality of demand, as, over time, a 13 period "cycle" will shift through the calendar. To avoid this, 11 dummy variables (*DUM*) were created which report the proportion of the 4-week period that falls within the calendar month (DUM_1 = January,... DUM_{11} = November).

Figure 1.
BSE Press Mentions
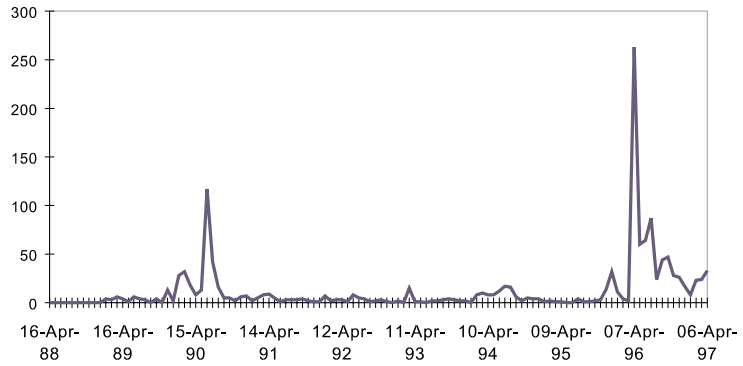
The impact of BSE was captured using 3 variables: bse_1 which is the number of articles published in the period, bse_2 which is the cumulative number of articles and bse_3 which is a stock measure of BSE, employing a 68 % rate of depreciation over each 4 week period. Although high, this depreciation rate does allow for some dynamic impact in the medium term, before the impact settles to the long-run effect. Because of the extremely large number of publications in March 1996, the issue of a declining marginal impact of media interest has to be considered. This has

---

[6] These data are not public but rather are available on commercial terms.

been achieved rather crudely by raising each of the BSE variables outlined above to the power of 0.9. The value of this coefficient, and the rate of depreciation on the stock BSE measure were identified simultaneously within a bivariate grid search over both parameters. Both bse_2 and bse_3 are statistically significantly within the demand system as a whole. Thus, the basic representation of the impact of the media is similar in both models, although some additional short-term dynamics have been identified in the later work, as might be expected given the shorter data periodicity.

Four advertising 'stock' variables (ADV_m) were also included (employing a 20% depreciation rate), covering species-specific (beef, lamb and pork) advertising, and for generic red meat. These are based on Media Expenditure Analysts Ltd (MEAL) data of advertising expenditure, deflated by the Retail Price Index (RPI) to give a 'volume' measure. The coefficients on the log of prices ($ln(P)$) were homogeneity and symmetry constrained, and, as in the Burton and Young studies, a Stone index was employed for total expenditure (M). The data period used is January 1988 to March 1997, giving 120 observations in total.

The (uncompensated) price and income elasticity estimates are reported in Table 3. They are generally smaller than those in Table 1, which may reflect the shorter periodicity employed, and the lack of any dynamics in the model. As one would expect, BSE has a negative impact on beef consumption, and positive impacts on the other 3 meats. The effects are summarised in Table 4, which reports the maximum change in the expenditure shares in any 4 week period associated with each of the two shocks to the system (in 1990 and 1996), as well as estimates of the average impact for the six periods following the start of the media interest in those years. The table also reports the estimated long-run impact of BSE on the shares, assuming that the cumulative number of articles relating to BSE is maintained at its March 1997 level.

Table 3. Long-run Elasticities ("MMD" model)	Beef Price	Lamb Price	Pigmeat Price	Poultry Price	Total Expenditure
Beef	-0.763	0.039	-0.058	-0.186	0.968
	0.205	*0.101*	*0.098*	*0.149*	*0.188*
Lamb	0.278	-1.176	0.334	0.001	0.614
	0.262	*0.160*	*0.146*	*0.218*	*0.331*
Pigmeat	-0.072	0.251	-1.104	0.096	0.829
	0.199	*0.111*	*0.133*	*0.145*	*0.216*
Poultry	-0.346	-0.103	-0.031	-0.835	1.315
	0.205	*0.101*	*0.030*	*0.166*	*0.232*

Standard errors are reported in italics.

The impact effects for 1990 are very similar to those estimated earlier: around 6% decline in beef and shifts towards pork and poultry, although it is notable that here lamb also gains. The impact of the March 1996 announcement was even greater in the short run: a decline of some 13% points in the share to beef, even allowing for the estimated declining marginal impact of the media at that time. The effect over the following six months as a whole is also substantial. The long-run effects, due solely to the effect of the cumulative number of articles, are also broadly similar to those of the earlier studies, with beef share being reduced by some 5%, although it should be noted that these are evaluated at the higher, 1997 level of cumulative publications. It is the other red meats which mainly gain, although the size of the effect on lamb and pork has switched. It should also be remembered that the reported changes are percentage-point changes in the expenditure shares: the absolute changes in meat demand are considerably higher.

