Source Interests, News Frames, and Risk Delineation:
A Content Analysis of U.S. Newspapers' Coverage
of Genetically Modified Food (1994–2015)

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Informed by agency–structure theory, this study examines how news source interests are associated with news frame, risk delineation, and balance of the coverage of genetically modified food. Through a content analysis of U.S. newspaper coverage of genetically modified food from 1994 to 2015, the study found that sources' interests were associated with news frame and risk delineation, but not balance of coverage. Disinterested sources were associated with the public interest frames more than the sources that had some embedded interest in the production and consumption of genetically modified food. Interested sources were associated with less risk delineation than disinterested sources. The findings suggest that sources do not influence news coverage only through their power status, but also from their embedded interests in the issues.

Keywords: content analysis, agency–structure theory, genetically modified food, public interest, news source, frame analysis

　　　　　Genetically modified (GM) foods take advantage of biotechnology to produce special features not available in traditional foods such as improving the nutritional quality of food, pest resistance, and disease resistance. But risks could also be introduced in consuming GM food such as unknown effects on human health and unintended harm to the environment and other organisms (World Health Organization, 2014). Although consumption of GM food has been growing in the United States, U.S. news media have given scant coverage to the issue (Botelho & Kurtz, 2008; Carver, Rødland, & Breivik, 2013; Flipse & Osseweijer, 2013; Nisbet & Lewenstein, 2002; Nucci & Kubey, 2007). Media coverage of

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risk-related issues has a significant impact on public awareness of risk and the perception of risk associated with a product (Hossain, Onyango, Schilling, & Hallman, 2003). Because mass media are a key source of risk-related information for the public and people rely on media for information about GM food (Hallman, Hebden, Cuite, Aquino, & Lang, 2004; Priest, 2001), how media cover issues related to GM food has a significant impact on the public's perception of, attitude toward, and consumption of GM food (Frewer, Miles, & Marsh, 2002; Wunderlich & Gatto, 2015). Several studies have examined news coverage of GM food, including TV news coverage of GM food (Nucci & Kubey, 2007), comparative analysis of newspaper coverage of GM food in the United States and United Kingdom (Botelho & Kurtz, 2008), frame analysis from the media-sociological perspective (Maeseele, 2010), and the analysis of media frame associated with uncertainty of risk (Clark, 2013). Although these studies offer insight into media framing on GM food, no studies have looked into the embedded interests of different social actors and the relationship between the source interest and the associated news frames. Through a content analysis of U.S. newspapers' coverage of GM food from 1994 to 2015, this study explores news sources as social actors and how sources' interests are associated with news frame, risk delineation, and balance of the coverage of GM food.

Literature Review

Media as Sources of Risk Information and Issues of Public Interest

Previous research has shown that newspapers are a primary source of public information about risk-related issues (McCallum, Hammond, & Covello, 1991). Whereas information sources have expanded significantly with the growth of the Internet, newspaper coverage of risk-related issues continues to be redistributed to the public through news portals and various online information channels (Pentina & Tarafdar, 2014). The possible risks of consuming GM food have been an area of continuous scientific research. Studies have found that media are one of the major factors influencing public knowledge about cancer risk (Stryker, Moriarty, & Jensen, 2008), risk perception of GM products (Aleksejeva, 2012), and consumer preference for symbols used to frame GM food (Rodriguez & Kulpavaropas, 2018). Research has shown that risk-related messages are chosen and shaped by journalists based on their own perspectives and judgments (Steiner & Bird, 2008; Wakefield & Elliott, 2003). Steiner and Bird (2005) found that journalists who cover GM food tend to have their own views on its safety. The coverage of scientific issues is "medialized" to different extents (Schäfer, 2009). Therefore, journalists' perspectives and judgments on issues related to science and risks could be a significant determinant of how risk-related messages are presented to audiences.

News value is a major factor in deciding how a story is covered (Shoemaker & Reese, 1996). Wakefield and Elliott (2003) found that journalists focus on issues that they view as newsworthy, which may or may not be of the greatest importance to their audience. Research has shown that the volume of coverage of a hazard is related to the news value in the rarity, exceptional nature, and recency associated with a hazardous event (Spencer & Triche, 1994). When newspapers covered Hurricane Katrina, only a small yet diminishing number of articles included public health information over time (Cohen, Vijaykumar, Wray, & Karamehic-Muratovic, 2008). These findings suggest that news coverage of risk-related issues, although providing information with news value, does not necessarily convey the information that serves public

interest and makes the general public better-informed consumers (Frewer, Miles, & Marsh, 2002; Nisbet & Lewenstein, 2002).

Sources as Social Actors and Their Interests

Few journalists are experts in scientific areas, so they depend highly on experts and other information sources in their coverage of GM food (Steiner & Bird, 2008). Although journalists often try to select informative sources for their stories, the sources that have the most access to media also actively feed information to media to influence the coverage of issues of social importance and shape public perceptions (Boehmer, Carpenter, & Fico, 2018). *Sources* here refer to people or organizations that provide information to media on the events or issues that journalists cover, including sources from government, organizations, and other social institutions (Shoemaker & Reese, 1996). Nisbet and Lewenstein (2002) show that government officials, industry members, and scientists have been dominant sources in U.S. media coverage of biotechnology. In the coverage of GM food, various actors are willing to provide information to media and voice their views. These actors use media to address issues of social importance with their embedded interest.

Agency–structure theory helps explain the role of news sources as social actors and how they shape news coverage based on their social roles and interests. *Agency* generally refers to micro-level individual human actors, but it can also refer to collections of human actors. *Structure* usually refers to large-scale social establishments—systems of socioeconomic stratification (e.g., the class structure that includes social institutions) or other patterned relationships among large social groups (Ritzer & Goodman, 2008) and the rules and resources recursively implicated in the reproduction of social systems (Giddens, 1984, p. 377). Structure, the rules and resources of the social system, can restrain agency, the social actors. But because structure relies on human actors to operate, the activities of an agency can change the structure in return. The actors perform rationally in a structure to advance their own interests (Hindess, 1989).

