Article

Meat market reaction towards mass media and science communication on Bovine Spongiform Encephalopathy

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ABSTRACT: *This study assesses the correlation between reports on food risk published in scientific journals and in the printed mass media and changes in the meat market. It focuses on the case of bovine spongiform encephalopathy (BSE) in the United Kingdom. The findings suggest that during the time BSE and its related human disease were of noticeable public concern, there was a predominantly negative correlation between the number of reports on BSE published in the British printed mass media and meat market variables. In contrast, reports of scientific research on the disease contributed to reducing the perception of food risk because these numbers correlated positively with the meat market.*

Introduction

The relationship between scientific information on food risk, on the one hand, and consumer behavior, on the other, has acquired increased significance in the scientific community, among those who frame public policy, and among business decision-makers.[1,2] Events such as outbreaks of bovine spongiform encephalopathy (BSE), foot and mouth disease (FMD), and avian flu have had important market implications, causing changes in consumption tendencies, product demand, and legislation concerning production and sanitary conditions.[3,4] One outcome of this situation is the demand for traceability and certification of origin,[5,6] which subordinates productivity and economic viability to good practice in food production.

Although science is recognized as the primary source of the information that, to some extent, modulates the behavior and evolution of contemporary Western societies, the information that conditions the daily lives of individuals seems to be delivered by the mass media news.

The understanding of perceptions of risk and people's attitudes toward threats is important for policy makers.[7] As a rule, public judgment regarding the safety of a food item is determined by the cognitive perception of the risk associated with its consumption. In addition to circumstantial risk situations, there is an institutionalized and structured environment of risks of which people become aware through access to

new knowledge.[8,9] Communication networks, social groups, cultural views, friends, and co-workers provide reference points for risk perceptions and amplify or attenuate these perceptions.[10] Thus, Douglas and Wildavsky[11] have emphasized that "risk is a collective construct".

Many researchers have dedicated themselves to studying the effects of mass media news on consumer behavior.[12,13,14,15,16,17] According to these studies, a balance exists between consumers' needs and their reactions to mass media news and policies to prevent food risk. Some researchers find that conflicting elements in the mass media represent factors that may induce uncertainty and insecurity in society,[18] with significant effects on market variables.[19,20,21,22]

Risk is the possibility of loss or unwanted consequences. Hence, risk involves the probability of an unwanted state occurring and the extent of the damage that it may cause.[23] The perception of risk arises from the information that people receive, signaling the nature and the likelihood of the damage produced by the unwanted phenomenon.

When such phenomena involve food safety, relevant information is the information that reaches consumers and alters consumer behavior and habits.[24] In general, scientific information reaches consumers through an indirect process. Upon completing his research, the scientist analyses the data obtained, writes a paper, and submits it for publication in an appropriate scientific journal. This manuscript describes careful analysis on the part of the scientist's peers and, when accepted, is published in a language that may be different from that practiced and understood by the public. Communication between the scientific world and the mass media is a first step in the process of transforming scientific findings into public knowledge.[25,26]

The gathering of facts of a scientific nature by journalists occurs, as a rule, in accordance with the standard journalistic practice of seeking news. In the case of a scientific fact, the journalist is delivering to the public differentiated information produced in accordance with recognized methodological rigor and should, therefore, be particularly concerned with accuracy.[27] Scientific journalism is concerned with the translation of the language of science to the lay public.[28]

The mass media's interest in scientific topics may change rapidly. The amount of news on specific scientific topics in the mass media tends to rise and fall as new issues, scientific or otherwise, attract the attention of journalists. This situation has led to the development of regularly updated, exclusively scientific bulletins. When a scientific report of evident public interest emerges, scientific journals, such as Nature and Science, issue weekly bulletins for accredited members of the mass media. The aim of this practice is to inform the mass media of the latest scientific discoveries.[29]

Journalism, as the main provider of information to the public, has a significant role in transmitting risk alerts to the public, especially new or emerging risks. Mass media also plays a key role in providing topics for debate and forming new opinions and beliefs. Although the press is unable to tell people how to think, it can suggest the topics about which readers should think.[30]

Frequently, the understanding of science is distorted when it is transmitted to the public.[31] Conflicting information from the mass media on risks can generate

uncertainty and insecurity in society[32] as well as changes in the consumption patterns of products linked to perceptions of food risk.[33,34] Given this uncertainty, it is necessary for science to reiterate information or to provide new information.

The present study aims to correlate scientific publications and mass media news about a case of food risk with changes in the meat market. For the purpose of this study, an analysis of the outbreak of BSE that occurred in the United Kingdom (UK) was conducted. That event generated intense debate in the mass media and in scientific society during the late 1980s and 1990s, spreading uncertainty and affecting the market for a primary food item.[35]

BSE is an incurable, fatal, transmissible infectious disease belonging to the group known as transmissible spongiform encephalopathy (TSE).[36] Its etiological agent is a prion (proteinaceous infectious particle). In humans, the most common examples of diseases caused by these proteins include Creutzfeldt-Jakob Disease (CJD), Gerstmann-Sträussler-Scheinker syndrome, fatal familial insomnia, kuru, and the variant of CJD (vCJD).[37] BSE first appeared in the UK and then affected other European countries; more recently, it has been diagnosed in North America. Although BSE came to light between 1983 and 1986, it was only in 1997 that the reports published by Bruce et al.[38] and Hill et al.[39] offered scientific evidence that the ingestion of products obtained from animals carrying the disease had induced a new variety of CJD that came to be known as vCJD or nvCJD.

Methods

The present study consisted of a bibliometric survey of online databases from high impact scientific publications[40] and the British printed mass media. This study is based on the hypothesis that there is an intercorrelation between the number of reports published in high impact scientific journals and articles in the printed mass media, on the one hand, and the behavior of variables in the UK meat market during the BSE crisis at the end of the 1980s and during the 1990s, on the other.[41,42]

Pearson's correlation ("r") coefficient was calculated to identify the presence of any correlation between the published information items and the behavior of market variables in three phases: before, during, and after the BSE crisis. The amount of information was represented by the annual frequency of each occurrence of keywords linked to BSE (the version of the disease found in animals) and vCJD (the variant of Creutzfeldt-Jakob Disease), which is the human disease caused by BSE. The criteria for identifying and selecting the keywords related to the scientific information and market variables are presented below, in the section specifically addressing with these variables.