Table 4.
Estimated Effect of BSE
on Expenditure Shares,
1990 and 1996
("MMD" model).

	June 1990	June-Oct. 1990 Average	April 1996	April-Aug. 1996 Average	Long Run
Beef	-5.8%	-3.9%	-12.9%	-10.3%	-4.9%
Lamb	2.1%	1.3%	4.2%	3.2%	0.8%
Pork	1.6%	1.6%	5.4%	4.3%	3.2%
Poultry	2.1%	1.1%	3.3%	2.8%	0.9%

Aggregate meat demand

All of the effects reported above have been within the context of an expenditure share system: they have measured shifts in the proportions of expenditure on different meats. They have said nothing about the effect of BSE on the aggregate meat demand, which, if it exists, could further the decline in beef consumption, and would dissipate (and possibly even reverse) any gains that the other meats may have achieved at the expense of beef *share*. However, investigations with the quarterly NFS data, using both single equation and food expenditure share systems revealed no significant impact on aggregate meat consumption. Investigations of aggregate meat consumption using a single equation framework for the AGB 4-weekly data found some evidence of reductions in demand, but these results were very fragile, and relied upon interactions between BSE and the effectiveness of advertising. At this stage we would suggest that there is little good evidence of any impacts of BSE on aggregate meat demand.

Summary and conclusions

Burton and Young (1996,1997) suggest that the first wave of media attention to BSE (from 1989 to 1995) had an immediate, detrimental effect on the market for beef and even though the market recovered to

some extent, beef producers suffered a *sustained* loss of market share. Although the impact effects of the first wave are similar using the alternative MMD data and model, the conclusions about the long-run effects differ to the extent that they give a smaller estimate of the long-run effect by 1997 than would been suggested by simulating the earlier models with the new, higher, level of media interest. This would seem to be due to the identification of a declining *marginal* impact of media interest, which may be reasonable given the extreme variability of the sporadic media interest in the issue. This raises a number of interesting questions that have not been explored fully here, such as the identification of the differential impact of sustained-but-low as compared to occasional-but-intense media reporting on long-run shifts in demand.

REFERENCES

ANDERSON (G.) and BLUNDELL (R.), 1982 — Consumer non-durables in the UK : A dynamic demand system, *Economic Journal*, Supplement 94, pp. 34-44.

BROWN (D. J.) and SCHADER (L. F.), 1990 — Cholesterol information and shell egg consumption, *American Journal of Agricultural Economics,* 72(3), pp. 548-555.

BURTON (M.) and YOUNG (T.), 1996 — The impact of BSE on the demand for beef and other meats in Great Britain, *Applied Economics*, 28, pp. 687-693.

BURTON (M.) and YOUNG (T.), 1997 — Measuring meat consumers' response to the perceived risks of BSE in Great Britain, *Risk Decision and Policy*, 2(1), pp. 9-18.

DEATON (A.) and MUELLBAUER (J.), 1980 — *Economics and Consumer Behaviour*, Cambridge , Cambridge University Press, England.

DEATON (A.), 1988 — Quality, quantity and spatial variation of price, *American Economic Review*, 78(3), pp. 418-430.

EALES (J. S.) and UNNEVEHR (L. J.), 1988 — Demand for beef and chicken products : Separability and structural change, *American Journal of Agricultural Economics,* 70, pp. 522-532.

MAFF — *Household Food Consumption and Expenditure*, Annual Reports of the National Food Survey Committee, London, HMSO.

MARTIN (W.) and PORTER (D.), 1985 — Testing for changes in the structure of the demand for meat in australia, *Australian Journal of Agricultural Economics,* 29, pp. 16- 31.

MMD, 1997 — *Red Meat Advertising and the Impact of BSE: An Econometric Analysis*, London , MMD Ltd., Mimeo.

MOSCHINI (G.) and MEILKE (K. D.), 1989 — Modelling the pattern of structural change in US meat demand, *American Journal of Agricultural Economics*, 71, pp. 255-261.

MOSCHINI (G.) and MORO (D.), 1996 — Structural change and demand analysis : A cursory review, *European Review of Agricultural Economics*, 23(3), pp. 239-261.

PINDYCK (R.) and RUBINFELD (D.), 1981 — *Econometric Models and Economic Forecasts* (2nd edition), McGraw-Hill.

TANSEL (A.), 1993 — Cigarette demand, health scares and education in Turkey, *Applied Economics*, 25, pp. 521-529.

YEN (S. T.), JENSEN (H. H.) and WANG (Q.), 1996 — Cholesterol information and egg consumption in the US : A nonnormal and heteroscedastic double-hurdle model, *European Review of Agricultural Economics*, 23(3), pp. 343-356.