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Media Coverage of Agrobiotechnology: Did the Butterfly Have an Effect?

Leonie A. Marks, Nicholas Kalaitzandonakes, Kevin Allison, and Ludmila Zakharova

This study examines media coverage of genetically modified (GM) crops in a risk communication framework. Content analysis is employed to investigate how specific environmental, food safety, and landmark events, such as the monarch butterfly and Pusztai controversies, and the cloning of Dolly-the-sheep, were reported by the media. Media coverage is from United Kingdom and United States newspapers over the period 1990 through 2001. On balance, findings show that the UK press has been more negative than the U.S. press in its coverage of GM crops. In addition, environmental and food safety events had a significant impact on the level and cycle of GM crop coverage.

Key Words: biosafety, content analysis, environment, GM crops, GMOs, media coverage

Understanding how environmental and food safety controversies are reported in the mass media is important for agribusiness firms. In the United States, less than 2% of the population is now engaged in agricultural production. Hence, the average food consumer has diminishing personal experience and knowledge of agriculture and food production systems. Likewise, as personal contacts and one-on-one experiences also diminish, consumers often rely on impersonal sources for information (TV, radio, newspapers, magazines, the internet). Indeed, over 90% of consumers receive information about food and biotechnology primarily through the popular press and television (Hoban and Kendall, 1993; Schulz, Burkink, and Marquardt, 2000). Further, while the media is not a singular influence, it has been found to play a role in the risk (and benefit) perception that the public holds (Bauer, Durant, and Gaskell,

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1998). As a result, agribusiness firms are increasingly affected by how the media report on food and environmental hazards. Understanding how the media report these risks and what factors drive such reporting is therefore important for agribusiness firms. Managing response to media coverage, particularly during heightened public awareness and controversy, will be a critical part of any public relations strategy.

Genetically modified foods (GMFs) and agricultural biotechnology have generated considerable attention, as well as controversy, since their introduction in the mid-1990s. While some have argued the technology is extremely beneficial, others have questioned its potential impact on the environment and raised concerns about its safety for human health (The Pew Initiative on Food and Biotechnology, 2002). For instance, transgenic crops have been perceived by some Europeans to carry unacceptable environmental and food safety risks. Such perceptions contrast with the broader acceptance of environmental applications of biotechnology (Gaskell et al., 2000), and its use in other applications such as medicine and drugs. While the United States has enjoyed a smoother ride than the European Union, it has also experienced environmental and food safety controversies in relation to biotechnology, such as the "monarch butterfly" research and, more recently, the recall of food products made from Starlink corn.

In this context, we investigate how the public controversy over genetically modified foods has been reported in the mass media, focusing, in particular, on their biosafety risks. Content analysis (Wimmer and Dominick, 1987) is employed to investigate how specific landmark events, and environmental and food safety controversies associated with GM foods, have been reported by the media. Our coverage is taken from United Kingdom and United States newspapers over the 12-year period 1990 through 2001.

Literature Review

Like all technologies, and, indeed, all human action, biotechnology is associated with risks, both known and unknown. The study of risk, encompassing the fields of risk assessment, perception, and communication, has developed over the past several decades in response to the challenges posed by an increasingly technologically oriented society (Slovic, 1987; Kates and Kasperson, 1983; Covello, 1983). In recent years, studies of risk have persistently uncovered the existence of a substantial gap between expert and public perceptions of risks. Accordingly, how the public forms perceptions of technological risk has been an area of considerable investigation (e.g., Krimsky and Plough, 1988; National Research Council, 1989; Slovic 1987, 1993, and 1997).

A substantial body of work has been dedicated to the psychological aspects of risk perception, uncovering a set of mental strategies or rules that all people use to simplify risk problems. The use of such simplifying rules, known as heuristics, often leads to biases, two of which are particularly important (Covello, 1983). The first bias is known as "information availability," or the tendency to believe an event or action occurs more frequently if instances are easy to imagine or recall. Hence, if

public debate or overall level of media coverage of the risks of a technology increases, then this may increase the perceived likelihood of those risks becoming manifest. The second important bias is "representativeness," or the tendency to assign comparable risk characteristics and degrees to activities or events which are roughly similar, such as nuclear power and nuclear war. Availability and representativeness form the basis for the assertion that exposure to information about the risks of technologies will increase the perceived riskiness of the technology itself.

Studies by Slovic (1987), and Slovic, Fischhoff, and Lichtenstein (1985) have shown that perceived risk is affected by the characteristics of risk itself, and consequently it is both quantifiable and predictable. Most risks can be grouped in terms of two main dimensions: (*a*) the degree to which the risk is a *dread risk*—its consequences are catastrophic, memorable, uncontrollable, potentially fatal, not equitable in their distribution, pose high risk to future generations, are not easily reduced, and are involuntarily imposed; and (*b*) the degree to which the risk is an *unknown risk*—it is not observable, not evident to those exposed, its effects are delayed, and not definitively known to science. These dimensions then provide the framework for a quantitative model of risk perception.

In a study based on this model, nuclear technologies and DNA technologies, including agrobiotechnology, each score high in both the dread risk and unknown risk factors, indicating the risks associated with these technologies are perceived in similar ways (Slovic, 1987; Slovic, Fischhoff, and Lichtenstein, 1985). It has been shown that unfortunate events of accidents involving technologies which score high in both the dread and unknown risk categories are particularly likely to produce broad social, political, and policy responses. That is, people are more likely to consider other impacts when dealing with these risks, such as ethical and moral or environmental factors or threats to future generations not usually accounted for by traditional statistical risk assessment [e.g., expected annual mortality rates (Slovic, 1987)]. This tendency is certainly evident in the ongoing debates regarding agrobiotechnology.