The production and consumption of GM food are activities within a social system that are governed by the rules and resources of the structure. The actors in the process—government officials, scientists, environmentalists, consumers, interest groups, and business people from industry—compete through media coverage as news sources. The controversy regarding GM food is actually a risk conflict among different social groups with competing interests (Maeseele, 2010).

Interest in this study refers to the gain or loss concerning financial or social aspects that a group of people might realize or immediately receive with the production and consumption of GM food. The level of embeddedness and tangibility of interest could be used to categorize two groups of sources: interested sources and disinterested sources. The groups that gain direct financial benefit or suffer an immediate loss from production and consumption of GM food are considered interested sources, and the groups that are not associated with direct financial gain or immediate loss are categorized as disinterested sources. By providing information to media as news sources, these actors try to advance their own interests in the process (Priest, 2001). In reality, some of these actors may have multifaceted stakes in the production and consumption of GM food and could cross the line that defines interest. For example, government officials and experts are neutral at the beginning of understanding and exploring the issue complexity associated with GM food. Government officials are concerned with the health or environmental effect from the

production and consumption of GM food and they make decisions based on scientific evidence. Although government officials are not connected to financial gain or other tangible loss, their work to ensure public safety could earn them public trust. Therefore, they could be categorized as low-interest sources. Some scientists work for the multinational corporations that are the major sources of transgenic seeds or have their GM food projects funded by corporations (Saunders, 2009). Other scientists advocate the use of GM food as good for the long-term benefit of the Earth. Despite their potential duel status, scientists are categorized as disinterested sources because most of them have no direct commercial gain and they are the most trusted evaluators of GM food (Lang & Hallman, 2005). Business people may argue for the "double (or triple) bottom line" with respect to GM food: the social value to feed the poor and the environmental value to use fewer pesticides. But they eventually receive financial gain, and are categorized as high-interest sources. Consumers as end users of GM food have a high stake in its production and consumption. But because of their relatively weak social status compared with the sources from institutions and corporations, and their low knowledge about GM food, they do not present evidence-based information with a strong voice through media. They are therefore categorized as low-interest sources. Although the actors in various sectors do not have a monolithic interest when dealing with the production and consumption of GM food, the actors in a particular position usually have some key interests that motivate them to speak to journalists. For example, scientists provide insight views to evaluate GM food for the benefits of the public, business people speak to promote GM food for their commercial interest, and environmentalists and interest groups advocate a particular position.

Media, therefore, become a "battleground" of competing interests of major stakeholders (Augoustinos, Crabb, & Shepherd, 2010). Patterson and Eakins (1998) observed that media always present the results negotiated among different social forces. Sources provide information to the media to present their viewpoints reflecting their stakes; for example, disinterested sources who are not directly connected to commercial gain or loss from the production and consumption of GM food may be more concerned with public interest, such as the effect of GM food on public health, whereas sources associated with commercial gain are more likely to emphasize the benefits brought by GM food. In this way, sources with different embedded interests can influence key aspects of the coverage, such as news frame and risk delineation of the coverage, which may affect audiences' understanding and interpretation of issues and events.

Frames, Risk Delineation, and Balance in the Coverage of GM Food

Media coverage of science, health, and risk-related issues has been studied using frame analysis. *News frame* is the perspective from which a story is presented, which may change the viewer's understanding or interpretation of events and/or evoke emotions (Entman, 1993, p. 52). When it comes to hazard-related events, how risks are framed can lead to risk amplification or attenuation (Kasperson et al., 1988). It is a process of information altering when information is transmitted from an information source to a receiver through an intermediate station to result in amplifying or attenuating perceptions of risk (Frewer et al., 2002).

Using different approaches of frame analysis, scholars have investigated how media cover agricultural biotechnology (Priest, 2001; Vicsek, 2013). U.S. media have changed from being positive to skeptical about risk events after 1996 with the commercial introduction of GM food (Priest, 2001). The UK

press framed agricultural biotechnology as controversial, more risky, and less beneficial than other applications of the technology in the 1990s (Bauer, 2002). Scholars also have found that the coverage frame of agricultural biotechnology shifted from the debate on the effect of GM food on human health to the labeling of GM food products in the late 1990s as the environmental and health safety controversies arose (Augoustinos et al., 2010; Flipse & Osseweijer, 2013). Botelho and Kurtz (2008) classify media coverage of GM food into 11 frames, including economic implications, globalization, and public opinion. Media frames identified from the coverage of biotechnology are related to environmental impacts, consumers' right to know, institutional influence, and various ethical issues (Kalaitzandonakes, Marks, & Vickner, 2004; Murphy & Vilceanu, 2005).

These frame analyses of media coverage of GM food or biotechnology often ended up with some self-defined frames (Murphy & Vilceanu, 2005). For this study, we identified four frames based on the nature of GM food and its implication to the public: (1) public concern, (2) public confidence, (3) risk, and (4) benefit. These frames fit into two dimensions: public interest and product attribute. The public interest frame refers to the story angle from which the well-being of the general public is emphasized. Public interest has been used as a guide to assess the performance of media and the efforts that the media make to advance the interest of the broader public (McQuail, 1992). The product attribute frame is identified as a material orientation of reporting GM food in contrast to the ethical perspective of public interest. News accounts are often constructed in ways that prioritize certain aspects over others. Shifts between news frames (e.g., ethical vs. material) have been found to influence the process and outcome of social judgments (Iyengar, 1991). The product attribute frame refers to the story angle from which special features regarding GM food are highlighted, such as rarity, exceptional nature, or recency. The public interest frame differs from the product attribute frame in that the former has a unique consumer orientation and concerns consumers' immediate and long-term well-being, and the latter focuses on the nature and properties of GM food. For example, an article titled "As Biotech Crops Multiply, Consumers Get Little Choice" is categorized as public concern: a public interest frame. The article "Genes from Engineered Grass Spread for Miles, Study Finds" highlights the unique features and the risk of genetic engineering: a product attribute frame. We expected that the public interest frame and the product attribute frame would vary in their association with the primary interests of the stories' sources.

