



Media Coverage, Public Perceptions, and Consumer Behavior: Insights from New Food Technologies

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Abstract

The media often play the role of translating new science to consumers. We discuss the recent literature that has examined the supply and demand factors that affect media coverage of new food technologies and the impact on public perceptions and consumer behavior toward food that utilizes these technologies. We start with a discussion of the ways in which the media influence public perceptions and consumer behavior related to foods made with new technologies. We then discuss the incentives of news media and the potential sources of biases in their reporting. We review empirical studies that have examined media reporting of new agricultural and food technologies, especially biotechnology, in terms of both their agenda setting and framing effects and the social amplification of risk. We synthesize the findings of studies that have examined the influence of media coverage on public attitudes and consumer behavior. We conclude and discuss avenues for future research.

Not that the media lie about the news they report; in fact, they have incentives not to lie. Instead, there [are] selection, slanting, decisions as to how much or how little prominence to give a particular news item. (Posner 2005)

1. INTRODUCTION

Consumers are inundated with information about food through a myriad of media access points from cell phones to traditional television and newspapers. Still, the public is said to be poorly informed when its consumption declines in opposition to new food technologies, despite claims by scientists and officials that such new technologies are safe. Lusk (2015) points out the divergence in risk perceptions between the scientific community and the general public with results from his food demand survey. He found that a large majority (82%) support mandatory labels on genetically modified organisms (GMOs) but that curiously approximately the same proportion (80%) also support mandatory labels on foods containing deoxyribonucleic acid (DNA). Indeed, the media and the information they provide are often blamed for the sometimes irrational and disproportional consumer response to new technology. A concern is that information provided by the media may not be objective or may not foster the public good.

The media often play the role of translating new science to consumers. The information is provided by either privately or publicly owned media that may have incentives to slant the information they provide in particular ways. Who owns the news media appears to matter. Privately owned media have become increasingly important globally. Whereas in the United States news coverage has always been largely commercial, in Europe private companies have become the dominant source of information only over the last two decades. Also, in other regions of the world, there is significant growth in private and commercial media, but state ownership of media is still more important in low-income countries. The structure of the private media market has also changed with the growth of 24-h news media, pay per view, satellite, cable, websites, and Internet blogs.

Commercial mass media have thus had an increasingly important influence on public opinion. Extensive media coverage affects consumer perceptions of products and risk and consequently consumer demand for goods and services. Yet the media are also criticized for being sensationalistic and biased in their reporting, focusing on sound bites and ignoring careful analyses. There is also concern that the increased commercialization of the media has produced a dumbing down of the news because this trend is leading to decreased quality and quantity of coverage of complex issues and because competitive pressures are associated with cutbacks in reporting and editorial quality (Alterman 2008). The emergence of the 24-h news cycle may have actually weakened journalism, and news reports include an increasing number of factual errors (Pew 2004).

These concerns have induced many European governments to continue to subsidize public news broadcasting to improve the overall news quality. However, it is not clear that public news is always unbiased or of higher quality. Furthermore, if subsidized public media offer higher-quality news, this may result in low-quality commercial news filling the leftover niche (Canoy & Nahuis 2005). This argument is similar to those in studies of the US media market, which show that the regional spread of so-called quality newspapers such as *The New York Times* and *The Washington Post* has induced a reduction in the quality of local and regional newspapers (George & Waldfogel 2006).

Although the literature on the (political) economics of the media is relatively recent, it is a burgeoning field, with applications in many areas, including political economy (impacts on electoral turnout and voting) and public goods provision (see, e.g., Della Vigna & Gentzkow 2010; Gentzkow & Shapiro 2008a,b; McCluskey & Swinnen 2011; and Prat & Strömberg 2011 for partial reviews). Similarly extensive is the literature on media coverage and its impacts on the

public. In this article, we review the literature that has examined the supply and demand factors that shape media coverage of new food technologies and the impact of such coverage on public perceptions and consumer behavior toward these technologies. This is an important area of focus because Hoban & Kendall (1993), Marks et al. (2003), and Wildavsky (1995) find that the vast majority of consumers receive information about food technologies primarily through the popular press and television and first encounter claims of harm to health and the environment through the media.