Risk Communication and Frame Theory

Somewhere between its assessment and perception, risk must naturally be communicated. In addition to the heuristics often used by individuals to make judgments about risks, sociologist Erving Goffman (1974) and others (Payne, Bettman, and Johnson, 1992; Irwin and Davis, 1995) have identified the importance of how information is "framed" in risk judgments. Frames, according to Goffman, "allow people to locate, perceive, and label" social events. Frames provide meaning, and a way of thinking about our lives, events, and the world in general. Payne, Bettman, and Johnson (1992), and Irwin and Davis (1995) argue that frames effectively structure the way information is presented and, depending on the frame, judgments about the perceived risks versus benefits of a technology might be quite different.

Risk communication can take place in the context of any number of frames. While some attempts at risk communication might frame risk in terms of expected annual

mortality rates, others might frame risk of the same technology in terms of less tangible elements, such as moral and ethical risk. Based on the findings of studies by Kahneman and Tversky (1984), Levin and Chapman (1990), and Boon and Griffin (1996), how risks are framed over time may also affect opinion formation, to the extent the opinion is formed by a series of decision-making events over an extended period of time. As Slovic (1997, p. 394) writes, "We now know that every form of presenting risk information is a frame that has a strong influence on the decision maker."

The Media's Role in Framing Risk

Because risk frames can have such a pronounced impact on risk perceptions and on an individual's decision-making process, those responsible for providing information may influence perceptions and behavior (Slovic, Fischhoff, and Lichtenstein, 1984). As frames, news stories offer the public definitions of social reality. Tuchman (1978) pioneered the concept of a "story frame"—the application of Goffman's frame theory to the mass media. In reporting a story, journalists turn an occurrence into a newsworthy event, a newsworthy event into a story, which is then communicated to the public. Journalists and editors adjust frames according to their own understanding, their ideologies, styles, and practical limitations such as deadlines and space (Best, 1990, 1991). Writing on science and technology can thus emphasize scientific facts, their sociopolitical implications, environmental risks, human health concerns, and so on (Hornig, 1990).

News, like all public documents, is a constructed reality, assembling facts and information within a narrative structure, or frame, which serves to communicate an event or story to the reader (Tuchman, 1976). Through frames, media highlight certain points of view and marginalize or ignore others, defining occurrences, and explaining how they are to be understood (Hornig, 1993).

In this study, we examine how different U.S. and UK media have framed their reporting of alleged environmental benefits and risks of GM crops. A common perception is that the European press has taken a negative stance toward agrobiotechnology, heightening public awareness of and the perceived risks associated with GM foods. Up-to-date studies which compare U.S. and European coverage of agrobiotechnology are lacking. We therefore test whether the British media has been more negative in its coverage of agricultural biotechnology than the U.S. media. We hypothesize the following:

- H_1: *In covering GM crops, UK reporters place greater emphasis on the risks relative to the benefits of the technology compared to U.S. reporters.*

In concert with the question of overall tone of coverage is the question of how specific events influence reporters' framing of environmental risks and benefits. In the United States in 1999, John Losey and colleagues published a laboratory study which indicated monarch butterflies could be harmed by GM corn pollen (Losey,

Raynor, and Carter, 1999). The study's findings were controversial and garnered international attention. In May 2000, UK imports of canola (rapeseed) were found to contain live modified organisms (LMOs) unapproved as seed in European markets. UK farmers unknowingly planted them in their fields. The event was widely reported by the European press. In the terminology of Kasperson et al. (1988), media act as "amplification stations," amplifying the risks associated with new technologies when focusing on such events. We therefore hypothesize:

- H_2: *During controversial events, such as the "monarch butterfly" and "GM contamination of seed," U.S. and UK reporters will emphasize the risks of GM crops more than their benefits.*

In addition to environmental events, GM foods have been directly linked to potential food and health safety risks. In the United Kingdom during 1998, research scientist Dr. Arpad Pusztai appeared on national television stating that GM potatoes fed to laboratory rats had caused severe damage to their organs and overall development. While Dr. Pusztai's study was generally discredited by mainstream scientific societies, and even his own research institute, it led to a crisis of confidence among British consumers about GM food products. His controversial study was subsequently published as a research letter in *The Lancet* (Ewen and Pusztai, 1999).

In the United States, the commingling of the food supply with Starlink (a GM corn feed approved only for animal consumption) led to recalls of multiple affected products, and received international attention. As a result, U.S. public awareness of agrobiotechnology increased (International Food Information Council, 2001, 2002). Signals of potential food safety hazards, such as the findings of Dr. Arpad Pusztai, may trigger reporters to look at other risk frames including environmental risks, social risks, moral and ethical risks, and so on. Because reporters often discuss both the food and environmental implications of biotechnology (Marks et al., 2002), we expect reporting of environmental risks to increase during food safety events. Accordingly, the following hypothesis is tested:

- H_3: *During food safety controversies, such as "Pusztai" and "Starlink," UK and U.S. reporters emphasize the risks of GM crops over their benefits.*

Finally, the short history of biotechnology has been marked by a number of "landmark" or "breakthrough" events. Dolly-the-sheep sparked controversy (over the possibility of human cloning), but also promised to deliver major benefits through the production of drugs manufactured from animals, and from xenotransplantation. The human genome project (HGP) opened up vast potential for combining new discoveries in human health with agricultural production—e.g., biopharming. A priori, one would expect such landmark events to remind of the technology's potential, leading to more positive coverage and an emphasis on the benefits of GM crop production. We therefore hypothesize:

- H_4: *During landmark events, such as "Dolly-the-sheep" and the "human genome project," UK and U.S. reporters emphasize the benefits of GM crops relative to their risks.*

In order to test these four hypotheses, we employ content analysis and seemingly unrelated regression. A brief discussion of our methodological approach follows.