As research has shown that the coverage of risk-related events focuses more on rarity, exceptional nature, and recency associated with a hazardous event (Spencer & Triche, 1994), we expected that the coverage of GM food by U.S. newspapers would focus more on product attribute than public interest. The coverage was divided into two time periods in this study: 1994–2004 and 2005–2015. The year 2004 was considered a cut-off line because much of processed foods on American shelves contained GM crop ingredients and GM food became regular products in the market in 2004 (Hallman et al., 2004). We therefore proposed the following hypothesis:

H1:   *Newspaper coverage of GM food presents more stories from the product attribute frame than from the public interest frame during (a) 1994–2004 and (b) 2005–2015.*

Social actors bear different interests when they provide information to the media. Disinterested sources such as experts who are not directly connected to commercial gain or loss from the production and

consumption of GM food may be more concerned with public interest, whereas sources associated with commercial gain (e.g., businesses) are more likely to emphasize the benefits brought by GM food. The following hypothesis was thus proposed:

H2:   *Disinterested sources are associated with stories framed with public interest more than interested sources that have embedded interest in the production and consumption of GM food.*

Media coverage of science, health, and risk-related issues has always been a concern. Wakefield and Elliott (2003) found that coverage of risk-related issues is selective and that newspapers are inconsistent in risk communication. How risks are delineated in the coverage not only shows whether the newspapers provide consistent and accurate coverage of risk-related issues, but also reveals how the social actors involved in a story interact with the rules of social systems. If sources in the story have an interest in commercial gain from producing and consuming GM food, the information provided by the sources may be associated with less delineation of risk than if the sources have no interest in gain or loss from producing and consuming GM food. Disinterested sources such as scientists would be associated with more risk delineation in stories than business people, the interested source who stands to gain. But compared with the interested sources who have concerns about the production and consumption of GM food, scientists would present information based on scientific evaluation, and be associated with less risk delineation in stories than environmentalists and interest groups, which have a high stake and are more concerned about the risks in the production and consumption of GM food. We therefore proposed the following hypotheses:

H3:   *Interested sources that stand to gain from the production and consumption of GM food are associated with less risk delineation in stories than are disinterested sources.*

H4:   *Interested sources that have concerns about the production and consumption of GM food are associated with more risk delineation than are disinterested sources.*

The quotes from sources with different interests could also be associated with whether a story is slanted to one side with regard to approving or disapproving of GM food. Such slanting results in one side of a story receiving more attention and produces media bias (Baron, 2004). Bias can occur from news producers (Bovitz, Druckman, & Lupia, 2002), information sources with power and knowledge (Baron, 2005), and media's response to consumer preferences (Mullainathan & Shleifer, 2005). Baron (2004) links story bias to balance. Story bias could appear as the imbalance between pro and con arguments presented in news. Fico and Soffin (1995) measured story balance with pro and con arguments when covering controversies. In the coverage of GM food, the interested sources that are either powerful industry giants or interest groups try to advance their interest vigorously and advocate their views through media coverage. When presenting information and views on GM food, disinterested sources, which tend to view issues objectively, are expected to present a more balanced view in the coverage of GM food than are interested sources. The following hypothesis was thus proposed:

H5:   *Disinterested sources are associated with a more balanced view than are interested sources in the coverage of GM food.*

Method

This study employed a content analysis to examine U.S. newspapers' coverage of GM food from 1994 to 2015. Because GM food is a specialized area that only a few newspapers cover regularly, we focused on the coverage by major U.S. newspapers. The data for analysis were collected in two phases because of the extended time frame of the study and coder availability at the different stages of the study. Phase 1 of data collection was completed in 2005 with stories from 1994 to 2004. Phase 2 of data collection was completed in 2016 with stories from 2005 to 2015.

The news coverage of 10 major U.S. newspapers was initially selected for content analysis. Among the 10 newspapers, *The New York Times* and *The Washington Post* were considered elite newspapers that set the agenda for other newspapers and influence policymaking on biotechnology (Nisbet & Huge, 2006; Nisbet & Lewenstein, 2002; Yue & Weaver, 2007). The other newspapers selected were *USA Today*, *The Boston Globe*, *The Houston Chronicle*, *The Chicago Sun-Times*, *The Atlanta Journal-Constitution*, *The San Francisco Chronicle*, *The (Minneapolis) Star Tribune*, and *The Denver Post*. The 10 newspapers are among the major metropolitan newspapers and are relatively evenly distributed in the United States. Nine of them were among the top 20 U.S. newspapers in 2006 except *The Denver Post*, which was ranked 25 (Alliance for Audited Media, 2006). These newspapers were more likely to have the resources to cover the risk-related topic. They were among the U.S. newspapers that carried the largest number of stories about GM food during 1994–2004.