Scientific Information

To analyze the scientific information, a selection was made from among 8,500 titles available online to date at the CAPES Periodicals Portal.[43] Only journals with an ISI (Institute for Scientific Information) impact factor greater than 2.0 in 2005 in the areas

of biology, medicine, and health sciences as well as others classified as multidisciplinary were selected. Only journals with full articles with issues available from at least January 1995 until December 2004 were included. Of the twenty-four journals initially analyzed, thirteen were selected that showed high correlations with the explored variables (table 1). Some of these journals have editions prior to 1995 available online. When pertinent, articles from this period were considered within this discussion.

Title	Periodicity	Area	IF[1]	ISSN[2]
Acta Neuropathologica	Monthly	Neurophysiology	2.56	0001-6322
Brain Research	Weekly	Neurophysiology	2.47	0006-8993
British Medical Journal	Weekly	Medicine	5.33	1468-5833
Chemistry and Biology	Monthly	Biological Sciences	6.13	1074-5521
Current Biology	Fortnightly	Biological Sciences	11.91	0960-9822
Current Opinion in Neurobiology	Monthly	Neurophysiology	9.73	0959-4388
Emerging Infectious Diseases	Monthly	Medicine	5.34	1080-6040
Journal of Agricultural and Food Chemistry	Fortnightly	Agricultural Sciences	2.10	0021-8561
Journal of Neurochemistry	Fortnightly	Neurology	4.82	0022-3042
Journal of Neurology	Monthly	Neurophysiology	2.78	0340-5354
Nature	Weekly	Multidisciplinary	30.98	0028-0836
Science	Weekly	Multidisciplinary	29.16	0036-8075
Trends in Biotechnology	Monthly	Environmental Sciences	7.52	0167-7799

[1] Impact Factor in 2005.
[2] International Standard Serial Number.

Table 1. List of selected periodicals, showing periodicity, area, impact factor, and ISSN.

The journals American Journal of Infection Control, Archives of Neurology, Behavioral Neuroscience, Bioscience, Current Opinion in Biotechnology, Food and Chemical Toxicology, Journal of Clinical Epidemiology, Journal of Evolutionary Biology, Journal of Experimental Medicine, Life Sciences and Meat Science were analyzed in detail, but low correlation was revealed. Accordingly, they were not considered in the discussion of the findings.

Information from the printed mass media

The news published in the mass media was collected from open online archives in five British newspapers and two economic magazines that have a worldwide circulation, as shown in table 2.

Publication	Website Link	Available online since
Newspapers		
Independent	www.independent.co.uk	October 1999
Telegraph	www.telegraph.co.uk	April 1996
The Guardian	www.guardianunlimited.co.uk	January 1997
The Sun	www.thesun.co.uk	January 1997
Times Online	www.the-times.co.uk	January 1987
Magazines		
Economist.com	www.economist.com	January 1997
Newsweek	www.newsweek.com	January 1993

Table 2. Printed mass media publications searched and date available online.

Researched keywords

Once the news sources to be explored had been chosen, the keywords that would indicate a perception of risk were selected. In the collection of both scientific and mass media information, the following keywords were sought from among those used by the scientific authors and journalists when referring to the topic of BSE: the acronym BSE and the terms bovine spongiform encephalopathy, transmissible spongiform encephalopathy (TSE), TSE, and mad cow disease. Terms indicating the corresponding human diseases were also investigated, including Creutzfeldt-Jakob Disease and other terms that address encephalopathy in general: Creutzfeldt-Jakob disease (CJD), CJD, nvCJD, and vCJD (the two latter were used after 1997).

To analyze the information from before the emergence of BSE as a disease, the frequency of the keyword prion, the agent considered to be the cause of these diseases, was also checked. To trace a parallel between BSE and other food-risk-related diseases, keywords related to foot and mouth disease and its acronym, FMD, were also searched.

Determination of the frequency of the keywords

In the scientific journals, the keyword search was conducted among the terms found in the title, abstract, and keywords. In the newspapers and magazines, the keyword search was conducted within the archive content using the website search engine. The absence of an abstract or keyword section prompted a search for keywords throughout the article, in the title, or within the body of the text. In the journals, magazines, and newspapers, care was taken to ensure that keywords present in indices or summaries were not counted to avoid double counting.

All of the articles that were found were filed and catalogued for later review and for the elimination of references unrelated to the purpose of the present study. Once

reviewed, the collected data were counted and filed by title, author, date of publication, and the name of the periodical in which the article was published.

Meat market information

The data on the import and export of meat from the UK were obtained from the website of the Meat and Livestock Commission.[44] The figures for the total beef production, beef cattle herd, and beef consumption in the UK were obtained from the website of the Food and Agriculture Organization of the United Nations.[45]

Results and Discussion

The keyword search among the twenty-four scientific journals and seven mass media vehicles resulted in a matrix of more than 3,700 data items. The ability to group different keywords and to contrast vehicles allowed a great number of comparisons to be made. In the present article, the frequency of the appearance of the keywords in some scientific journals and mass media vehicles is presented. These were selected by the degree of importance given to the subject, as shown by the number of references to the keywords. Then, the correlations between the appearances of the keywords in the scientific journals, mass media, and the behavior of the meat market variables in the UK are discussed.

Coverage of the BSE by scientific journals

The journals Nature and Science can be considered as having the highest impact factors among journals concerned with current scientific events. Figure 1 shows the frequency of the appearance of topics linked to the animal disease (BSE) and the human disease (CJD) in the studied journals. It was found that the scientific journals preferred to use the complete names of the diseases (bovine spongiform encephalopathy, for example). In the figures, the abbreviations for the diseases are used (for example, BSE).

   BSE was first detected in animals in 1986. Until 1994, the number of reports concerning BSE published in Nature and Science was small. Scientific proof of the link between the animal disease (BSE) and the human disease (CJD) was presented in 1996. From that moment on, it was perceived that there was a need to stop treating the subject as merely a veterinary problem and to address the wider dimensions of the problem.[46] Figure 1 shows that Science was interested in the topic of BSE in 1996 and 1997 and in the topic of CJD in 1998, with reduced references to these topics until the year 2000. The curves corresponding to Nature were similar, although with greater intensity: whereas Science made five references to BSE in 1996, in the same year, Nature made almost 140 references.
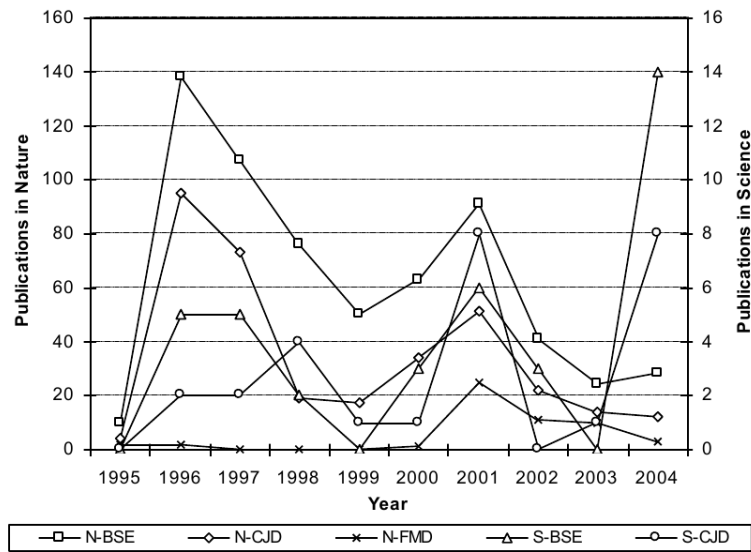
Notes: N-BSE = keywords BSE, bovine spongiform encephalopathy and mad cow disease found in Nature; **N-CJD** = keywords CJD, Creutzfeldt-Jakob disease, nvCJD and vCJD found in Nature; **N-FMD** = keyword foot and mouth disease found in Nature; **S-BSE** = keywords BSE, bovine spongiform encephalopathy and mad cow disease found in Science; **S-CJD** = keywords CJD, Creutzfeldt-Jakob disease, nvCJD and vCJD found in Science.

Figure 1. Keyword entries grouped by disease in Nature and Science journals.

In 2001, possibly due to an outbreak of FMD in Europe, there was an increase in the number of references to BSE and CJD in the two journals, although the expression foot and mouth disease was not used by Science that year. In 2002 and 2003, the three diseases were rarely mentioned. In 2004, the apparent interest of the British journal Nature in the topics of BSE and CJD remained low, whereas the American journal Science showed increased interest coinciding with the appearance of sick animals in North America.

Among the investigated scientific journals, the British Medical Journal had the most references to the keywords considered in the present study. Figure 2 shows the results of the survey for this journal.

In the British Medical Journal, a weekly scientific journal, there was a large number of articles on the subjects of BSE and CJD between 1995 and 2004. The number of citations for these diseases remained high throughout that period, with well-defined peaks in 1996 and 2001. During the entire time frame of the analysis, in contrast to the other journals included in the study, the keyword prion was rarely mentioned in this vehicle. It should also be noted that the interest of the British Medical Journal in the human disease CJD decreased in 2004. In scientific journals, the reduction in the number of articles published on a specific problem may be the result of the emergence of other research problems that inspire greater interest among scientists.[47] The reduced interest in CJD in 2004 may be related to the growing interest in articles dealing with avian flu in that year.
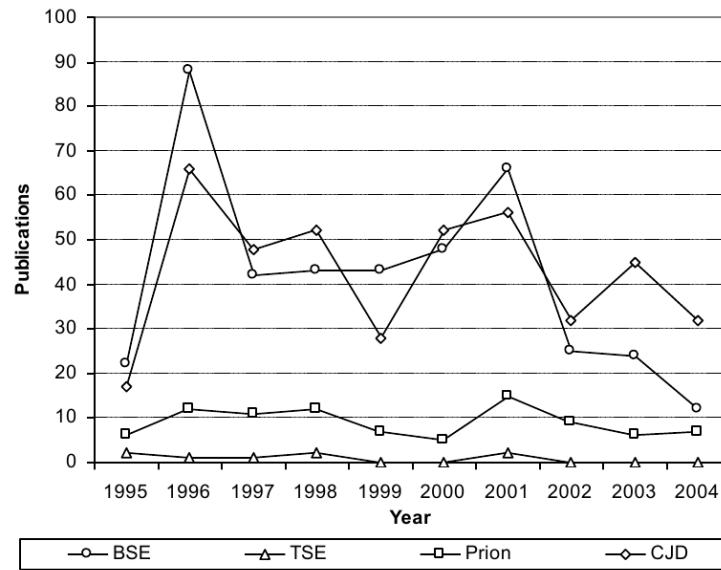
Figure 2. Keyword citations grouped by disease in the British Medical Journal.

Coverage of BSE by printed mass media

The search conducted in the printed mass media on the keywords BSE, CJD, FMD, and prion revealed a larger number of citations than that found in the scientific journals. The media can be grouped into two distinct types of publications: online versions of the publications the Economist.com and Newsweek (magazines directed toward economic and social issues) and five British newspapers: Independent, Telegraph, The Guardian, The Sun, and Times Online.

Although the total number of entries for the keywords was low, counting the number of citations by year showed that the Economist.com was more interested in the crisis than Newsweek. For all of the groups of keywords, the Economist.com had more than twice the number of citations found in Newsweek.

An example of coverage of BSE offered by the British newspapers is shown in figure 3, which includes the survey of the Telegraph with the number of monthly entries about BSE and FMD in the period from April 1996 to December 2004.

Figure 3 shows the monthly evolution of the number of entries of the keywords FMD and BSE. During 2001, there was another outbreak of FMD in Europe, which apparently led to an increase in the number of entries on BSE. Prior to 2001, there was a large number of articles on BSE in November and December of 2000, with 58 entries in each month. This number decreased and then increased again in April 2001, when there were 60 entries. The increased frequency of the term BSE in April 2001 may be a consequence of the outbreaks of FMD that occurred in Europe. The numbers for October 2000 are most likely related to the publication of the document The BSE Inquiry,[48] which revealed important facts regarding the BSE crisis that had previously been confidential.
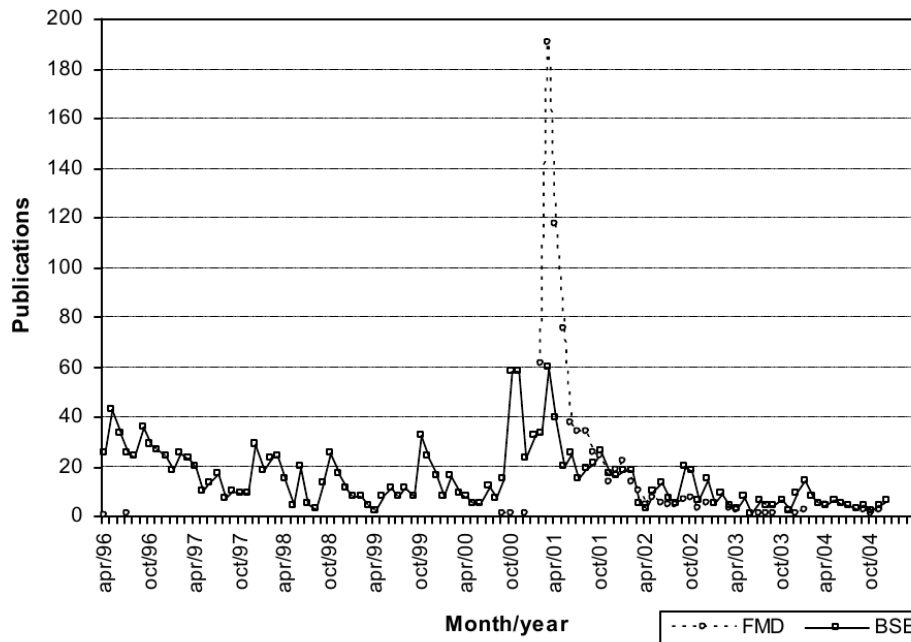
Figure 3. News published monthly using the keywords BSE and foot and mouth disease in the Telegraph newspaper.

It is important to note that no references to the subject of FMD were made until March 2001. Hence, it appears that in the period between 1999 and 2004, the greater number of articles on BSE was the result of the reappearance of FMD. Both diseases attack cattle, are infectious and difficult to control, and give rise to perceptions of food risk.

In contrast to the scientific journals, it was found that the newspapers preferred to use the abbreviations BSE and FMD instead of the full names (bovine spongiform encephalopathy and foot and mouth disease, respectively).

Meat market reactions to the communication on BSE

The perception of risk and its repercussions in the market arise as a result of multiple factors. The information published in scientific publications and in the printed mass media on a certain risk can directly influence consumer behavior. It can also indirectly influence certain social processes, bringing about, for example, the mobilization of stakeholders, official reactions and procedures, and commercial market strategies.

This study of the behavior of variables in the meat market during the BSE crisis may indicate how the market was affected by the mention of this disease in scientific journals and printed mass media news.

It is assumed that the public perception of a food risk as significant as BSE would affect the beef market specifically as well as the markets for related products, altering demand and, consequently, the prices of these products. Figure 4 shows the variation in

prices paid to farmers for the main meats produced and consumed in the UK in the decade during which the BSE crisis developed.

Figure 4 shows increasing beef prices until 1993, which may be the result of a reduction in supply due to the slaughter of animals that occurred during the 1980s in an attempt to control BSE. From 1993, there was a decrease in the prices paid to beef producers that coincided with an increase in the price paid to the producers of lamb. In a study that examined the supply and demand curves for beef in relation to the emergence of BSE, it was found that the effects of the disease on prices became relatively stable at approximately thirty months following the crisis. The variations were approximately 6%, 11%, and 61%, respectively, for retail and wholesale and prices paid to farmers.[49] For the cited authors, the prices of British meat reflected the public awareness of insecurity during the 1990s, which led to a reduction in consumption of the product in the UK and in other European countries.[50]

Figure 5 shows the variation in per capita consumption of beef in the UK during 1990 and 2005. A historical review shows that the first scientific record of BSE was published in 1987 by Wells et al.,[51] although the first report of the slaughter of sick animals dates from 1983. In the journal Nature, the first report concerning the disease was by Hope et al.[52] Correlating these facts with the data shown in figure 5, it can be seen that the consumption of meat continuously fell in the UK between 1991 and 1997. There was another decrease from 1993, which in this case was sharp. A further decrease in consumption occurred in 1996 and was followed by growth in 1998. The data may indicate that following the publication of scientific proof of the potentially lethal risk of consuming beef in 1997, the population reacted positively, increasing consumption of this meat.
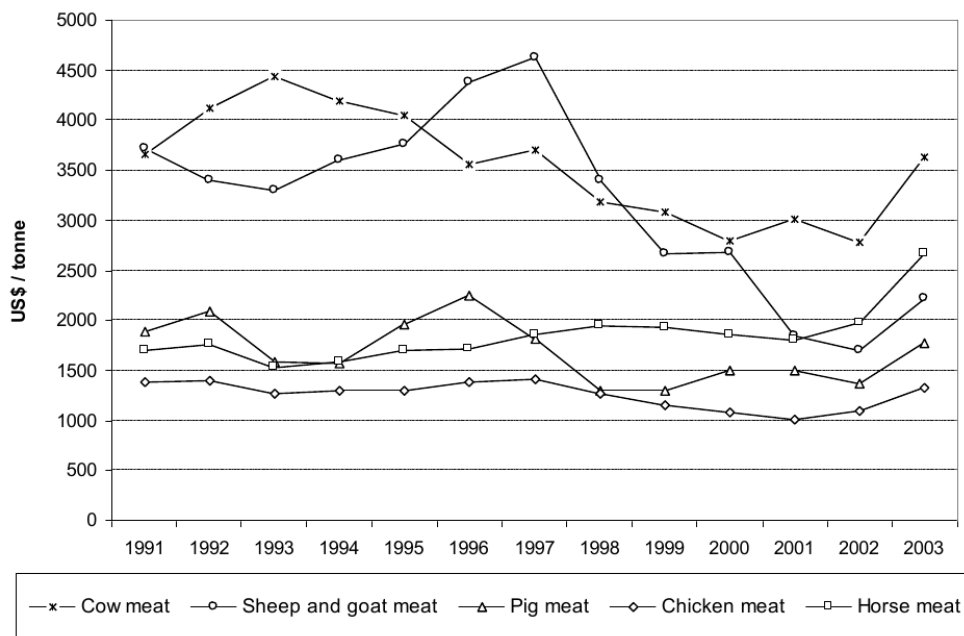

Figure 4. Prices paid to farmers in the UK, pounds per ton (source: FAO, 2007).
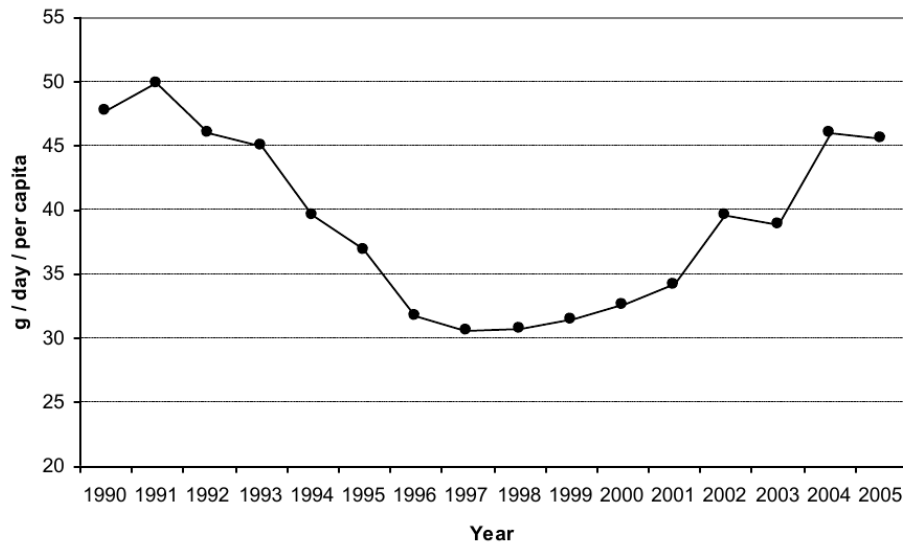
Figure 5. Variation in per capita beef consumption in UK (source: FAO, 2007).

Similarly, it appears that the fact that the British government publicly acknowledged the relationship between the bovine and human diseases led the population to take note of the risk and to react positively, resuming the consumption of beef. The data on the British balance of trade show a growth in beef imports after this period.[53] The behavior shown in figure 5 may represent evidence of a link between the perception of risk, experienced as a result of the information received by the population, and its repercussions in the variation in consumption.

Analysis of the correlation between the reports and meat market behavior

In the present study, the reports published and made available online in different types of scientific and mass media vehicles during the most critical period of the BSE crisis in the UK (between 1995 and 2004) were brought together and quantified. Using these data, correlations were established between the number of references to keywords associated with the BSE and CJD diseases and a set of variables that affect the market for meat.

Table 3 shows the highest-value correlations found for the keywords associated with BSE. Table 4 corresponds to CJD. The established correlation coefficients can be considered indicative of the relationship between the information published on a determined food risk and the respective perception of risk as manifested in the UK meat market.

Analysis of the correlations between the reports on BSE and the meat market

Table 3 shows that among the scientific journals, the weekly publications showed the highest level of correlation with beef consumption in the UK. For example, the highest

negative correlation (-0.88) between beef consumption and the number of publications on the disease occurred in the weekly British Medical Journal. This finding indicates that the larger the number of articles on BSE published in this weekly, the lower beef consumption was. In contrast, when beef consumption began to increase from 1997 (figure 5), there was a reduction in the number of references to the keywords related to BSE in that journal (figure 2). Some market variables, such as UK beef import and export, had high positive correlations with the publication of information on BSE in the non-weekly scientific journals.

The British newspapers were found to present correlations greater than |0.60| with all of the analyzed market variables except those related to the lamb meat supply chain, for which correlations were low.

Market Variables	British Newspapers	Economic Magazines	Weekly Scientific Journals	Non-weekly Scientific Journals
Price paid to beef producers	0.73 Times On-line	-0.74 Economist.com	0.40 Science	-0.52 Acta Neuropath.
Price paid to lamb producers	-0.41 The Guardian	0.38 Newsweek	0.53 Nature	0.56 Cur. O. Neurob.
Price paid to pork producers	0.66 Independent	0.37 Newsweek	0.60 Science	0.58 Current Biology
Beef exports	-0.89 The Sun	-0.57 Economist.com	-0.40 Nature	0.98 Ch. and Biology
Beef imports	-0.91 The Sun	0.45 Newsweek	-0.59 Brit. M. Journal	0.88 J.A.Food Chem.
Beef production	-0.90 The Guardian	-0.56 Economist.com	-0.48 Nature	-0.60 Current Biology
Beef stocks	0.78 Times On-line	-0.58 Newsweek	0.60 Brit. M. Journal	-0.75 J.A.Food Chem.
Chicken imports	-0.72 The Sun	0.45 Economist.com	-0.54 Brit. M. Journal	0.74 J.A.Food Chem.
Consumption of beef	-0.88 The Sun	0.34 Economis.com	-0.88 Brit. M. Journal	0.74 J. of Neuroch.
Consumption of pork	-0.94 The Sun	0.27 Economist.com	0.58 Brain Research	0.76 J. of Neuroch.
Consumption of lamb	-0.46 The Guardian	-0.49 Newsweek	0.35 Science	0.67 J. of Neuroch.
Sum of positive coefficients	2.17	2.26	3.06	5.91
Sum of negative coefficients	-6.11	-2.94	-2.89	-1.87
General sum of coefficients	-3.94	-0.68	0.17	4.04

[1] Involves one of the keywords: BSE, *bovine spongiform encephalopathy,* or *mad cow disease*

[2] Abbreviated title of the vehicle

Table 3. Highest correlations found between UK market variables and BSE[1] citations in different types of publications[2].

The economic magazines presented correlation coefficients greater than |0.60| only in the case of the variable price paid to farmers for beef. This finding may indicate that these publications have a more marked effect on product prices than on issues related to their consumption.

According to table 3, the highest sum of negative correlation coefficients was found in the newspapers, followed by the economic magazines. The highest sum of positive coefficients was found in the non-weekly scientific publications containing full articles, followed by weekly scientific publications. Hence, references to BSE in the newspapers had predominantly negative effects on the market variables in general, whereas the scientific publications had predominantly positive effects.

Analysis of the correlations between reports on CJD and the meat market

Table 4 shows the results of the correlation coefficients calculated between the keywords associated with the human disease, CJD, contained in the information vehicles and the meat market variables.

Table 4 shows that the newspapers had high correlations, all greater than |0.67|, with all of the studied meat market variables. The correlations of the keywords linked to the human disease, CJD, mentioned in the British newspapers with the variables linked to the beef supply chain (except beef imports) were negative. In contrast, the correlations with the price paid to the rural producer for pork, with beef and chicken imports, and with the consumption of lamb were positive.

In the weekly scientific journals, positive correlations were found for the meat market variables linked to the prices paid to farmers for different meats, the import of beef and chicken meat, and the consumption of pork and lamb. The scientific weeklies were also negatively correlated with the stock of beef cattle. The non-weekly scientific journals showed high negative correlation coefficients for beef consumption as well as high and positive coefficients for the consumption of pork and lamb meat and the import of beef and chicken meat.

The sum of the coefficients shown in table 4 suggests that the printed mass media had a predominantly negative effect on the meat market variables, whereas the scientific publications on CJD produced a predominantly positive effect. The sum of the positive coefficients presented by the non-weekly scientific journals was greater than the sum of the positive coefficients found in the British newspapers and in the economic magazines. The newspapers presented the highest sum of negative coefficients.

Obviously, the sums of the correlation coefficients shown in tables 3 and 4 could be altered by the exclusion of some meat market variables. For example, it is possible that the value 0.93 for the linear correlation between UK beef exports and the entries of keywords linked to CJD in the journal Chemistry and Biology was merely a coincidence, but it greatly affected the results presented in those tables. It was noted that when the beef export ceased, the references in the cited journal also ceased. This is an important factor conditioning the interpretation of the results of this study.

Market Variables	British Newspapers	Economic Magazines	Weekly Scientific Journals	Non-weekly Scientific Journals
Price paid to beef producers	-0.68 Independent	-0.57 Economist.com	0.58 Nature	0.66 Cur. O. Neurob.
Price paid to lamb producers	-0.70 The Guardian	0.53 Newsweek	0.55 Nature	-0.69 Acta Neuropath.
Price paid to pork producers	0.71 Independent	0.58 Newsweek	0.76 Nature	0.70 Cur. O. Neurob.
Beef exports	-0.69 The Sun	-0.46 Economist.com	-0.42 Brit. M. Journal	0.93 Ch. and Biology
Beef imports	0.94 The Sun	0.48 Newsweek	0.57 Brit. M. Journal	0.93 J. of Neurology
Beef production	-0.85 Independent	-0.40 Newsweek	-0.44 Nature	0.95 Ch. and Biology
Beef stocks	-0.87 The Sun	-0.51 Newsweek	-0.80 Brit. M. Journal	-0.92 J. of Neurology
Chicken imports	0.73 The Sun	0.49 Newsweek	0.73 Brit. M. Journal	0.75 Emerg. Inf. Dis.
Consumption of beef	-0.87 Independent	0.37 Newsweek	-0.83 Nature	-0.76 Cur. O. Neurob.
Consumption of pork	-0.79 The Sun	0.26 Newsweek	0.55 Brain Research	0.77 J. of Neuroch.
Consumption of lamb	0.75 The Guardian	0.46 Economist.com	0.50 Brit. M. Journal	0.73 Acta Neuropath.
Sum of positive coefficients	3.13	3.17	4.24	6.42
Sum of negative coefficients	-5.45	-1.94	-2.49	-2.37
General sum of coefficients	-2.32	1.23	1.75	4.05

[1] Involves one of the keywords CJD, vCJD, nvCJD, or *Creutzfeldt-Jakob disease*
[2] Abbreviated title of the vehicle

Table 4. Highest correlations between UK market variables and CJD[1] citations in different types of publications[2].

Correlations between mass media and science communication on BSE and the meat market

From table 3, which shows the highest correlations between the keywords related to BSE in the different types of information vehicles and the meat market variables, three Cartesian graphs were derived positioning the correlations with the different types of information vehicles investigated (figures 6, 7, and 8).

Figure 6 positions the identified correlations with the scientific weeklies and the non-weekly journals. Of the eleven positions shown, four are positions of positive correlations (figure 6, quadrant I), and one is a negative correlation (figure 6, quadrant

III). Two of the positive correlations refer to the consumption of lamb and pork meat, respectively. The remaining two refer to the prices paid to lamb and pork producers, respectively. The negative correlation refers to beef production. The other six variables are positioned in quadrants II and IV (figure 6) because they present a positive signal for one type of publication and a negative signal for another.
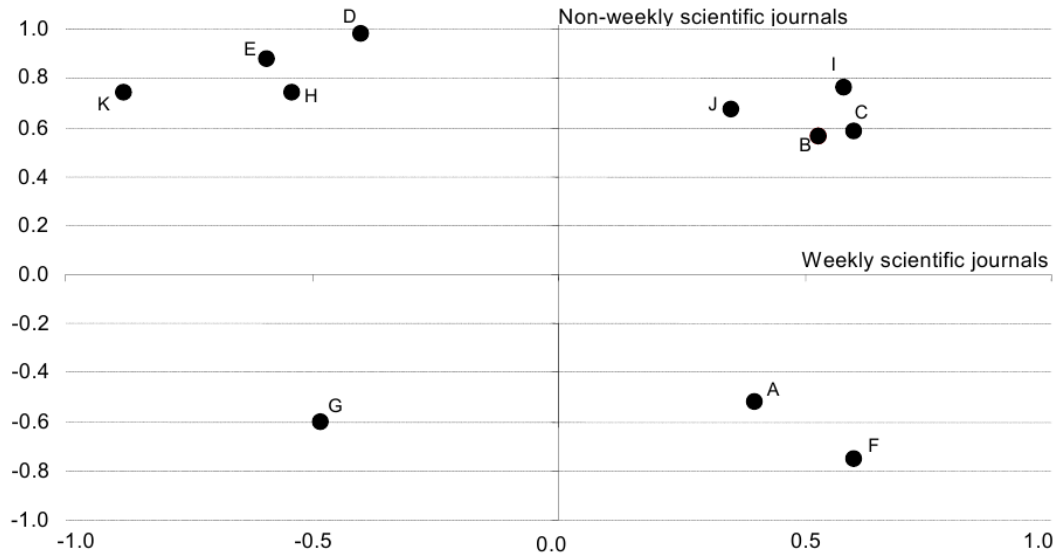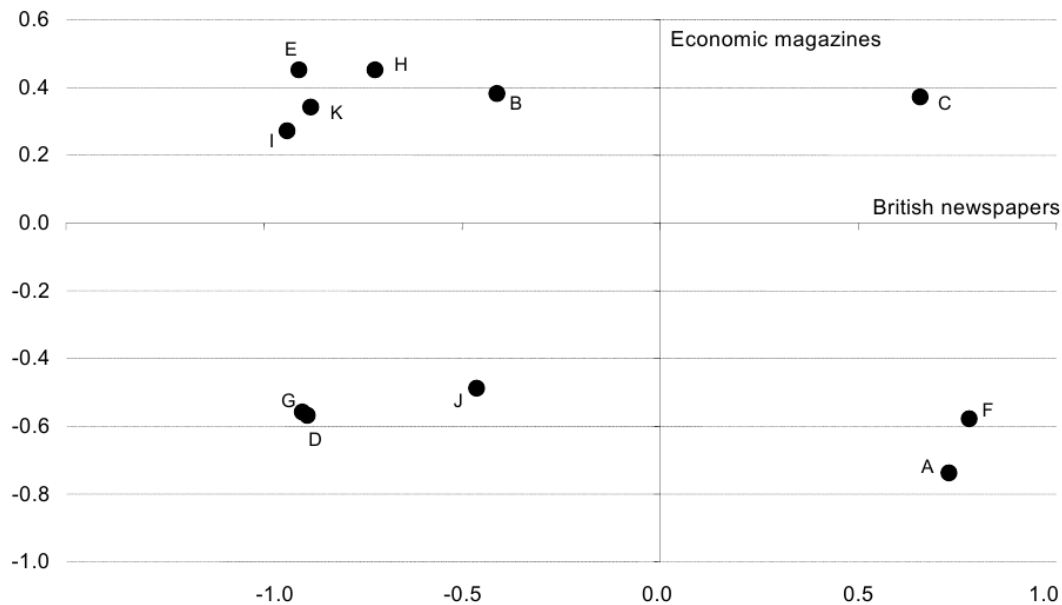

Legend: X axis shows linear correlation between variable with BSE-related keywords in weekly scientific journals; Y axis shows linear correlation between variable with BSE-related keywords in non-weekly scientific journals; A – beef producer prices; B – lamb producer prices; C – pork producer prices; D – beef exports; E – beef imports; F – cattle stock; G – beef production; H – chicken imports; I – pork consumption; J – lamb consumption; K – beef consumption.

Figure 6. Relationship between scientific publications and market indicators regarding BSE in the UK.

According to figure 7, as shown in table 3, the negative correlations of the references to BSE with the meat market variables were greater in the British newspapers than in the economic magazines.

Among the four types of information vehicles analyzed, the non-weekly scientific journals and the British newspapers contained the references to BSE that showed the greatest correlation with the meat market (table 3, figures 6 and 7). Figure 8 positions the identified correlations with these two types of publications.
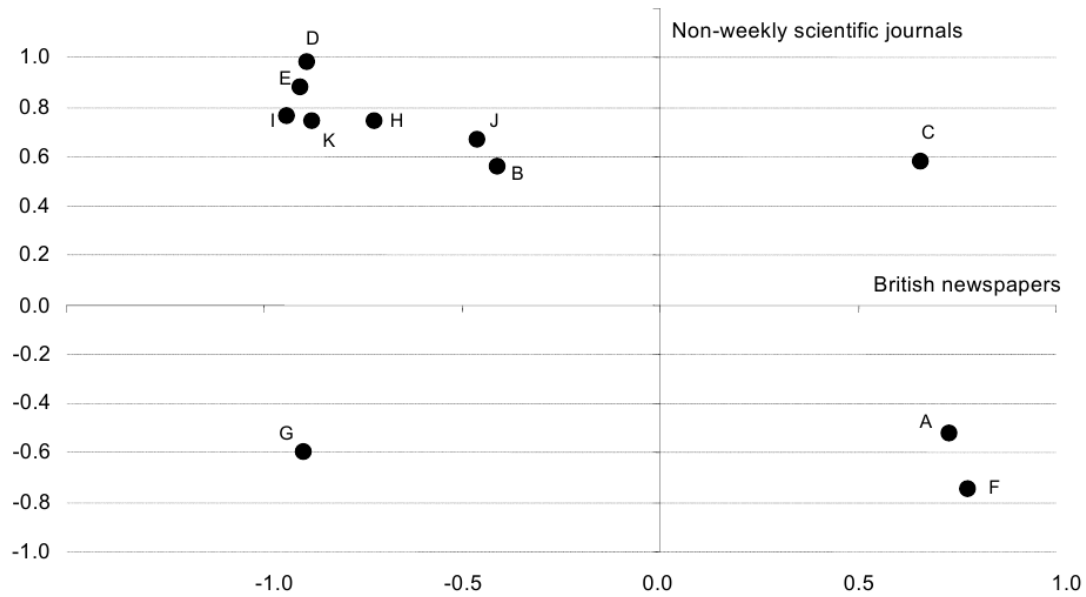
Legend: X axis shows linear correlation between variable with BSE-related keywords in British newspapers; Y axis shows linear correlation between variable with BSE-related keywords in economic magazines; A – beef producer prices; B – lamb producer prices; C – pork producer prices; D – beef exports; E – beef imports; F – cattle stock; G – beef production; H – chicken imports; I – pork consumption; J – lamb consumption; K – beef consumption.

Figure 7. Relationship between mass media news and market indicators regarding BSE in the UK.

Figure 8 shows that the variable prices paid to pork producers had a positive correlation with both the non-weekly scientific journals and the British newspapers (figure 8, quadrant I). In contrast, the variable beef production had a negative correlation in the two types of vehicles (figure 8, quadrant III). That is, the more information that was published on the subject of BSE in the printed mass media news and the non-weekly scientific journals, the greater the reduction in beef production in the UK was.

The increase in the references to BSE in the non-weekly scientific journals was correlated with the reduction in the price paid for beef as well as the reduction in the stock of beef cattle in the UK (figure 8, quadrant II).

Furthermore, in relation to beef, an inverse relation can be seen in the meat market variables (beef exports, beef imports, and beef consumption) when the non-weekly scientific journals and British newspapers are compared (figure 8, quadrant IV). Both the positive correlations with the references in the non-weekly scientific journals and the negative correlations with the entries in the newspapers were high for those meat market variables. The same can be said with regard to variables related to the consumption of pork meat and the import of chicken meat.

Legend: X axis shows linear correlation between variables with BSE-related keywords in British newspapers; Y axis shows linear correlation between variables with BSE-related keywords in non-weekly scientific journals; A – beef producer prices; B – lamb producer prices; C – pork producer prices; D – beef exports; E – beef imports; F – cattle stock; G – beef production; H – chicken imports; I – pork consumption; J – lamb consumption; K – beef consumption

Figure 8. Relationship between non-weekly scientific journals, British newspapers, and market indicators regarding BSE in UK.

A brief look at figure 8 suggests that although non-weekly scientific journals on BSE were predominantly positively correlated with variables of the meat market, the news published in the British newspapers had a predominantly negative correlation with the same meat market variables.

In quadrants III and IV of both figure 6 and figure 8, one can notice that beef exports, beef imports, beef production, beef consumption, and chicken imports all correlate negatively with both the weekly scientific journals and the British newspapers. This finding may be explained by the fact that reports published in the weekly scientific journals Nature and British Medical Journal are often readily made public by the British newspapers.

Conclusions

The present research has sought to characterize a possible relationship between the market behavior of a certain food product (meat) in view of a potential food risk and the information on that risk in the scientific literature and the printed mass media.

In situations of real or presumed food risk, the understanding of how and to what extent scientific information interferes with consumer behavior remains incipient. People seem to rarely be well informed or motivated to consider conflicting facts,

ideas, and arguments. Given the daily news regarding food risk, citizens do not wait for a scientific solution to their choice dilemmas. In the short term, they subordinate their behavior to prejudgments founded on beliefs and values. However, in the medium and long term, scientific consensus may attract attention and gain the confidence of the lay public, suggesting safe references for decision that are often consolidated within communities through their incorporation within official guidelines and regulations. In this process of building public trust in science, the printed mass media, together with the civil authorities, have an important role to play in defining controversies and modulating people's behavior.[54,55]

In the present study, an attempt was made to analyze a case of food risk in which scientific information, the printed mass media, and meat market behavior were reciprocally interconnected and influenced. However, the cause-and-effect relationship was not investigated. Causality tests are necessary to define the cause-and-effect relationship between changes in market variables and the frequency of citations of BSE and CJD in scientific and printed mass media sources.

The analysis of the positive and negative coefficients of correlation linked to BSE show that the overall sum of the correlation coefficients amounted to -3.94 when analyzed in newspapers and had a similar — but positive — value (4.04) when analyzed in non-weekly scientific journals. The sum of coefficients for the economic and scientific weeklies were close to zero. In relation to the human disease CJD, the sum of the coefficients remains high in non-weekly scientific journals (4.05), whereas newspapers show negative but less pronounced coefficients (-2.32).

Based on the correlation findings, the results suggest that sources of information affect the groups of stakeholders in the meat market differently. Although economic magazines seem to fit well with the behavior of traders, scientific publications seem to have a significant impact on consumers. This finding can be explained by access to and confidence in the source of information. Traders may consistently access economic magazines to obtain information about the market and may react promptly, making decisions that affect the market variables. Consumers, in contrast, may consistently react and decide by accessing scientific knowledge. Two possible explanations can be proposed: first, printed mass media fails in communicating scientific information to consumers; second, consumers' access scientific information through other mass media sources, such as broadcasting, television, or the internet.

The correlations plotted in the quadrants showed that the market variables, except the prices paid to producers of pork and beef and stock and cattle production, showed positive correlations with the scientific journals and non-negative correlations with the weekly newspapers. The fact that all variables related to the consumption of different types of meat meant that this behavior could be interpreted as reliable scientific information by consumers. In general, scientific information seems to influence consumers' behavior as expected in an at-risk economic environment. That is, when science presents information about the risk of consuming beef and consumers trust that information, the expected behavior is that consumers will substitute pork or lamb meat for beef. The findings confirm this economic behavior of consumers.

The findings may also be influenced by other aspects of the relationship between science and the mass media. The first implication is related to the time information is provided by science and the mass media. Mass media communication about an event such as BSE/CJD is immediate, whereas scientific knowledge requires more time to be produced and communicated. Second, the trust of traders and consumers in the source of information may affect the way each source of information impacts their decisions. Third, the results may be influenced by the content of communication by science and the mass media. Depending on stakeholders' beliefs and trust, they may react differently if the message content sent by science and/or the mass media is positive, negative, or neutral.

Finally, it may be that the determination of correlations such as those employed here have only limited value in studies of this nature. This may constitute the major criticism of this research. However, some conclusions can be reached. If the correlations established in this study focusing on BSE and the corresponding human disease, CJD, are representative of other cases of food risk and translate into cause-and-effect relationships, references in the mass media to food risk topics would have a generally negative impact on the market. However, coverage in scientific publications would have a positive impact. These findings may shed some light on the role of research and scientific publications in reducing uncertainty in relation to phenomena that involve perceptions of food risk, producing positive repercussions in the market.

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