Methodological Approach

Content Analysis

"Content analysis is a systematic method for analyzing and quantifying message content and message handling. It is a tool for observing and analyzing the overt communication behavior of selected communicators" (Budd, Thorp, and Donohew, 1967, p. 2). Instead of soliciting people's behavior directly (through interviews), or measuring response to specific events or stimuli, content analysis may be used to analyze communications that people have produced as accounts of behavior (Kerlinger, 1964).

To provide content for this study, electronic data sources were searched based on an extensive list of key words. Seventy-nine key words or word pairs were used to search articles (title, full text, appendices, and so on) for relevance. The main key words include "agbiotech*," "agricult* and biotech*," "agribiotech*," "agricult* biotech*," "agrobiotech*," "agro-biotech*," "biotech* and farm*," "biotech* and crop*," "GM* and crop*" "GM* and plant*," "transgenic," and so on. Wild cards (*) were used to broaden the search and ensure that the entire population of articles relating to agricultural biotechnology coverage was collected. Each article was read in context in order to eliminate irrelevant articles. The resulting database of articles relates to all agricultural (plant, animal, and food) applications of biotechnology.

Categorization and Coding of Data

The most important step in content analysis is the identification and categorization of the variables under study. Categories, such as subject matter or direction categories, serve the same function as variables in content analysis. As Budd, Thorp, and Donohew (1967) caution, "No content analysis is better than its categories." Variables (categories) must be defined through an operational definition or set of definitions. These definitions should allow for systematic observation that implies reliability and repeatability. In addition, these categories must be exhaustive and mutually exclusive.

In this research, two coding categories were developed across the environmental frame—namely, associated "benefits" and "catastrophic and memorable events" in reporting of the technology. It is well documented in the decision and psychometric literature that individuals are willing to trade off potential benefits versus risks of differing technologies. Tolerance of even very minor risks may be small if individuals

perceive no benefits associated with the risk (Frewer, 1999). On the other hand, very high benefits accruing to the risk-bearers can mitigate relatively high associated risks (Slovic, 1987).

Coding and Context Units

Both manual and electronic coding can be used to conduct content analysis. Electronic content analysis saves time, eliminates the need for multiple human coders, and accommodates large data sets. It offers more flexibility to investigators because dictionaries can be more easily modified and reapplied to the same texts (Lee, 1997). Electronic content analysis also provides greater reliability because it removes human errors due to fatigue or changes in understanding of coding rules. However, if a category is complex, wide-ranging, and inclusive, then manual coding may be necessary (Lee, 1997). Given the population size, we used computer-aided analysis to quantify the variables under study.

In developing the dictionaries, a two-step procedure was used. Two human coders manually coded a stratified random sample of articles ($n = 50$)[1] from the entire population of articles. This approach allowed the researchers to test the reliability (consistency and validity) of the initial variable definitions. Two measures of reliability were employed—Krippendorff's alpha and *R*-squared (coefficient of determination). Both measures account for variation in interval- and ratio-level data. For the benefits variable, $\alpha = 0.91$ and $R^2 = 0.93$. For the catastrophic and memorable events variable, $\alpha = 0.91$ and $R^2 = 0.98$. Common standards for what constitutes an acceptable level of agreement for intercoder reliability statistics are not in place (Neuendorf, 2002, p. 143) and depend on the statistic. In general, however, beyond-chance reliability measures (such as Cohen's kappa, Scott's pi, Krippendorff's alpha) are afforded more liberal criteria than simpler measures (Neuendorf, 2002, p. 143). The range of 0.80 to 0.90 for beyond-chance measures is considered good to excellent (Krippendorff, 1970; Riffe, Lacy, and Fico, 1998; Banerjee et al., 1999).

Given the acceptable levels of agreement achieved by the two human coders, dictionaries of words and word phrases relating to the conceptual categories (measured by our operational definitions) were constructed. Words "before" and "after" the word or phrase included in each category, or key-word-in-context (KWIC) analysis, were used. Development of the variables (dictionaries) involved an iterative process. Once an initial list of words had been developed, computer-generated key-words-in-context lists were used to determine which words and phrases contained in the draft dictionaries were accurate indicators of the variable in question. Following the approach of Bengston and Xu (1995, p. 8), words and phrases consistently used ambiguously or incorrectly were either removed from the dictionaries or manually coded. The dictionaries were refined until words or word phrases were used correctly 80% (or more) of the time across the entire population of articles.

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[1] Fifty articles are considered a minimum for reliable subsamples (Neuendorf, 2002).

The dictionaries do not contain the same number of words or phrases. Similar to the work of Bengston and Xu (1995, p. 14), we found that relative size has little impact on the dictionaries' ability to capture the bulk of risk/benefit-related content toward the various applications. Many of the words and phrases, while accurate indicators of direction, are used infrequently. Attention was therefore focused on the quality of words and phrases in measuring the conceptual category.[2]

The resulting environmental benefits dictionary included phrases such as "cut pesticide use," "eliminate the need for chemicals," "reduce cultivation of the land," "reduce soil erosion," and so on. Memorable risk events linked to the environment included "Chernobyl," "Bhopal," the "Exxon Valdez," "Three Mile Island," "Times Beach," "GM seed contamination," the "monarch butterfly," the "extinction of the Dodo," and so on. Catastrophic risks included phrases such as "calamitous," "catastrophic scenarios," "cause ecological disaster," "cause extinction," "destroy the environment," and so on. Only phrases relating to (potentially) large-scale detrimental impacts of the technology on the environment were included in the catastrophic category. Each variable is constructed as a count of benefit/risk words and phrases per article. In principle, therefore, an article can contain both risk and benefit words/word phrases simultaneously, no risk/benefit words or word phrases, or either risk or benefit words/word phrases.

Six variables were also developed to test whether reporting on environmental risks and benefits was directly affected by key biotech events. The main biosafety events during this time period were the monarch butterfly (*MON*) controversy of 1999 and the contamination of conventional rape (canola) seed with GM seed (*GMC*) in Europe. Food safety events include the Starlink controversy (*STAR*) in 2000 and reporting of the research on GM potatoes by Arpad Pusztai (*PUS*) in 1998/1999. Landmark events include Dolly-the-sheep (*DOLLY*) and the human genome project (*HGP*).

Dictionaries of direct words and phrases such as "Starlink," "Dolly," "Pusztai," and so on were developed and counted for each event. In addition, related phrases, such as "taco recall," were used to measure the degree of reporting of the event over time. Obviously, at the peak of the controversy, such phrases show up repeatedly throughout the text of articles, only subsiding in frequency as coverage and interest wane. Table 1 summarizes the events and details the main dates when each event was first reported by the media.

Model Estimation

The impacts of events on reporting of GM crops in U.S. and UK newspapers are modeled as a system of seemingly unrelated regressions (SUR) given that the error terms may be correlated across newspapers, and therefore estimation efficiencies are

[2] We tested our finalized dictionaries relative to a subset of manually coded articles. Intercoder reliability statistics were in the acceptable range of $\alpha = 0.75$ and $R^2 = 0.82$ for benefits, and $\alpha = 0.79$ and $R^2 = 0.97$ for risks.

Table 1. Biotechnology Events (1990–2001)

Event	Dates of Main Coverage	Variable Name	Description
Dolly-the-sheep	< February 1997 < June 1997 < September 1997	*DOLLY*	< Dolly is born < Human cloning banned in U.S. < Dolly's telomeres are found to be old
GM contamination	< May 2000	*GMC*	< UK imports of canola (rapeseed) found to contain live modified organisms (LMOs) which farmers planted unwittingly in their fields
Human genome project	< April 2000	*HGP*	< Human genome mapped, garnering world-wide attention and commercial optimism
Monarch butterfly	< May 1999	*MON*	< John Losey et al. publish lab study results indicating monarch butterflies are harmed by GM corn pollen
Pusztai crisis	< August 1998	*PUS*	< Dr. Arpad Pusztai goes on UK national TV saying GM potatoes fed to lab rats caused serious harm to their organs and health
Starlink corn	< September 2000	*STAR*	< U.S. food supply found to be contaminated with Starlink corn approved for use only in animal feed

possible. Coverage in five newspapers was analyzed: the *Daily Telegraph* and the *London Times* for the United Kingdom, and the *Washington Post*, *USA Today*, and *Wall Street Journal* for the United States. Generalized least squares estimation is used, correcting for first-order autocorrelation where detected. The empirical model is specified as follows:

$$(1) \qquad DIF_i = \alpha_i + \beta_{1i}(MON + \beta_{2i}(GMC + \beta_{3i}(PUS + \beta_{4i}(DOLLY + \beta_{5i}(STAR + \beta_{6i}(HGP + \beta_{7i}(TIME + \mu_i,$$

where *MON*, *GMC*, *PUS*, *DOLLY*, *STAR*, and *HGP* represent (predetermined) event variables related, respectively, to the monarch butterfly controversy, the contamination of rapeseed by GM seed, the report of Dr. Pusztai's study, "Dolly-the-sheep," the Starlink controversy, and the human genome project. Each event variable is measured by coverage in each newspaper. DIF_i measures absolute differences in reporting of environmental benefits and risks in each (ith) newspaper—the *Daily Telegraph* (*DT*), *London Times* (*LT*), *Washington Post* (*WP*), *Wall Street Journal* (*WSJ*), and *USA Today* (*UST*). *TIME* is a time trend variable.

As shown in figures 1 and 2, coverage is sporadic early on in the series across the set of newspapers. Therefore, the empirical model is estimated using 144 consecutive months of data for each newspaper, with zeros substituted at the appropriate dates for nonexistent coverage. This assumes there is no qualitative difference between

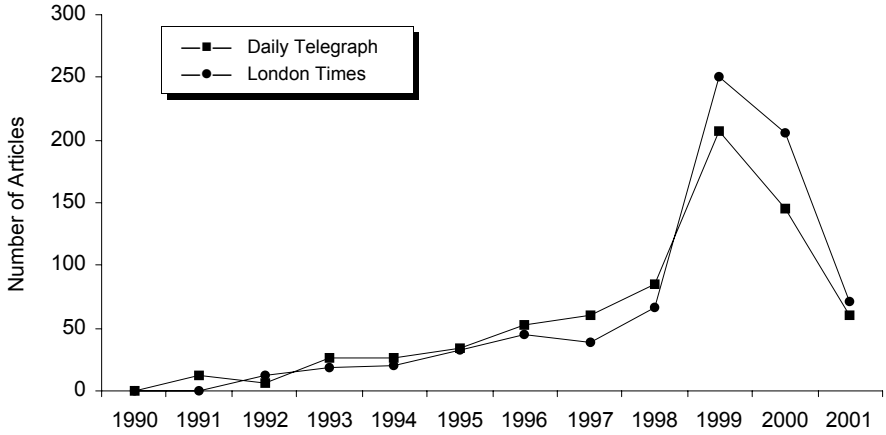

Figure 1. Coverage of agrobiotechnology in national UK daily newspapers, 1990–2001

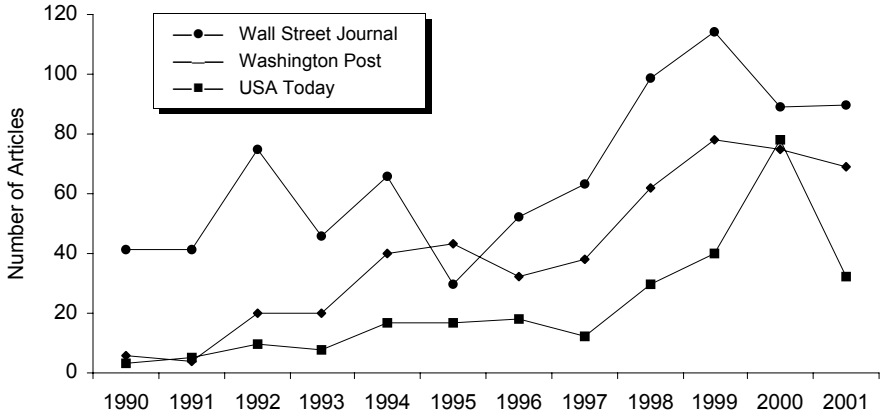

Figure 2. Coverage of agrobiotechnology in national U.S. daily newspapers, 1990–2001

noncoverage and coverage where reporters chose not to report either environmental risks or benefits associated with GM crops.

Possible cross-correlation in the error term among newspapers is explicitly modeled; that is, $\sigma_i = \text{var}(\mu_i)$, and $\sigma_{ii} = \text{cov}(\mu_i, \mu_i) \ldots 0$, where $i = 1, \ldots, 5$. The coefficients β_{51}, β_{52}, β_{24}, and β_{25} are set to zero. Both UK papers chose not to report on the Starlink event during the period of coverage (despite its international significance). Interestingly, other UK newspapers, such as the *Guardian*, the *Financial Times*, and the *Independent*, did allocate space to Starlink. Likewise, in the United States, both the *Wall Street Journal* and *USA Today* chose not to run the GMC story.

Empirical Results

Since the early 1990s, coverage of agrobiotechnology has increased in both the United Kingdom and the United States. Figures 1 and 2 detail reporting of GMFs from 1990 through 2001 in the two countries, respectively. All newspapers have trended upward over time; however, coverage of agricultural biotechnology issues increased dramatically in UK newspapers from 1998, reflecting the intense debate that has taken place about the technology in the United Kingdom. Well over 200 articles appeared in each paper during 1999—a three- to four-fold increase over the previous year. Since that time, coverage has declined, with 1999 proving to be the "peak" of media coverage (figure 1).

In contrast, U.S. coverage (figure 2) has been more continuous than reporting in the United Kingdom. Despite increased coverage of the monarch butterfly study in 1999 and Starlink in 2000, U.S. coverage of GM foods actually declined for two out of the three newspapers during 2000 and 2001. It appears U.S. consumers have been exposed to a more continuous, steadily broadening debate over the 1990s rather than contentious, controversial media coverage (Marks, Kalaitzandonakes, and Zakharova, 2002).

Hypothesis H_1: UK versus U.S. Reporting of GM Crops

In pairwise comparisons of word or word phrases, frequency results indicate hypothesis H_1 is rejected. H_1 stated that in covering GM crops, UK reporters would place greater emphasis on the risks relative to the benefits of the technology, compared to U.S. reporters. *USA Today*, although slightly more positive, was not found to be significantly different in its reporting from the *London Times* ($\chi^2 = 2.38$, 1 d.f., $p > 0.12$), and the *Daily Telegraph* ($\chi^2 = 2.72$, 1 d.f., $p > 0.10$). However, the *Washington Post* and the *Wall Street Journal* were found to be significantly more positive in their reporting relative to UK papers. At the aggregate level, the UK papers did emphasize the risks over the benefits of GM crops relative to the U.S. papers ($\chi^2 = 37.53$, 1 d.f., $p > 0.001$).

In pairwise comparisons, the U.S. papers differed in their coverage. The *Washington Post* and *USA Today* ($\chi^2 = 0.019$, 1 d.f., $p > 0.890$) were not significantly

different in their reporting. However, both papers emphasized the risks more than did the *Wall Street Journal* ($\chi^2 = 20.81$, 2 d.f., $p > 0.001$). The coverage in the *London Times* and the *Daily Telegraph* was not significantly different across the two papers ($\chi^2 = 0.042$, 1 d.f., $p > 0.838$). However, over the entire 1990–2001 time period, the *London Times*, *Daily Telegraph*, *Washington Post*, and *USA Today* all focused more on catastrophic and memorable environmental risks of GM crops relative to the *Wall Street Journal*, which gave more coverage to potential benefits. Indeed, for all four papers, risks exceeded benefits in absolute terms.

These results reveal that on both sides of the Atlantic, environmental risks (e.g., irreversible transgenes) rather than benefits (e.g., less pesticide use and associated benefits to water quality, land savings, less impact on wildlife) have been the focus of newspaper reporting. Analogs to memorable and catastrophic events (e.g., nuclear accident in Chernobyl) have been used in such coverage. On balance, the UK media have been more negative than their U.S. counterparts (except *USA Today*).

Hypotheses H_2–H_4: The Impact of Related Events

Figures 3–6 provide summary yearly data for the United States and the United Kingdom, expressed as a percentage of articles. From visual inspection of these graphs, reporting of the environmental risks relative to benefits of biotechnology appear to be cyclical and event driven. Discrete events coincide with an increase in the level of reporting of catastrophic and memorable risks. This finding is formally confirmed in table 2. As expected, environmental events such as the monarch butterfly research had a strong impact on reporting of environmental risks on both sides of the Atlantic. H_2 is supported for both the United States and United Kingdom, indicating reporters emphasized the biosafety risks of GM crops more during the monarch butterfly event.[3]

Other environmental events, such as the "contamination" of European canola (rapeseed) with GM seed, also had a significant impact on reporting. In both UK papers, reporters emphasized the biosafety risks over the benefits of GM crops during the event. A qualitative difference was found, however, with the *Daily Telegraph* providing more balanced coverage (although overall negative) than the *London Times*.[4] Unlike the monarch butterfly research, the GMC event was more localized, being largely reported in the United Kingdom. Only one U.S. paper chose to cover the story, and then only indirectly, with no significant relationship found.

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[3] When biosafety benefits alone were regressed on the explanatory events variables, both the *USA Today* and *Wall Street Journal* significantly (5% and 1% levels, respectively) increased their reporting of the environmental benefits of GM crops. However, their emphasis on associated potential risks was stronger and outweighed any increased coverage of environmental benefits. Hence, U.S. reporters provided more balanced coverage of the monarch butterfly event, airing both sides of the debate. UK reporters, on the other hand, emphasized the risks and allocated less coverage to environmental benefits during the monarch event.

[4] In separate regressions, where both risks and benefits were regressed as individual explanatory variables, the *Daily Telegraph* significantly (1% level) increased its reporting of both benefits and risks during the GM contamination event, whereas the *London Times* emphasized risks over benefits (with GMC having a negative, although not significant, relationship with biosafety benefits).

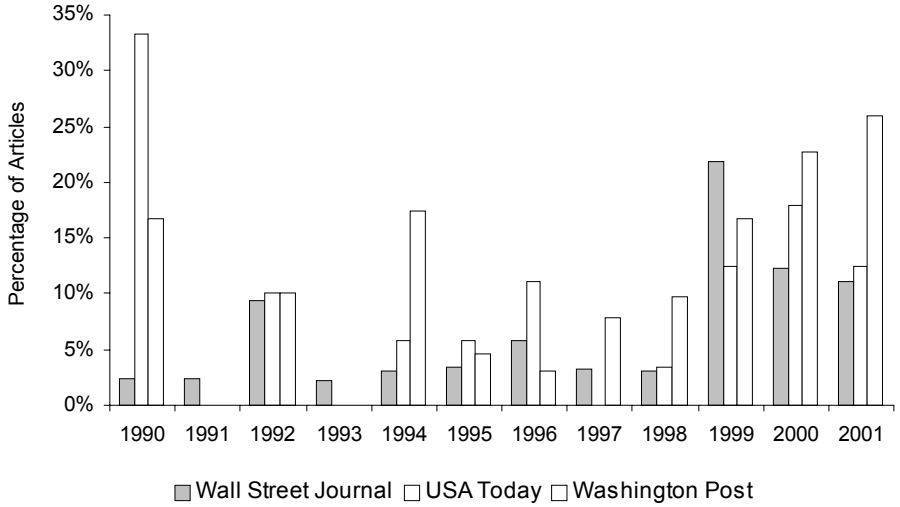

Figure 3. Coverage of biosafety risks in the United States, 1990–2001

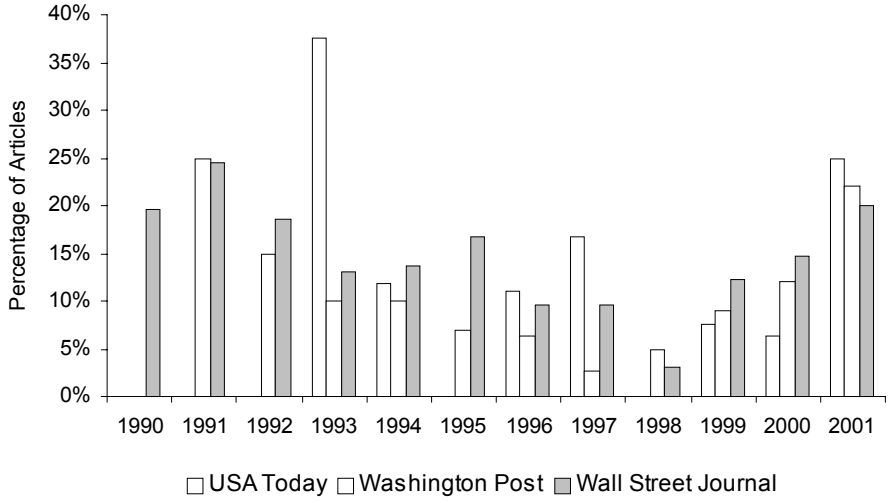

Figure 4. Coverage of biosafety benefits in the United States, 1990–2001

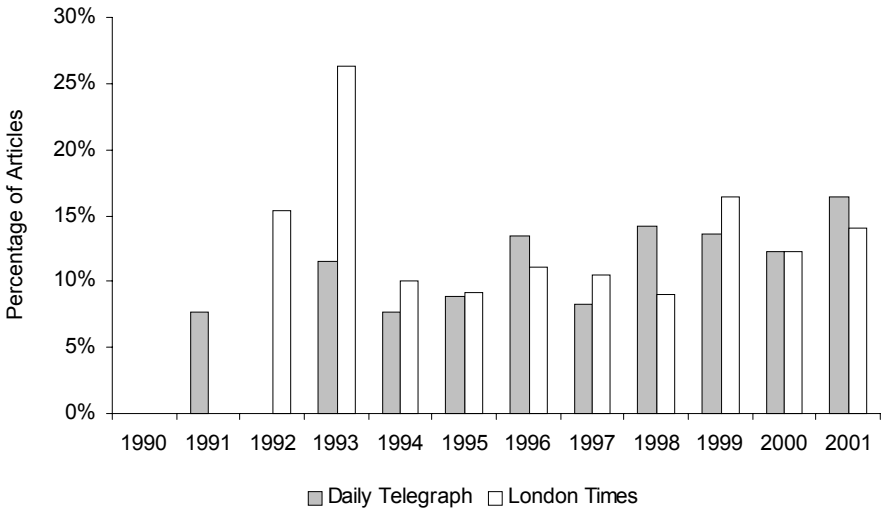

Figure 5. Coverage of biosafety risks in the United Kingdom, 1990–2001

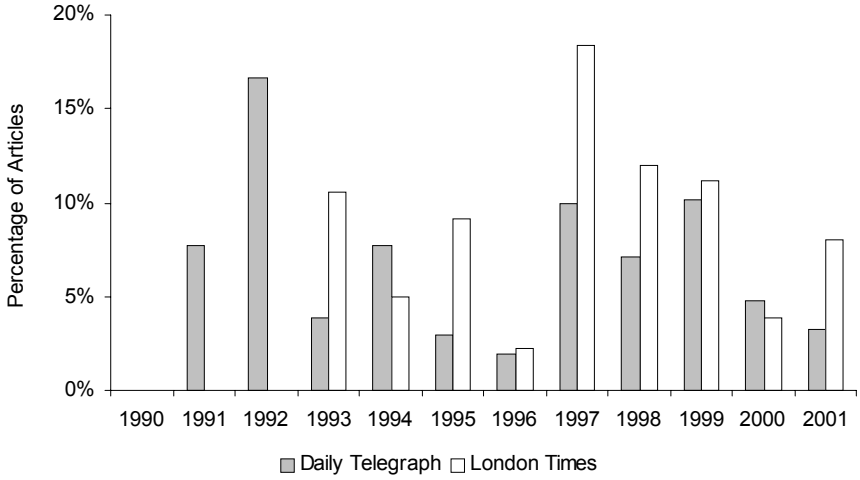

Figure 6. Coverage of biosafety benefits in the United Kingdom, 1990–2001

Table 2. Effect of Events on Biosafety Reporting by Country and Newspaper

	United States			United Kingdom	
Variable	*Washington Post* (*DWP$DIF*)[a]	*Wall Street J.* (*WSJ$DIF*)	*USA Today* (*UST$DIF*)	*London Times* (*LT$DIF*)	*Daily Telegraph* (*DT$DIF*)
Intercept	!0.753	1.516***	0.046	!0.566	0.399
	(!0.840)	(3.366)	(0.134)	(!0.932)	(0.779)
MON	!1.022***	!0.679***	!0.720***	!1.156***	!1.260***
	(!12.070)	(!7.423)	(!3.307)	(!6.950)	(!7.470)
GMC	0.432	—	—	!0.214**	!0.487***
	(0.610)			(!2.100)	(!6.690)
PUS	0.516	!0.591***	8.076	0.097*	!0.005
	(0.930)	(!1.959)	(1.607)	(1.890)	(!1.130)
STAR	!0.035	0.030	0.070	—	—
	(!1.325)	(1.555)	(1.582)		
DOLLY	0.100	0.119	0.042	0.025	0.074
	(0.710)	(0.915)	(0.259)	(0.283)	(0.585)
HGP	!0.141	0.229**	!0.092*	!0.056	0.151
	(!0.533)	(2.076)	(!1.646)	(!0.689)	(1.234)
TIME	0.012	!0.016***	!0.003	!0.001	!0.019***
	(1.070)	(!2.685)	(!0.584)	(!0.165)	(!2.730)
AR(1)	0.385***	—	—	—	—
	(5.246)				
Adjusted R^2	0.52	0.41	0.04	0.27	0.45
DW Statistic[b]	1.27	2.13	2.04	2.01	2.02

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 10%, 5%, and 1% levels, respectively. Numbers in parentheses are *t*-values.

[a] The "D" before the variable name indicates the model was first-differenced due to an AR(1) error process.

[b] Durbin-Watson statistic for untransformed model.

Food safety events also had an impact on the reporting of GM crops, although H_3 is rejected. The research of Dr. Arpad Pusztai coincided with a significant increase in reporting of environmental benefits and risks in the *London Times*, with an emphasis on benefits over risks ($p > 0.06$). Reporting on the research of Dr. Arpad Pusztai (in late 1998) coincided with a general "heating up" of the GM food controversy in the United Kingdom. One explanation for this result, therefore, is that as the debate became more contentious, proponents and opponents aired their viewpoints in the media, and the debate broadened to include other nonfood safety issues, such as environmental ones. In the United Kingdom, in particular, environmental groups have been more vocal than other nongovernmental organizations. Hence, when the opportunity of national media attention presented itself (in 1998), Pusztai's research appears to have amplified the debate.

In contrast, Starlink did not have the same effect in the United States. Starlink is insignificant in explaining biosafety coverage in all three U.S. papers.[5] The Starlink

[5] Starlink significantly increased reporting (1% level) of biosafety risks in the *Washington Post* when regressed on risks only.

incident led to a recall of over 300 food products from the commingling of Starlink corn in the U.S. food supply (Lin, Price, and Allen, 2001, p. 31). Disruption to international (Asian, European) export markets resulted. A plausible explanation for the lack of impact of Starlink in the U.S. case is that it occurred after the monarch research, which had already expanded the debate to environmental issues.

Our results do not generally support hypothesis H_4. Landmark events, such as the human genome project, did generate a certain level of expectation and enthusiasm about the potential of biotechnology in the *Wall Street Journal*. However, the opposite result holds for *USA Today*. Moreover, the arrival of Dolly-the-sheep did not significantly impact reporting of GM crops across all five newspapers.

Discussion

Our results allow certain conclusions about the coverage of GM foods and agrobiotechnology. The peak in media coverage of agrobiotechnology occurred in 1999 and, at least for now, the controversy appears to have diminished. Despite a low level of coverage of environmental issues, on both sides of the Atlantic the findings show environmental risks rather than benefits have been the focus of newspaper reporting. On balance, the United Kingdom has been more negative than the United States. Environmental events such as the monarch butterfly study and GM seed contamination, and food safety events such as the research of Dr. Arpad Pusztai, had a significant impact on both the level and cycle of environmental coverage.

Our analysis and conclusions on the media coverage of agrobiotechnology, however, can be generalized. How events are picked up and amplified by the media has immediate and long-term implications for agribusiness. Some events are general in nature (e.g., the monarch butterfly), and emerge as truly international by the very fact that global media choose to report them. Because agribusiness firms increasingly do business in global markets, the international transmission of such events is important. The media, acting as "amplification stations" (Kasperson et al., 1988), serve to raise public awareness and debate (Bauer, Durant, and Gaskell, 1998). As consumers increasingly gain an understanding of food production and marketing through the media, agribusinesses will be increasingly affected by how global media outlets report on food issues over time.

However, not all food safety and biosafety events are reported internationally—as the predominantly UK coverage of the commingling of GM canola with conventional seed or the lack of Starlink coverage in the two UK newspapers would suggest. Our findings confirm that newspapers vary in how they cover a breaking story, and have a definite bent toward regional and local issues. Given that newspapers target certain audiences, a customized approach allowing for segmented outlets will be an important part of any public relations strategy.

Our findings also suggest it would be a mistake to ignore what initially might appear to be unrelated, or at least less relevant, media events. The research of Dr. Arpad Pusztai, while predominantly a food safety issue, triggered more broad risk communication in the UK media in 1998. Monitoring, managing, and being ready

to respond to industrywide issues affecting tangential businesses, or even competitors, will be an increasingly important public relations strategy. It was only after European markets had essentially been lost (at least in the short run) that North American firms realized their common interest in providing a more united message to consumers and the media about the potential benefits of agricultural biotechnology (e.g., via the Council for Biotechnology Information).

Clearly, it might be more difficult for agribusiness firms to overcome the series of food safety crises that have plagued the United Kingdom in recent years. Nevertheless, a useful function is served by ongoing strategic responses which attempt to restore public confidence in the food supply, in general, and biotechnology, in particular. For example, follow-up research conducted by independent scientists (Sears et al., 2001; Oberhauser et al., 2001; Pleasants et al., 2001) on the field-level impacts of Bt corn on the monarch butterfly did not confirm the 1999 initial laboratory findings of Dr. Losey and colleagues. Such follow-on studies have gone some way toward diffusing public concern in the United States, Canada, and to a lesser extent Europe. While the subsequent findings of "no harm" were less reported than the original study, U.S. and UK reporters nevertheless did report the non-corroborating findings in 2001. As memorable events, like the monarch butterfly controversy, are referred to long after the initial story breaks, the dissemination of such findings by credible scientists (regardless of whether they confirm or refute the original research) is important. And industry must be ready to respond.

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