The data collected from 1994 to 2004 reflect the coverage of GM food since it entered the U.S. market and gradually became widely adopted (Botelho & Kurtz, 2008; Nucci & Kubey, 2007). GM food started to show potential as a mass product around 1994. By 2004, 60% to 70% of processed foods in American market were produced with ingredients from GM crops and GM food became widely available in the market (Hallman et al., 2004). After checking the terms used to refer to GM food through preliminary database searches in several newspapers, we found that *genetically modified food* was the most used term along with two other often used terms *genetically engineered food* and *genetically altered food*. The three terms were then used as the keywords to identify news stories of GM food. The news stories by the 10 newspapers during the 11-year period were acquired through a LexisNexis database search. The unit of analysis was a complete story, defined as an article that addressed primarily news events, issues, and other occurrences regarding GM food, excluding editorials or opinions. The stories selected were staff written and did not include those from news wires because news wires serve media subscribers and their stories appear on media only if news editors select them, which is the premise of media's social influence. In total, 842 news stories about GM food published from January 1, 1994 to December 31, 2004 were identified from the 10 newspapers, including 200 stories from *The New York Times*, 109 from *The Washington Post*, 60 from *USA Today*, 76 from *The Boston Globe*, 66 from *The Houston Chronicle*, 95 from *The Chicago Sun-Times*, 47 from *The Atlanta Journal-Constitution*, 75 from *The San Francisco Chronicle*, 87 from *The (Minneapolis) Star Tribune*, and 27 from *The Denver Post*.

Phase 2 of data collection was completed in 2016. Phase 2 differed from Phase 1 in social environment in several aspects: (1) Production of GM food increased significantly; (2) consumption of GM food became widespread; and (3) the debate on the effect of GM food on human health continued, but the focus shifted,

extending to issues such as the labeling of GM food products (Augoustinos et al., 2010; Flipse & Osseweijer, 2013). Following the same procedure to identify stories, we attempted to find all stories covering GM food from 2005 to 2015 from the 10 newspapers for Phase 2. The database Factiva was used to retrieve news stories because of the availability of the data source at the time of data collection. Only seven of the 10 newspapers on which the data were collected in Phase 1 were available in the database. Keywords used to search for articles were refined and *gene-modified*, *GM food*, and *GMO* were used in addition to the original search terms. After excluding wired news, editorials, and opinions, 436 news stories about genetically modified food were identified from January 1, 2005 to December 31, 2015 from seven U.S. newspapers. Among those stories, 205 were from *The New York Times*, 105 from *The Washington Post*, 28 from *USA Today*, 27 from *The Boston Globe*, 12 from *The Atlanta Journal-Constitution*, 13 from *The San Francisco Chronicle*, and 46 from *The (Minneapolis) Star Tribune*. No articles were retrieved from *The Houston Chronicle*, *The Chicago Sun-Times*, and *The Denver Post*. The scale of coverage remained the same for *The New York Times* and *The Washington Post*, whereas the coverage of the other five newspapers significantly shrank during the period 2005–2015. With the data from seven of the original 10 newspapers collected in Phase 2, a full picture of the coverage of GM food by U.S. newspapers is somewhat compromised. However, because the major newspapers of the original 10 newspapers and those from the four major U.S. media markets remained, the general trend of the coverage of GM food by U.S. newspapers was not considerably distorted. The LexisNexis database was used later to double-check the result of the Phase 2 data collection. No difference in the number of stories was found between the results retrieved from the Factiva and LexisNexis databases.

Measurement of Key Variables

News Frame

This study adapted the frame measures from studies related to media framing of GM food (Maeseele, 2010; Vicsek, 2013), risk-related issues (Culley, Ogley-Oliver, Carton, & Street, 2010; Jullien, 2016), and public interest (Newman & Nisbet, 2015). Five categories of coverage frames were identified for analyzing the coverage: (1) risk, danger, and hazard involved in producing and consuming GM food (e.g., "Genes From Engineered Grass Spread for Miles, Study Finds"); (2) benefit, advantages, and gains associated with producing and consuming GM food (e.g., "U.N. Unit Sees Great Promise in Biotech Research on Crops"); both risk and benefit frames emphasize the properties of the product more from a scientific and technological perspective, not the risk or benefit to the general public; (3) public concern, expression on matters regarding the well-being of the public with regard to producing and consuming GM food (e.g., "California County Debates Use of Gene-Altered Foods"); (4) public confidence, positive belief, and reassurance of the public about producing and consuming GM food (e.g., "Facing Biotech Foods Without the Fear Factor"); and (5) other: all other framing aspects not fitting the above categories. One frame was selected for a story identified in the headline or the lead. If the story angle could not be identified from the headline or the lead, the rest of the story was consulted until the attribute of the story was identified. If a story dealt with more than one frame, such as both risk and public concern, the story angle prominent in the headline or the lead was selected as the frame of the story. If a unique frame could not be identified, such as a story dealing with both risk and benefit, the "other" category was selected.

The four main categories of the coverage frames were classified into two dimensions: (1) public interest and (2) product attribute. The public interest frame contained stories framed as public concern and public confidence. The product attribute frame included stories dealing with risks and benefits of producing and consuming GM food without a public and societal perspective.

Risk Delineation

Risk delineation refers to the intensity that a story concerns the risks involved in producing and consuming GM food. This study measured risk delineation with the amount of risk-related information expressed in a news story. Risk is normally measured with indicators associated with an event or an object. No established measure was found to measure the amount of risk expressed in messages. The key indicator of risk in a message is the words associated with risk. To reach acceptable intercoder reliability, this study measured risk delineation in three categories: (1) high, when risks were mentioned or discussed in three or more paragraphs; (2) low, when risks were mentioned or discussed in one to two paragraphs; and (3) none, when there was no mention or discussion of risks. The three categories were identified with clear distinction for easy coding and the attainment of the acceptable reliability.

Story Balance

Story balance refers to the degree that a story was slanted to one side with regard to approving or disapproving of GM food based on the sources quoted in a story. The measure of story balance was adapted from Fico and Sofin (1995) by identifying the presence of statements in three categories: (1) pro argument (advocating or approving), (2) con argument (opposing or disapproving), and (3) none (no pros or cons were presented).