More than 100 published studies have empirically analyzed how various news media have covered agricultural biotechnology and genetically modified (GM) foods, the use of synthetic pesticides and growth hormones in agriculture, the use of nanotechnology in food processing, and other new food technologies. These studies have generally focused on the agenda setting and framing roles of news media and their impacts on public perceptions and attitudes. Studies on media coverage of GM foods exemplify the wide-ranging hypotheses tested and the rich data and analytical methods used, and, thus, we review the primary findings of these studies here.

We structure the rest of the study as follows. In Section 2, we discuss the ways news media coverage of new technologies in food and agriculture may influence public perceptions and consumer behavior related to foods made with new technologies. In Section 3, we discuss the incentives of news media and the potential sources of biases in their reporting. In Section 4, we review empirical studies that examine media reporting of new agricultural and food technologies, especially biotechnology, in terms of both their agenda setting and framing effects and the social amplification of risk. In Section 5, we synthesize the findings of studies that examine the influence of media coverage on public attitudes and consumer behavior. Finally, in Section 6, we conclude and discuss avenues for future research.

2. MEDIA AND CONTROVERSIES OVER FOOD TECHNOLOGIES

Use of new technologies in agriculture and food production has consistently led to increased productivity and food supplies, reduced food prices, enhanced food attributes, and entirely new products (Huffman & McCluskey 2014). Such new technologies include synthetic pesticides, growth hormones, biotechnologies, nanotechnologies, and various new processing techniques. Despite assurances from scientists, governments, and industry that new food technologies are safe, consumers have often been skeptical and even polemic. These negative consumer attitudes are sometimes blamed on consumers being poorly informed. However, consumers from highly educated and affluent segments are often the most guarded (Curtis et al. 2008). Indeed, many of these consumers choose to opt out of consuming foods produced with new technologies by buying organic and other foods, which are produced without biotechnology seeds, growth hormones, and synthetic pesticides (Loureiro et al. 2001). Such consumers generally do not fit the profile of uninformed consumers. Rather, they seem willing to pay a small share of their typically high income to avoid perceived risks associated with foods made with the use of new technologies.

The use of new technologies in agriculture and food production therefore seems increasingly dependent on consumers' risk perceptions. Although consumers may like the lower prices and the potential product-enhancing attributes of foods produced with new technologies, they may also be suspicious of such products when the underlying production processes and technologies seem risky to them (Annunziata & Vecchio 2011). A typical example of such behavior is the frequently displayed negative attitudes toward GM foods (Lusk et al. 2005). The scientific consensus is that first-generation GM foods are equivalent to their conventional counterparts. However, on average, consumers say that they want a discount to choose GM foods over conventional ones (Lusk et al. 2005). The consumer response in the market determines product success because, in the end,

consumers' perception of risk—rather than the perception of objective, technical risk—directly affects consumer choices and market demand.

What is behind the elevated perceived risks associated with new food technologies that consumers seem to display so readily? Lusk et al. (2014) primarily discuss how developments in the economic and socio-psychological literature shed light on consumer preferences for food technology and the determinants of food technology acceptance. Heiman & Zilberman (2011) find that both positive framing and negative framing affected the likelihood of purchasing GM products at a given price but that negative framing had a stronger impact in deterring consumers. Other commentators point the finger at the news media. For instance, Bauer & Gaskell (2002) suggest that negative consumer perceptions and attitudes toward biotechnology may have been cultivated by plentiful media coverage and unbalanced reporting of its relative risks and benefits. Lusk et al. (2014) briefly discuss the impact of media on consumers' risk perceptions. They explain that media can frame food technologies by emotionalizing an issue and increasing salience with repetitive messaging.

Because in many countries the news media serve as primary sources of risk communication for the general public (Boholm 1998), they may also define the agenda of public concern. This process of mediated public attention is known as agenda setting or sizing and highlights the role of the media in focusing the public's attention on one issue and not on another (Cohen 1963, McCombs & Shaw 1972). The main theoretical claim of the agenda setting hypothesis is that the degree of emphasis placed on selected issues by the news media adds salience to these issues: The greater the volume and prominence of media coverage are, the more important the public will judge the issues to be (Entman 1991, McCombs & