Food Safety Gone Mad (Cow)

By: Emmy Bartling

Faculty Advisor: Heather Royer

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Abstract: We study the correlation of online Google search for mad cow disease in the UK and reported food safety procedures following recommended practice outlined by the FSA, two decades after the mad cow disease crisis in the UK in 1993. Using four waves of food safety survey data between 2010 and 2016 and Google Trends web and news search data over the corresponding time period we find that an increase in the average news search before and during a survey is correlated with a statistically significant decrease in safe food practices, as measured by the index of recommended practice (IRP), albeit the effect is small. This may be evidence of a moral hazard problem: news search for mad cow disease may reveal the efforts of agencies and producers to protect against foodborne illnesses, making individuals less accountable in their own actions to stay food safe.

Introduction

The World Health Organization (WHO) estimates that foodborne diseases are the cause of 420,000 deaths globally each year, and children under five account for 40% of these deaths. Nearly 1 in 10 people fall ill to one of more than 200 diseases that originate in unsafe food containing harmful bacteria, viruses, parasites or chemicals[1]. This results in nearly 33 million healthy life years lost annually. Foodborne disease puts an unmeasurable strain on health care systems, national economies, tourism and trade; hence, food safety has enormous health, policy and economic implications. WHO states: "foodborne diseases are preventable, everyone has a role to play," and this includes food consumers at the end of the chain. In this paper, we narrow the scope of food safety to the individual in the kitchen, since some of the most common foodborne illnesses, like from salmonella and E.coli, can be prevented with proper food handling and preparation techniques. In addition, food safety practices in the home are virtually the only step in the food process that cannot be regulated or easily monitored, and providing food safety education to all would be expensive and perhaps ineffective. Thus, research about who is and is not food safe in the kitchen identifies at-risk individuals, and understanding what motivates individuals to change their food safety practices is necessary when deciding how to remedy the global problem in the cheapest and most effective manner.

We focus our study of food safety practices on the UK because of its prominent history of foodborne illness outbreaks and meat scares. In 1986, cattle in Britain began suffering from Bovine spongiform encephalopathy (BSE) or mad cow disease, a transmissible foodborne disease that affects the central nervous system. BSE causes a spongiform degeneration of the brain and spinal cord, and infected animals may act nervous or violent and lose the ability to

[1] www.who.int/foodsafety

stand. The disease can be transmitted to humans by eating food contaminated with brain, spinal cord of digestive tract of infected cattle. In 1993, 120,000 cattle had been diagnosed with BSE in Britain and by March of 1996, 4.5 million cattle were slaughtered during the eradication program. From 1995 to 2004, 177 people in the United Kingdom and 52 in other countries, primarily in Western Europe, died from contracting BSE.[2] The mad cow disease outbreak lead to drastic new food supply safeguards in the UK and motivated the creation of the Food Standards Agency (FSA), a government agency responsible for food safety and food hygiene across the United Kingdom. The BSE crisis significantly altered today's landscape of food safety precautions and health information in the UK, especially because normal disinfectant procedures do not prevent the disease. Even well-cooked contaminated meat can infect cattle and humans who consume it. Hence, mad cow disease is interesting to study in the context of food safety because there are no preventive measures that can be taken in the home to prevent the illness, but it is possible that exposure to mad cow disease information, especially in the UK where the history of meat scares is well-known, still changes food safety practices.

In this paper, we use four years of FSA food safety survey data and Google Trend search trend data to answer the following question: Does attention to mad cow disease (as reflected in the volume of news and web search) affect reported food safety habits? We hypothesize that if search corresponds with negative media exposure of mad cow disease[3], then an increase in news and web search will improve food safety practices (as measured by the Index of Recommended Practice (IRP)) because of scare resurgence and misconceptions about how to prevent mad cow

[2] www.centerforfoodsafety.org "Timeline: Mad Cow Disease Outbreaks."

[3] We do not measure negative media exposure, rather we make the assumption that most of the news stories are negative. We read some of the news articles that came out during an increase in news search, and the stories typical paint mad cow disease in a negative light. For example, one article in 2015 was about a cow in Italy found to have BSE.

disease. We find that when we control for year (which controls for the average increase in IRP over time), the relationship between news search and IRP is small but statistically significant, and an increase in average news search is correlated with a decrease in IRP. We do not find a significant difference in the effect of online search on IRP over the years or when we take into account the concern of an individual. Our results may be evidence of moral hazard: individuals lose incentive to practice safe food procedures at home when they become more aware of the safeguards in place by government agencies and producers to prevent the spread of mad cow disease.

Related Literature

The combination of food safety, mad cow disease, online search and risk perception situate this paper at the intersection of different types of past research. We organize related literature by three main topics: BSE in the UK, food safety and concern, and FSA research with the Food and You survey data.

In the late 1990's, much economic research surfaced about how the BSE crisis impacted prices and demand in the meat market in the short run, but less literature is available on the long run effects of the outbreak. Burton, Young and Comb (1999) identify a declining marginal impact of media coverage of BSE attention on demand for beef beginning in 1997. By measuring shifts in the proportions of expenditure on different meats, they find that there is no significant impact on aggregate meat consumption in the UK. We argue, that although prices or demand may not reflect BSE attention, mad cow disease and foodborne illnesses outbreaks may still weigh on the minds of UK citizens and influence food safety practices in the home.

Children, the elderly, pregnant women and people with weak immune systems are the most vulnerable to foodborne illness. In one study, previous experience with food poisoning had no significant impact on food safety knowledge and practices in children, who were observed to have a high level of perceived severity and a low level of perceived vulnerability for food-related risks (Ovca et al., 2014). Parents are the primary source of food safety information for children (Byrd-Bredbenner et al., 2010; Coulson, 2002; Eves et al., 2006); hence, understanding food-related risks and proper food handling practices is critical for the food preparers' own health, as well as for family members and children. Therefore, the effects of information about mad cow disease on food safety may be spread and amplified through the household.

In Food Scandals, Media Exposure and Citizens' Safety Concerns: A Multilevel Analysis across Chinese Cities, a paper most related to our own research, authors Liu and Ma state that "it is both theoretically and socially imperative to understand what drives citizens' concerns over food safety." They write that perceived risk is directly related to experience and media coverage of food scares and scandals: "Social risk is jointly shaped by individuals' personal propensity, information, knowledge, and experience. People who have personally encountered or heard about food safety accidents are more concerned than those who have not." Using survey data collected January 2013 in 30 cities in China and an archive of online news reports on food safety, they examine the effects of food scandals and individual demographics on public confidence in food safety. In the survey, the measure of public concern is nearly identical to that in our own data set: respondents are asked on a five-point scale to what extent they are usually concerned about food safety issues, with 1 being "never concerned" and 5 being "very concerned." To measure media exposure, they use a three-year moving average of media reported food scandals in each province for the three years prior to the survey, with the largest weight on the most recent

year. They use a multilevel model, with concern as the dependent variable and media exposure as the independent variable, as well as controlling for individual-level demographic and socioeconomic variables. Their findings are summarized by the following: citizens with more media exposure and higher education levels are more concerned about food safety risks, higher-income respondents are not more concerned about food safety than lower-income respondents, and respondents with children are more concerned about food risk, but the relationship is not significant. Liu and Ma conclude with policy implications and suggestions for future research: "the government can implement various measures to address the food safety knowledge gap among consumers," "future research may attempt to disaggregate this concept [citizens' food safety perceptions] into safety perceptions of specific foods and attributes." Our research hopes to address both of these concluding comments by identifying differences in food safety knowledge with the Index of Recommended Practice, and narrowing the scope of food safety risk to Mad Cow Disease.

The public's perceptions of social risk are primarily determined by media coverage (Koné and Mullet, 1994). Further, socioeconomic variables that are strong predictors of an individual's health and food safety related risk perceptions include household income, number of children, gender, age and voting preference (Dosman et al., 2001). Finally, risk perceptions may have a relatively larger influence than risk preferences, and so providing individuals with information on the risk of genetically modified foods could influence consumer behavior (Jayson et al., 2005).

Data

The Food Standards Agency (FSA) is a department under the Government of the United Kingdom created in 2000 after several high-profile outbreaks and deaths from foodborne illness.

The primary goal of FSA[4], as outlined by its website, is to use its "expertise and influence so that people can trust that the food they buy and eat is safe and honest. Our work touches everyone in the country. We all eat." In 2010, the FSA initiated the Food and You Survey[5] in order to measure the public knowledge of recommended food safety practices, better understand the behavior and concerns of consumers, and inform health and food policy. The survey is a biennial, random sample survey of adults aged 16+ across the UK. The first wave was conducted in 2010, with subsequent waves in 2012, 2014, and 2016. Table 1 summarizes the months that fieldwork was conducted for each wave, which is important for when we examine the corresponding news and web search for each period.

Table 1: Survey Wave Fieldwork Length

Survey Wave	**Fieldwork/Survey Dates**	**Total time of surveying**
Wave 1 (2010)	March 2010 – August 2010	6 months
Wave 2 (2012)	March 2012 – September 2012	7 months
Wave 3 (2014)	March 2014 – August 2014	6 months
Wave 4 (2016)	May 2016 – September 2016	5 months

The sample was drawn from the Postcode Address File (a list of all the addresses in the UK), which was clustered into Primary Sample Units (small geographical areas randomly selected

[4] www.gov.uk. The motivation for the creation of the Food Standards Agency is based on a policy paper published in 1998, 5 years after the peak of the BSE crisis in the UK: ("The Food Standards Agency, A Force for Change - Preface by the Prime Minister"). It outlines the importance of public information and health education on food matters: "The Government's aim in setting up the Agency is to strengthen food safety and standards policies and procedures so as to rebuild the public's trust in the machinery for handling food safety issues."

[5] www.food.gov.uk. Since its inception in 2000, the FSA has commissioned surveys to collect quantitative data on the public's reported behavior, attitude and knowledge regarding food and food safety. Now described as the 'flagship consumer survey' by the agency, the Food and You Survey was developed partly from the Consumer Attitudes Survey (CAS), which was a face-to-face survey conducted annually by the FSA between 2000 and 2007.

across England, Wales, Scotland and Northern Ireland). Then a list of addresses were randomly selected from each Primary Sample Unit. The surveys consisted of 3163, 3231, 3453 and 3118 individuals in each of the respective waves, and were collected through face-to-face interviews using a Computer Assisted Personal Interview method. The survey takes, on average, one hour to complete. A summary of the unweighted sample of each wave is given in Table 2.

Table 2: Demographic Summary of Food and You Survey

Food and You Survey Sample, unweighted				
	Wave 1	**Wave 2**	**Wave 3**	**Wave 4**
Gender				
Male	1299	1315	1488	1233
Female	1864	1916	1965	1233
Age (years)				
16-24	284	298	278	223
25-34	448	488	481	421
35-44	463	463	494	475
45-54	418	485	524	519
55-64	395	425	477	534
65+	708	676	816	925

In all of the waves, consumers were asked demographics and narrow questions from a range of food topics from the following categories: shopping for food, cooking in the home, eating habits, food safety practices in the home, eating outside the home, history of food poisoning and allergies, and food safety perceptions. Examples of questions from the survey are below:

- Over a typical week, which of these best describes the level of responsibility you have for preparing and cooking food in your household?
- Do you suffer from an adverse reaction after consuming certain foods?

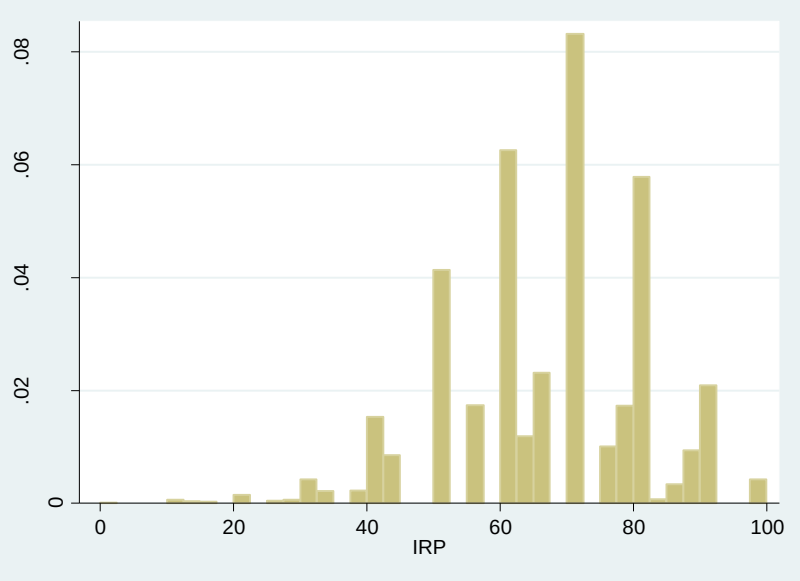
- Do you know what the power of your microwave is, in watts?
- In general, how confident would you say you are, when buying or consuming food and drink, that it is always what it says on the label or menu?

An important variable from the data set, which will be the dependent variable in our regression model, is derived from the variable OverallRP, or overall recommended practice. OverallRP is a composite measure of reported domestic food safety practices, and is calculated to measure how closely someone's behavior is in line with recommended practice. It is constructed using 16 questions from Food and You, which combined measure 10 main domestic food safety behaviors (the ten items can be found in the Appendix). Each answer to a question is scored 1 for RP responses (practices that are in line with FSA recommendations and are considered "food safe") and 0 for non-RP response. Respondents answering less than five of the questions do not receive a score. We dropped 42 individuals total from all 4 survey waves who did not receive a score for OverallRP. The overall score is constructed with the following equation:

$$OverallRP = \frac{total\ number\ of\ questions\ scored\ as\ 1\ (following\ recommended\ practice)}{total\ number\ of\ RP\ questions\ answered}$$

Hence, OverallRP can take values from 0 to 1. In order to measure smaller changes in recommended practice in our analysis, we multiply OverallRP by 100 and call this variable the Index of Recommended Practice (IRP), therefore IRP can take values from 0 to 100. The distribution of IRP of all 4 waves combined, a total of 11,430 observations, is shown in Figure 1. The distribution of IRP is bell-shaped, with an average of 66.2 and a standard deviation of 14.7.

Figure 1: Distribution of IRP



The second data source that is used in conjunction with the Food and You survey data is Google Trends, which we use as a proxy of the population's attention and interest in mad cow disease. Public attention based on internet search trends is used in health-care epidemiology, and past research suggests that Google Trends is as good as an indicator of public attentiveness to an issue than the more traditional media volume index (Ripberger, 2011). Google Trends provides a time series index, beginning January 1, 2004, of the number of queries entered into Google for a given topic in a given geographical area. The trends are not based on total number of searches, but indexed based on query share: "the total query volume for the search term in question within a particular geographic region divided by the total number of queries in that region during the time period being examined" (Choi et al. 2012). In other words, the interest index is calculated relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means the term was searched half as frequently as during peak popularity. A score of 0 means there was not enough data for this term. Google Trends data

is computed using a random sample of Google search data, including real time data and non-real time data, which can be pulled from the beginning of 2004.

All Google Trend data used in this analysis is for the geographical region United Kingdom over the same time period[6]: March 2009 to October 2016, or beginning a year before Wave 1 and ending a month after the completion of Wave 4. We will refer to this generally as the time period in all other sections of the paper. In addition to specifying geographical region and time frame, we also had to be precise in the search term we wanted Google to return a trend for. Quotation marks are crucial for filtering the results in Trends[7], and we had to choose between "mad cow" and "mad cow disease." Using the abbreviated scientific name "BSE" had too many related search queries for the BSE Sensex market index, and the unabbreviated scientific name, bovine spongiform encephalopathy, both had too few searches and likely indicates an individual who knows more about mad cow disease than the average UK citizen. "Mad cow" has had nearly double the amount of news and web searches on Google in the UK during the same time period as "mad cow disease". Moreover, from March 2009 to October 2016, the term "mad cow" had an average value of web searches of 52, while the term "mad cow disease" had an average value of 27, and the "mad cow" trend line of interest is always above the

[6] The indexing procedure of Google Trends is dependent on the time frame specified, since all values are based on their relationship to the highest search volume in the time period. More specifically, mad cow disease search reached an all-time peak, or an interest index value of 100, in March 2004 when viewing search interest from 2004-present, or Google's maximum time frame. Search frequency is on average only about a quarter as high between 2010 and 2016 as it was in March 2004, but since we are concerned with search popularity close to the survey waves, especially so that we can compare small increases and decreases in search trends, we want the interest index to be calculated on this narrower time frame. Hence, the data we use for mad cow disease search trends reaches an interest index of 100 within the frame of March 2009 to October 2016, although this was not an all-time high, just the peak popularity during that time.

[7] support.google.com/trends/ "Search tips for Trends": Typing tennis shoes into Trends, not in quotation marks, can include searches containing both tennis and shoes in any order (such as funny shoes for tennis), while typing "tennis shoes" into Trends, with double quotation marks, includes the exact phrase, possibly with words before or after (such as white tennis shoes). For this reason, we want to put mad cow in quotations to avoid including searches about a cow getting mad that he is tipped, for example.

"mad cow disease" trend line. The correlation between the two terms is 0.732, so they approximately move together over any given time. We choose to use the search trend data for "mad cow" because a lazy searcher interested in mad cow disease may only type the first two words instead of all three, and we want to ensure we include all searches intended for the disease[8]. This may make the data less precise, but we will discuss this in more depth in our concluding remarks.

The final specification that can be made with Google Trends is to filter by search type; more specifically, by web search, news search, google shopping or YouTube search. We use both the news search and web search options in our analysis. News search reflects the most extreme amount of attention surrounding mad cow disease, since the searches are for stories that made the news. For example, a large spike in the volume of news searches for mad cow disease in the UK occurred when there was a high profile news story about a cow found with BSE in Italy in 2015. Web search, on the other hand, measures general, less extreme interest in mad cow

[8] Google Trends provides a list of the terms most frequently searched with "mad cow" during the same search session, within the UK. Theses top searches are the most popular related search queries, and are scored on a relative scale, where 100 is the most frequently searched term, and 50 is a term that was searched half as frequently, and so on. "Mad cow disease" is the number one related web search query for "mad cow", with a value of 100, and the next top 4 related queries for the UK during this time period were "mad cow disease humans," "mad cow disease in humans," "mad cow disease UK" and "mad cow disease symptoms." Hence, majority of the searches about mad cow are related to the disease and thus this research. It is important to note that MadCowModels is the name of a free portfolio hosting and networking site in the UK, Mad Cow Beads is a jewelry and bead shop on Etsy, and Mad Cow Productions is a theatrical and production company in England, with related query values of 6, 4, and 4 respectively. Hence, occasionally a search for "mad cow" in the UK is not referring to the disease. This is a downside to using Google Trends and the more general term "mad cow" as a proxy for interest in the disease. However, many of the top related queries for "mad cow disease" refer to other topics as well, usually other diseases, like hand foot and mouth disease. Thus, both search terms have some unrelated (for our purposes) corresponding queries. In summation, since a "mad cow" search typically implies "mad cow disease" but Google Trends calculates interest in the "mad cow disease" search without the "mad cow" searches (even if the search was intended for the disease), we choose to use the term "mad cow.")

disease. The two graphs below show the interest over time in mad cow disease for each search method. Web search and news search have a correlation of 0.08, and so the two types of search do not have similar trends and capture different types of attention on mad cow disease. Hence, we use both search types in our analysis for completeness.

Figure 2: Web Search for “mad cow” and related queries, March 2009 to October 2016

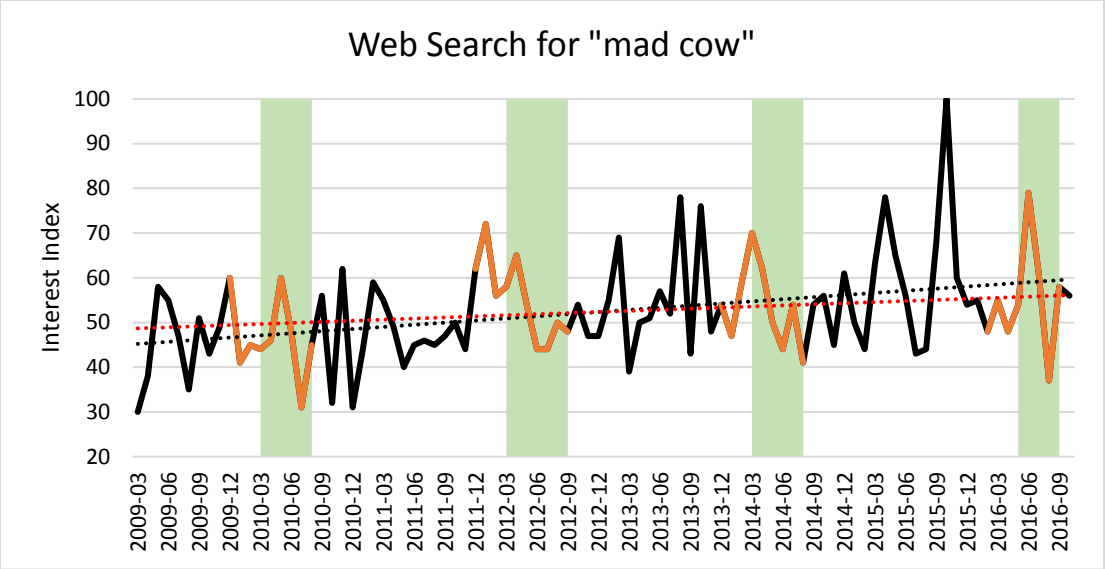
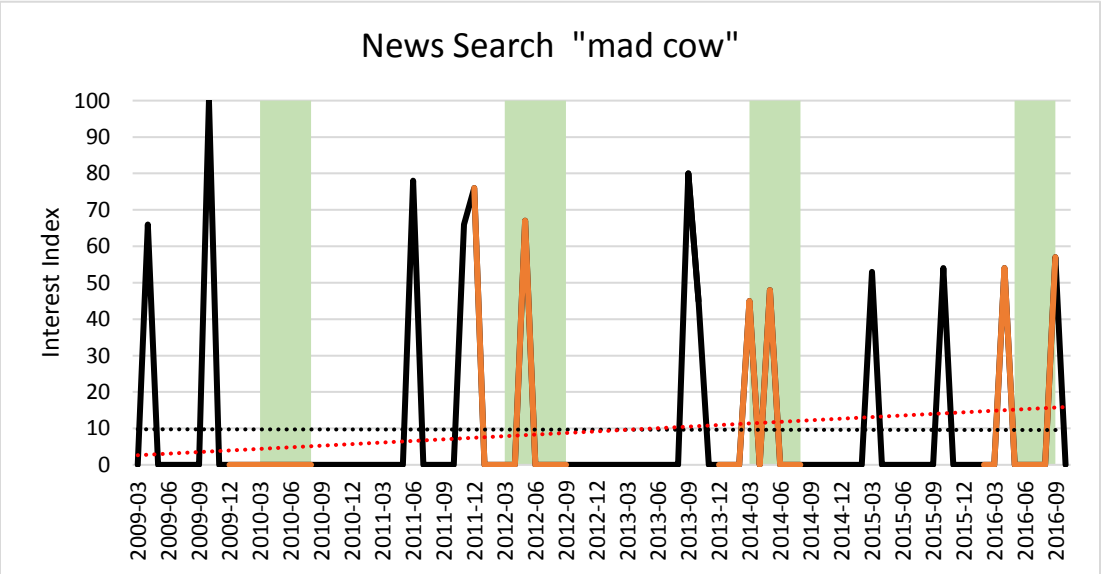


Figure 3: News Search for “mad cow” and related queries, March 2009 to October 2016



The solid line in Figures 2 and 3 above shows popularity of the search "mad cow" on google from March 2009 to October 2016 in web search and news search respectively. The vertical green bars highlight the time frame of each survey wave. The dotted black line in each figure is the trend line of search over the time period, which is upward sloping for web search and horizontal for news search because of the frequent zeroes that are averaged in. In other words, news search for mad cow is either virtually zero or very frequent.

Combining the survey data and search trend data is imprecise because of the lack of time series information available about the surveys. We do not know the exact day or even month that an individual was surveyed for Food and You, only which wave they were in. Hence, fieldwork dates are the best approximation we have of when an individual is surveyed, which is a 5-7 month interval. Since we cannot distinguish between the first and last individuals surveyed in each wave, we cannot measure the correlation between search and IRP within waves, only between waves, which limits the variation in the search data. The best we can do is let search be a proxy for the interest in mad cow disease around the time an individual was surveyed, which we let be a 9-month interval for each survey wave. Note the four orange segments of the interest lines in Figures 2 and 3. Each segment highlights the search frequency for approximately a 9 month period: the search during all 5-7 months survey wave, plus the three months before it. A search for mad cow disease may have a residual effect on food safety a few months later, and by combining the three months prior to the survey with the search during the survey, we ensure that at least three months of former search data is considered for each individual, regardless of whether they were surveyed on the first day or the last day of the fieldwork. Considering that "public attention rarely remains sharply focused upon any one domestic issue for very long - even if it involves a continuing problem of crucial importance to society" (Ripberger, 2011,

quoting Downs, 1972), we think that 9-months will fully capture the interest and search for mad cow disease corresponding to each survey wave. The red dotted line in each figure above models the trend in search for the four nine-month periods only. For web search, the 9-month segments trend line is very similar to the all-time trend line because there are not any major spikes or jumps existing in one and not the other. For the news search 9-month segment trend line, the slope is relatively flatter and positively sloped.

Methods

To measure interest in mad cow disease, we calculate the average of the interest index for news and web search during the 9-month periods corresponding to each wave. Table 3 displays these averages below. It is interesting to note that neither average news search nor average web search has been increasing consistently over time: Wave 2 had the highest news search average and Wave 3 had the highest web search average. Every observation in the same survey wave is assigned the same value for news search average and web search average.

Table 3: Average News Search and Web Search during and prior to each wave

	News Search Average	**Web Search Average**
Wave 1	0	46.6
Wave 2	14.3	79
Wave 3	10.3	80.1
Wave 4	13.8	55

We use a linear regression model to quantify the strength of the relationship between IRP and online search for mad cow disease. IRP is the dependent variable and one of the measures of mad cow search is the independent variable of interest, yielding two models: one with average news search and one with average web search, given by equation 1 and 2.

Equation 1:

$$IRP_i = \beta_0 + \beta_1 NewsSearch_i + \beta_2 Year_i + \cdots + \epsilon_i$$

Equation 2:

$$IRP_i = \beta_0 + \beta_1 WebSearch_i + \beta_2 Year_i + \cdots + \epsilon_i$$

Each regression is run with a news search measure and a web search measure, because there may be different effects based on the type of search. The "+…+" represents the list of control variables, each with a β_n. The control variables are binary socio-demographic variables from the survey, including gender, age, income, size of household, as well as more interesting variables like frequent meat consumption, history of food poisoning, and concern for food safety.

All individuals of the same survey wave are assigned the same value for search and year. $Year_i$ is a trend variable that is supposed to capture year effects. (A value of year=0 corresponds to 2010, year=2 corresponds to 2012, ect.). This model assumes that IRP increases linearly with year, and if year effects are not adequately captured by this trend variable, then the effects may be biased by misspecification.

To expand our analysis on the correlation of search and IRP, we also use two linear regression models with interactions. Perhaps the BSE crisis is forgotten or weighs less on the UK mind as we move further into the future, hence we interact mad cow search and year to test if the effect of search on IRP has changed between the survey waves. The following regression equations 3 and 4 are used for this interaction.

Equation 3:

$$IRP_i = \beta_0 + \beta_1 NewsSearch_i + \beta_2 Year_i + \boldsymbol{\beta_3 NewsSearch_i \times Year_i} + \cdots + \epsilon_i$$

Equation 4:

$$IRP_i = \beta_0 + \beta_1 WebSearch_i + \beta_2 Year_i + \boldsymbol{\beta_3 WebSearch_i \times Year_i} + \cdots + \epsilon_i$$

The variable Concern in our analysis is nearly identical to the measure in (Liu et al., 2016). It is a binary variable, with a value of 1 corresponding to an individual who reported that they "definitely agree" or "tend to agree" with the statement "I often worry about whether the food I have is safe to eat." A value of 0 corresponds to an individual who reported neither agree or disagree, tend to disagree, or definitely disagree. Past literature suggests that higher media exposure is correlated with higher concern for food safety (Liu et al., 2016), and so it is likely that an increase in online search for mad cow disease affects IRP differently for concerned individual than one that is not. We choose to interact search and concern to capture individual-level concern as opposed to aggregate concern and interest that is reflected in the news and web search. The following regression equations 5 and 6 are used for this interaction. Note that year is still controlled for in this model.

Equation 5:

$$IRP_i = \beta_0 + \beta_1 NewsSearch_i + \beta_2 Concern_i + \boldsymbol{\beta_3 NewsSearch_i \times Concern_i} + \cdots + \epsilon_i$$

Equation 6:

$$IRP_i = \beta_0 + \beta_1 WebSearch_i + \beta_2 Concern_i + \boldsymbol{\beta_3 WebSearch_i \times Concern_i} + \cdots + \epsilon_i$$

Results

A preliminary regression was first run without a search variable so that we could compare the coefficients on our demographic controls to the findings in related literature and also observe

which non-demographic controls may be relevant when moving forward in our analysis. A summary of the results for 11 key variables is in Table 4. Notably, meat consumption has a significant negative effect on IRP. An individual who reported consuming meat at least 5-6 times a day has an IRP 1.875 points lower than a less frequent meat eater, all else constant. Being a vegetarian does not have a significant effect on IRP. Considering that many of the questions used to calculate IRP concern storing, washing and cooking meat (the FSA is adamant on improving the number of foodborne illness cases from animal products and specifically meat), this result does not suggest that familiarity with and frequency of eating meat improves reported food safety score. On average with all else constant, females score 4.068 points higher than males, having kids under 16 in the household improves score by 1.305 points and a respondent living in an urban area scores -0.841 points lower than their rural counterpart. We do not find significant association between a food allergy and reported food safety activities. Nearly all of these results for demographics mirror the findings of the FSA in their research of vulnerable consumers: "women tended to have a higher IRP score than men" and "no association was found between respondents reporting having a food allergy, and their reported food safety activities" (*Food and You Waves 1-3 Secondary Analysis).* The FSA suggests that people with food allergies already avoid having the food allergens in their home, and therefore do not need to take extra food safety precautions to avoid cross-contamination.

Table 4: Preliminary Regression

IRP	**Coeff.**
Year	0.568*** (0.073)
Frequent meat eater	-1.917*** (0.685)
Concerned	1.529*** (0.352)
Food Poisoning	0.395 (0.318)
Vegetarian	-0.228 (1.191)
Food Allergy	0.647 (0.736)
Female	4.077*** (0.318)
Kids under 16 in household	1.492*** (0.449)
Urban	-0.836** (0.394)
***p<0.01 **p<0.05 *p<0.1 R-squared= 0.0595 *Note: The table gives estimated coefficients from the linear regression model with robust standard errors in parenthesis. Other controls include age, ethnicity (white or not), marital status, working status, household size and household income.*	

On average, IRP increased by 1.141 points each survey wave, which raises an important question: what changes food safety? Could an increase in attention to mad cow disease change IRP? To test our hypothesis, we first use equation 1 and 2, which measure the effect of news search on IRP and the effect of web search on IRP, respectively. (The results for news search are given in the "Without Interaction" column of Table 5, and the results for web search are given in the "Without Interaction" column of Table 6).

The coefficient on news search in the first column of table 5 (without any interaction term) is -0.082: small, negative and significant. Although 0 is not in the 95% confidence interval

of the true value of the effect of news search on IRP, this effect is very small. An increase of 10 index points for average news search (which is approximately the difference in news search volume between Wave 1 and Wave 3) is correlated with a decrease in average IRP scores of 0.82, or 0.055 standard deviations below the mean IRP. The coefficient on year in the first column of table 5 (without any interaction term) is 0.722: positive and significant. That is, on average, IRP increased by 1.44 points every survey wave.

Table 5: Interaction of average 9 month **News Search** and **year**

	Without Interaction	With Interaction
IRP	**Coeff.**	**Coeff.**
Average news search before & during survey	-0.082** (0.039)	-0.089** (0.041)
Year	0.722*** (0.105)	0.524 (0.330)
Interaction: Search and Year	-	0.0161 (0.026)
***p<0.01 **p<0.05 *p<0.1 *Note: The table gives estimated coefficients from the linear regression model with robust standard errors in parenthesis. The controls are gender, urban, vegetarian, kids under 16 in household, frequent meat eater, concern, history of food poisoning, food allergy, age, ethnicity, marital status, working status, household size and household income.*		

The results when we use web search as a proxy for interest instead of news search are similar in sign but smaller in magnitude. The coefficient on web search in the first column of table 6 (without any interaction term) is -0.020: small, negative and barely significant. Zero is in the 95% confidence interval, and so there is not statistical evidence that web search is correlated with higher IRP, which was our hypothesis. The coefficient on year in the first column of table 6 (without any interaction term) is 0.598: positive and significant. That is, on average, IRP increased by 1.19 points every survey wave.

Table 6: Interaction of average 9 month **Web Search** and **year**

	Without Interaction	With Interaction
IRP	**Coeff.**	**Coeff.**
Average web search before & during survey	-0.020* (0.010)	-0.043* (0.023)
Year	0.598*** (0.075)	0.129 (0.441)
Interaction: Search and Year	-	0.008 (0.008)
***p<0.01 **p<0.05 *p<0.1 *Note: The table gives estimated coefficients from the linear regression model with robust standard errors in parenthesis. The controls are gender, urban, vegetarian, kids under 16 in household, frequent meat eater, concern, history of food poisoning, food allergy, age, ethnicity, marital status, working status, household size and household income.*		

When we consider a model with an interaction between year and search (equations 3 and 4), the results are not statistically significant. That is, there is not significant evidence that the effect of news search or web search on IRP is different each year. In the second column of Table 5, the coefficient on the interaction term, news search and year, is 0.016 and insignificant, and in the second column of Table 6, the coefficient on the interaction term, web search and year, is 0.008 and insignificant. We likely do not have enough variation in the year or search data to observe a difference over time. Note that the coefficient on news search and web search does not change much when we include the interaction term, and they maintain the same significance level.

Next we investigate the effect of search on IRP when concern is taken into account. We interact concern with each type of search, as given by equation 5 and 6. The results for news search is given in the second column of Table 7 and the results for web search is given in the second column of Table 8. For both search types, the interaction is insignificant, suggesting that the food safety practices of concerned individuals do not change more or less in response to news

or web search than non-concerned individuals. In other words, the effect of aggregate level interest (as measured by news and web search) on reported safety practices is unaffected by individual level concern. Concern does, however, have a significant effect on IRP individually. On average, an individual concerned with the safety of their food more closely follows recommended practice than their counterpart, all else equal. Concern had one of the largest coefficients in magnitude, following white, female, married, and frequent meat eater variables,[9] suggesting that concern is a significant predictor of safer reported food practices.

Table 7: Interaction of average 9 month **News Search** and **Concern**

	Without Interaction	With Interaction
IRP	**Coeff.**	**Coeff.**
Average news search before & during survey	-0.082** (0.039)	-0.089** (0.041)
Concern	1.529*** (0.352)	1.553*** (0.352)
Interaction: search and concern	-	0.016 (0.026)
Year	0.722*** (0.105)	0.524 (0.330)
***p<0.01 **p<0.05 *p<0.1 *Note: The table gives estimated coefficients from the linear regression model with robust standard errors in parenthesis. The controls are gender, urban, vegetarian, kids under 16 in household, frequent meat eater, concern, history of food poisoning, food allergy, age, ethnicity, marital status, working status, household size and household income.*		

[9] Coefficients are quoted from the regression with news search and year as independent variables, and no interactions; i.e. the "without interaction" column of table 7.

Table 8: Interaction of average 9 month **Web Search** and **Concern**

	Without Interaction	With Interaction
IRP	**Coeff.**	**Coeff.**
Average web search before & during survey	-0.020* (0.010)	-0.042* (0.023)
Concern	1.537*** (0.352)	1.533*** (0.362)
Interaction: search and concern	-	0.008 (0.008)
Year	0.598*** (0.075)	0.129 (0.441)
***p<0.01 **p<0.05 *p<0.1		
Note: The table gives estimated coefficients from the linear regression model with robust standard errors in parenthesis. The controls are gender, urban, vegetarian, kids under 16 in household, frequent meat eater, concern, history of food poisoning, food allergy, age, ethnicity, marital status, working status, household size and household income.		

Conclusion

The purpose of this paper is to examine if an increase in attention to mad cow disease, as measured by search trends for the term, change food safety practices for individuals in the UK. This question is interesting because of the extensive history of dealing with mad cow disease in the UK, and the uniqueness of mad cow disease as a foodborne illness that cannot be prevented with safer food practices in the home. When we control for year effects, we find that an increase in average news search decreases IRP by a small but significant amount, which is opposite of our hypothesis. This result may be evidence of moral hazard. When mad cow disease makes the news, the FSA and food producers must ensure consumers that extensive measures are being taken to prevent the spread of the disease. This emphasis on safeguards may reassure consumers that the food that reaches them is already safe, and hence they can be more lax in their own safety practices when preparing food. On the other hand, we do not have as significant evidence that web search impacts IRP. This may be because of the difference between news search and web search. We use Google Trends search data as proxy for public attention to mad cow disease,

and news search likely better reflects the public's interest in this topic. News search trends show the most extreme amount of attention to an issue, like when an instance of mad cow disease makes the news, while web search is independent of an outbreak or big news story. For example, an individual doing a project on mad cow disease would do a web search.

Since our results are so small, it is also possible that mad cow disease web searches have no effect on IRP because there has been a stronger emphasis on food safety education since the BSE crisis. If the population is aware that safety procedures in the home are ineffective at preventing mad cow disease, then public attention to the issue shouldn't change food safety measures in the home. Hence, we encourage that future research studies the relationship between other foodborne illnesses- ones that can be prevented with safer preparation and cooking techniques- and IRP. Listeria is a more current foodborne illness issue in the UK, and would an interesting area of research.

Although it is not the main focus of our regression analysis, a significant negative coefficient is calculated for the frequent meat eater variable in every regression we run, which implies that eating a lot of meat does not mean the individual knows more about safe meat handling and preparation practices. This may be because of omitted variable bias, since frequent meat eaters may share a common characteristic that isn't measured by the controls in our model, like stubbornness. With an increase in popularity of vegetarianism, veganism and non-meat options, the individuals who are unwilling to be flexible in their high meat diet may also be stubborn in changing their food safety habits to safer ones. Another theory has to do with how meat is cooked: steak can be ordered medium rare or partially raw, but never chicken or eggs for example. Perhaps this taste preference plays a psychological role in the perceived safety of meat over chicken or eggs. Chicken and egg consumption were not measured in every survey wave,

but we suggest including these variables in future models to test this hypothesis. Future waves of the Food and You Survey- Wave 5 (2018) and Wave 6 (2020)- are already contracted to be carried out, so future research can be improved with more survey waves of data.

The interaction of news search and year and the interaction of web search and year were both insignificant, suggesting that the effect of search on IRP did not change linearly over time. However, since limitations in the data forced us to assign the entire survey wave the same value for search frequency, we may not have enough variation in search for significant results either way. For future research, we suggest finding a better way to connect survey and search data, ideally at the individual level.

The interaction of concern and search was also insignificant; hence, a concerned individual did not change food safety practices in response to search more than a non-concerned individual. Concern did however, have a large significant effect on IRP, although we do not find this surprising. It is reasonable that someone worried about the safety of their food will follow recommended practices more closely. It is possible that an individual who is already concerned about mad cow disease is not additionally impacted by population-level attention to the subject.

We have found that google news searches for mad cow disease have a very small negative effect on food safety practices, and web search has a negligible effect. Implications of our findings are important for policy making and efforts to improve food safety. It is estimated by FSA that foodborne diseases cost nearly £1.5 billion in 2008, and that a 1% reduction in the number of foodborne illness cases (or approximately 10,000 fewer cases), would save the economy £15 million pounds per year, much less than the cost of FSA interventions to improve number of cases. Even in the age of technology, online search about foodborne illness, specifically mad cow disease, does not have a huge impact on food safety procedures, even in the UK, which has a significant history of meat scares. Nevertheless, more news search is correlated

with worse food safety practices. This may be due to misinformation online, or news stories that make individuals feel more safe and confident in the measures taken to prevent mad cow disease or other foodborne illnesses by the government, producers and agents along the "farm to fork" chain. Our results suggest an issue of moral hazard, so FSA should continue agency initiatives that bring foodborne illness information to the consumer, and emphasize that the burden to prevent a disease is still on everyone.

Appendix

Items used to calculate IRP	
Item	**Topic(s)**
1	Chilling questions
2	Cooking food to steaming hot
3	Eating chicken/turkey if meat is pink or has pink/red juices
4	Number of times you would consider reheating food
5	How you usually tell food has been reheated properly
6	Washing raw meat/poultry
7	Where/how you store raw meat and poultry
8	Washing hands before food preparation/after handling raw meats/fish
9	Knowledge and checking of use by dates
10	Last day you would consider eating Sunday leftovers

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