Source

A source was defined as a person or an organization associated with direct or indirect quotes in a story. The types of sources coded were government officials, experts (scientists, medical professionals, and other experts in the field), environmentalists, consumers (end users of GM food), interest groups (groups that advocate interests relating to production and consumption of GM food), businesses (sources from industry), and others (sources that do not belong to any of the above categories).

Sources were further categorized based on source interest, which refers to the degree to which a source was connected to direct or indirect gain or loss with regard to the production and consumption of GM food. Three levels of source interest were identified: (1) Experts, such as scientists, who were not directly connected to commercial gain from producing and consuming GM food were categorized as disinterested sources; (2) business, environmentalists, and interest groups directly involved in either commercial gain or potential health or environmental loss from the production and consumption of GM food were categorized as high-interest sources; and (3) government officials not directly connected to commercial gain but needed to evaluate GM food and make policy decisions were categorized as low-interest sources; consumers who were not associated with immediate commercial gain or loss and less likely to voice their views in the news coverage were also categorized as low-interest sources.

For the data collected from stories published from 1994 to 2004, seven groups of three coders were trained in one session using a unified coding protocol and by following the procedures of content analysis (Riffe, Lacy, & Fico, 2005). Ten percent of the stories were selected for an intercoder reliability test. Scott's pi was used to test the intercoder reliability of nominal variables. The intercoder reliability was tested first among the individuals in a group, and then among the groups of coders. The intercoder reliability test results were: story slug = .94, coverage frame = .86, risk delineation = .84, story balance = .80, and source = .92. A minimum level of 80% agreement was considered acceptable (Riffe et al., 2005).

For the data collected from stories published from 2005 to 2015, two coders were trained using the same coding protocol and went through the intercoder reliability test with 10% of the news articles. The intercoder reliability test results were: story slug = .92, coverage frame = .90, risk delineation = .88, story balance = .81, and source = .85.

All news stories published by the selected newspapers during the study period were included in the analysis. Although the stories under analysis did not contain all stories on GM food published by U.S. newspapers, they did compose all stories from the selected newspapers. The study is therefore considered a census of the news stories published by the selected newspapers during the specified period. The results present a general picture of how the selected U.S. newspapers covered GM food.

Results

There were 842 news stories published by the 10 newspapers during 1994–2004, an average of 78 stories a year. In these stories, experts (42.4%) and government officials (41.3%) were the dominant sources in the coverage of GM food, followed by business sources (29.2%). About one fourth of the stories contained interest-group sources (24%). Environmentalists (15.4%) and consumers (15.8%) were the least-quoted sources in the coverage.

There were 436 news stories published by the seven newspapers during 2005–2015. In these stories, business sources (49.3%) were quoted more than experts (44%) and government officials (40.4%), followed by interest group sources (35.1%). Consumers (22.0%) and environmentalists (13.3%) were the least-quoted sources in the coverage (see Figure 1).
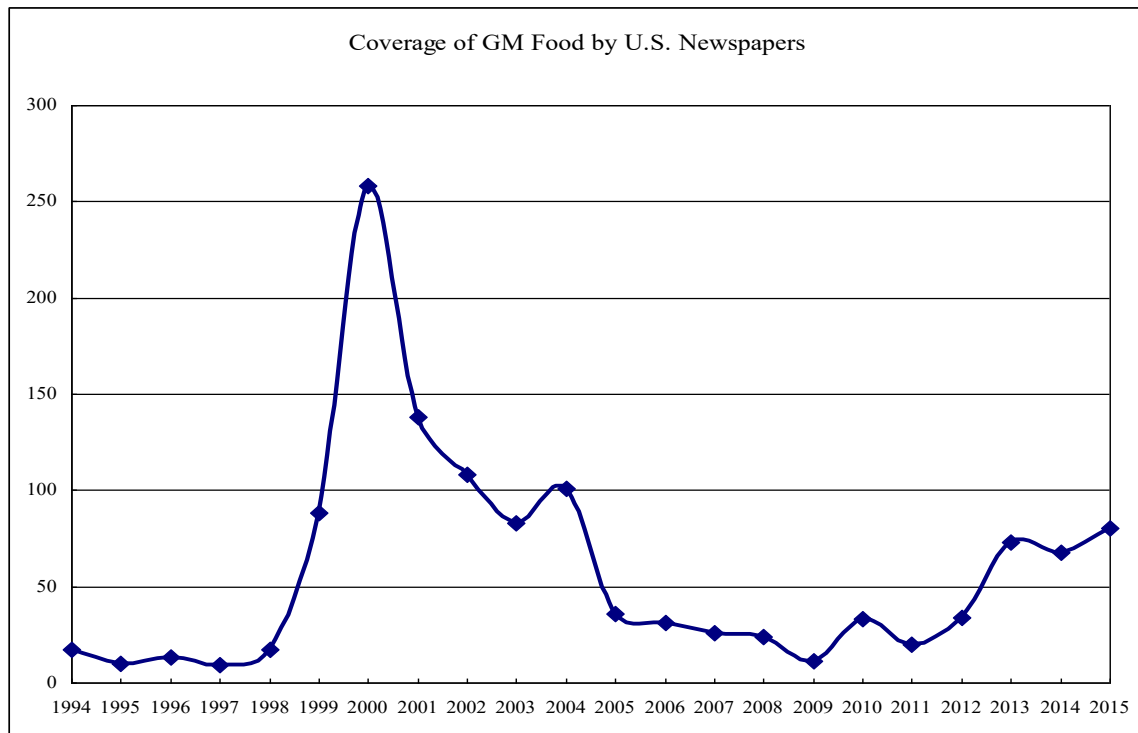
Figure 1. Coverage of genetically modified (GM) food by U.S. newspapers during 1994–2015.

One of the important patterns in the coverage was the change in coverage frames from 1994 to 2015. The volume of coverage of GM food by the U.S. newspapers from 1994 to 1998 was relatively low, and there was almost no variation among the four frames. However, newspaper coverage of GM food rose sharply in 1999 and peaked in 2000, when public concern became the dominant frame and benefit of GM food the least noticeable frame. After 2002, the newspapers' coverage of GM food continued to decline and reached the bottom in 2009. The coverage was in a rising trend after 2009, but at a relatively low level. All frames were low except public concern, which rose considerably after 2011 (see Figure 2).
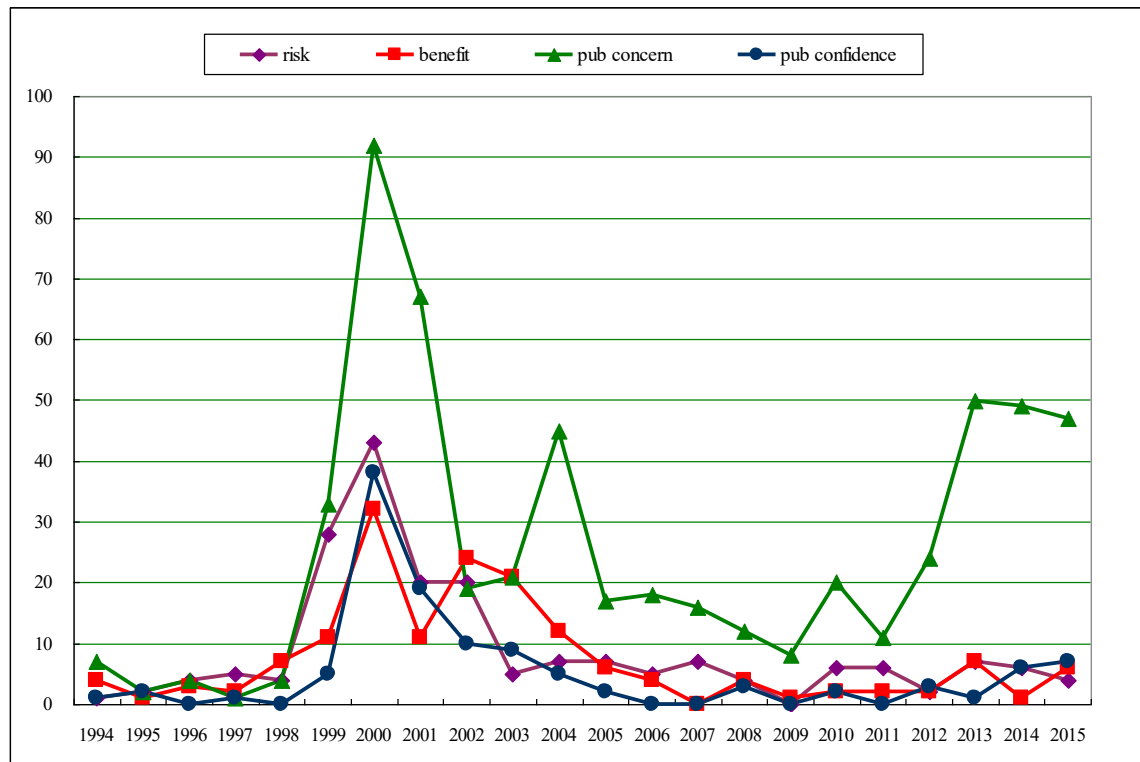
Figure 2. Changes of coverage frames of genetically modified food by U.S. newspapers during 1994–2015.

Crosstab was used to test all hypotheses except Hypothesis 1. A chi-square test to show statistical significance is usually applied to crosstab. In this study, news source was measured as a binary variable, and a story could contain information from multiple sources. Running a chi-square test across sources measured as binary variables will not produce highly lucid results. Besides, this study was a census based on all news stories published by the selected newspapers from 1994 to 2015, and the study did not attempt to project the news coverage of all major U.S. newspapers. Therefore, the differences between the percentages observed shown in the findings were the actual differences in the specified population, and no inferential statistics are needed.

Hypothesis 1, which predicted that the newspaper coverage of GM food would present stories more from the product attribute frame than from the public interest frame during (a) 1994–2004 and (b) 2005–2015, was not supported. During 1994–2004, the coverage was dominated by stories with a public concern frame (35.0%), and the public confidence frame was identified in 10.7% of the stories; therefore, the public interest frame appeared in 45.7% of the stories. A risk frame was identified in 16.5% of the stories and a benefit frame in 15.2%; therefore, the product attribute frame appeared in 31.7% of the stories. During 2005–2015, the public concern frame (62.4%) and public confidence frame (5.5%) combined so that the

public interest frame appeared in 67.9% of the stories. A risk frame was identified in 12.4% of the stories and a benefit frame in 8.0%. The product attribute frame appeared in 20.4% of the stories (see Figure 3).
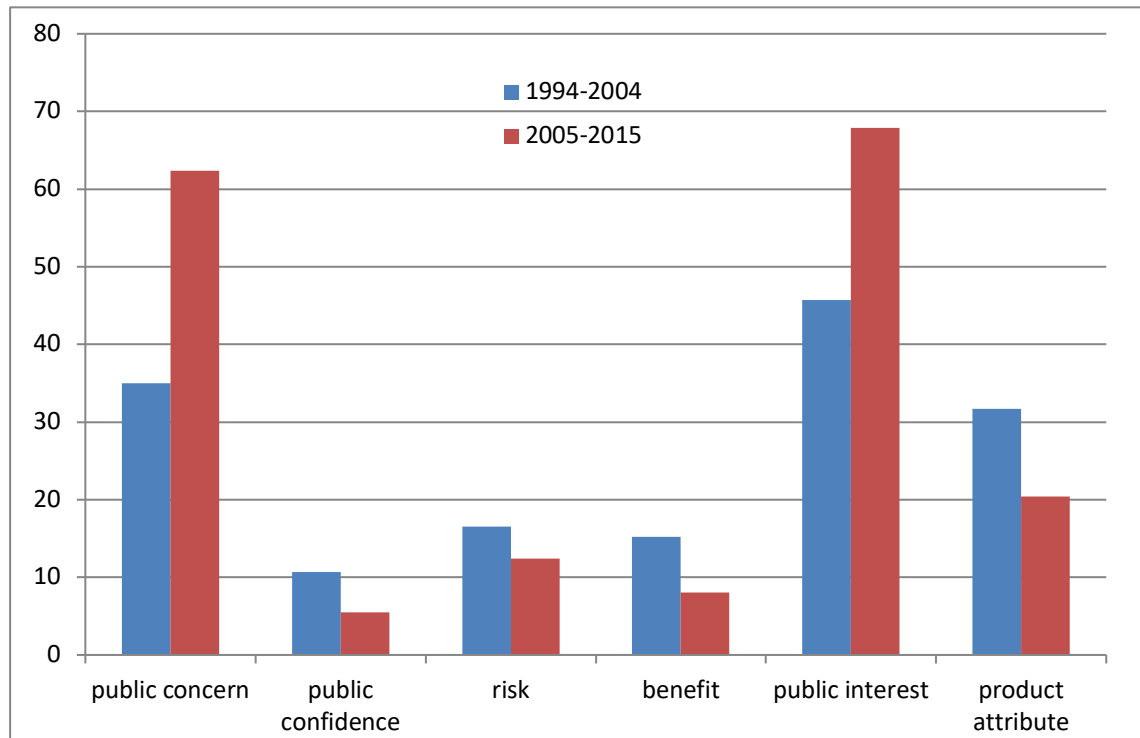

Figure 3. Comparison of coverage frames of genetically modified food by U.S. newspapers during 1994–2015.

Hypothesis 2, which predicted that disinterested sources would be associated with stories framed with public interest more than interested sources with embedded interest in the production and consumption of GM food, was partially supported. We tested the hypothesis by comparing the percentages of frames associated with related sources. Experts, the disinterested source, were associated with 21.7% of the public interest frames, whereas environmentalists (7.2%) and interest groups (15.5%) were associated with fewer public interest frames than the disinterested source experts, which supported the hypothesis. However, business sources (22.5%) with high embedded interest were associated with the public interest frame at a level similar to that of experts (see Table 1).

Table 1. Percentages of News Frames Associated With Sources (N = 1,278).

Source	News frame					Frame dimension	
	Public concern	Public confidence	Risk	Benefit	Other	Public interest	Product attribute
Businesses[a]	20.3	2.2	3.8	3.4	6.3	22.5	7.2
Consumers[b]	8.2	1.0	3.3	1.9	3.5	9.2	5.2
Environmentalists[a]	6.2	1.0	3.0	1.6	3.0	7.2	4.6
Experts[c]	18.2	3.5	6.7	6.7	7.9	21.7	13.4
Government officials[b]	20.5	3.8	4.9	3.6	8.2	24.3	8.5
Interest groups[a]	14.4	1.2	4.5	3.0	4.8	15.6	7.5
Other sources	8.0	1.5	2.6	2.0	6.3	9.5	4.6

[a] High-interest source. [b] Low-interest source. [c] Disinterested source.

Hypothesis 3, which predicted that interested sources that stand to gain from the production and consumption of GM food would be associated with less risk delineation in stories than are disinterested sources, was supported. Business, a high-interest source that stands to gain from the production and consumption of GM food, was associated with some degree of risk delineation (high = 4.6%, low = 17.4%, total = 22.0%); experts, the disinterested source, were associated with a higher level of risk delineation (high = 7.8%, low = 21.3%, total = 29.1%) than business sources.

Hypothesis 4, which predicted that interested sources with concerns about the production and consumption of GM food would be associated with more risk delineation than disinterested sources, was not supported. Environmentalists and interest groups are high-interest sources with concerns about the production and consumption of GM food. Environmentalists were associated with 11.5% (high = 3.8%, low = 7.7%) of risk delineation, whereas interest groups were associated with 18.8% (high = 5.4%, low = 13.4%). Experts, the disinterested source, were associated with 29.1% (high = 7.8%, low = 21.3%) of risk delineation, a relatively high level; government officials, who might be indirectly connected to health or environmental loss from the production and consumption of GM food, were associated with 26.7% (high = 8.9%, low = 17.8%) of risk delineation. Businesses, the interested sources that gain from the production and consumption of GM food, were associated with 22.0% (high = 4.6%, low = 17.4%) of risk delineation, a medium level. Consumer sources, a low-interest source, were associated with 12.3% (high = 3.8%, low = 8.5%) of risk delineation, a relatively low level.

Hypothesis 5, which predicted that disinterested sources would be associated with a more balanced view than interested sources in the coverage of GM food, was not supported. When disinterested source experts were quoted, the stories presented a relatively similar amount of pro (23.6%) and con (20.5%) arguments. Among the interested sources, the stories that quoted business people presented a similar level of pro (18.3%) and con (17.5%) arguments, whereas environmentalists (19.3% pro vs. 19.2% con) and interest groups (15.6% pro vs. 16.3% con) presented no variant level of pro and con arguments. Consumers as low-interest sources (9.5% pro vs. 9.8% con) were associated with the stories presenting the same level of pro and con arguments. Although the actual level of pro and con arguments presented in stories varied by sources, both disinterested sources and interested sources were associated with stories that presented

relatively equal amounts of pro and con arguments. Experts were the sources associated with stories that presented noticeably more pro arguments (23.6%) than con arguments (20.5%), but the difference was not substantial (see Table 2).

Table 2. Percentages of Risk Delineation and Balance Associated With Sources (N = 1,278).

Source	Risk delineation			Balance	
	High	Low	None	Pro	Con
Businesses[a]	4.6	17.4	14.1	18.3	17.5
Consumers[b]	3.8	8.5	5.6	9.5	9.8
Environmentalists[a]	3.8	7.7	3.2	9.0	9.1
Experts[c]	7.8	21.3	13.8	23.6	20.5
Government officials[b]	8.9	17.8	14.3	19.3	19.2
Interest groups[a]	5.4	13.4	9.0	15.6	16.3
Other sources	3.4	8.3	8.7	7.9	7.7

[a] High-interest source. [b] Low-interest source. [c] Disinterested source.

Discussion

This study examined source use in the coverage of GM food from the agency–structure perspective. The analysis of source use as social actors provides a novel perspective on the effect of information source on news coverage of socially important issues and offers an enlightening explanation on source use as an influential factor in the coverage of GM food and the relationship between source use and the key aspect of the coverage of GM food.

The study found that sources' interests play an important role in shaping news coverage. The disinterested sources differed from the interested sources in their association with the coverage frames and risk delineation. Although experts and government sources were both dominant sources in the coverage, these two leading sources played different roles in framing the news coverage because of their primary interests: Expert sources were more associated with product attribute frames, whereas government officials were more associated with public interest frames. Their social roles and interests defined their undertakings when working with the media. Previous studies suggest that source use influences coverage frame (Carpenter, 2007). This study goes one step further to explore the effect of source interest on news frames. Our findings, then, suggest that sources do not influence news coverage only through their power status, but also via information reflecting their special interests. That is, the embedded interests of sources lead to variation in the association between the quoted source and the major aspects of the coverage. The findings of this study partially support the agency–structure theory through media coverage of GM food influenced by various agencies.

This study examined the news frames from two dimensions: the public interest frame and the product attribute frame. The findings for Hypothesis 1 did not support the notion of weighted product attribute in the coverage of GM food because public concern, the frame reflecting the public interest, dominated the coverage of GM food. This finding can be explained by the nature of the topic. The production and consumption of GM food are risk-related issues of social importance and public interest as well.

Presenting public concern as a dominant frame allows newspapers to produce informative stories with social significance that have far more influence than coverage based on a product attribute frame.

The finding for Hypothesis 2 revealed that news sources differ in their association with the public interest frame and product attribute frame. Experts were among the sources associated with the highest percentage of public interest frames, but they also accounted for the highest percentage of product attribute frame because they are knowledgeable about GM food and are drawn on as sources most often. It seems surprising that business sources are associated with more public interest frames than product attribute frames compared with other interested sources. But if we take into account that many stories about GM food originated from public information officers in the industry, the public interest emphasis by business sources could be part of the companies' efforts to build their public image and ethical identity. The finding is consistent with the notion of corporate social responsibility that helps firms develop a positive public image and ethical identities with key stakeholders of the firm such as customers and investors (Castaldo, Perrini, Misani, & Tencati, 2009; Fukukawa, Balmer, & Gray, 2007). When business sources talk about public interest, their corporate responsibility rhetoric serves their ultimate goal of promoting GM food.

Our findings did not support the notion that interested sources that have concerns about the production and consumption of GM food would be associated with more risk delineation than disinterested sources (H4). The result could be explained by the knowledge level of the two parties. Whereas interested sources such as environmentalists and interest groups tend to delineate risks to advance their stake, the experts, the disinterested sources, have a higher level of knowledge and are more capable of delineating risks. Our findings for Hypothesis 5 showed that the sources varied in their pro and con arguments, but all sources were associated with a relatively balanced view. The finding could be due to journalists' sensitivity when reporting about GM food, a topic that concerns the interests of the broader public. When dealing with an issue concerning high-stakes issues for the audience, newspapers attached to a community cannot take reporting about GM food lightly. They have to process information from sources carefully and present a balanced view in their coverage of a controversy.

This study answers important questions regarding the effect of source interests on news coverage. Nonetheless, it has several limitations. The first is the reduction in number of newspapers in Phase 2 of data collection because of the availability of newspaper content. The missing information from three newspapers did not allow us to present a full picture of the coverage. Second, we did not look into the substances of the key issues in public concern that may have caused crescendos in the coverage, nor did we assess story quality (e.g., presence of facts, accuracy of reports, credibility of interpretations), which may have had an impact on public perceptions of risk and source credibility. Third, the study showed that news source was an influential factor in shaping different aspects of the coverage, but it did not investigate possible influences from other external factors, such as market development of GM food and public attention to GM food. The findings of the study are confined only to the first portion of the formal framing theory, which posits that journalistic routines, information sources, and media protocols, among other factors, have a bearing on media frames. Content analysis could not capture audience effects. Future studies could use survey to look at important external factors and find what roles they play in the newspaper coverage of issues of public interest and social importance with regard to GM food. From the content side, further research could examine the relationship between source use and the key aspects of the coverage in association with the related social events and

continue to explore the relationship among internal variables, such as how health- and risk-related information intertwines with journalists' awareness of the need to address issues of public interest and social importance.

Conclusion

Agency–structure theory helps define news sources in a new light by considering sources not just as social forces that hold power, but also as social actors who actively promote their interests through news coverage. When the social actors are quoted, their embedded interests become the key factor in leading the direction of the coverage and influencing the key aspects of the news coverage. The findings of this study partially confirm the role of sources as social actors in advancing their interests. This study helps clarify how U.S. newspapers treat an issue of public interest that involves science, risks, and public health, and opens a new route to the study of news sources from the perspective of agency–structure theory. News sources as social actors are restrained by the structure of social systems, but they constantly adapt their actions based on the changes in social systems to advance their interests through providing information to media as news sources and to fulfill their goals of changing the rules to their own benefit.

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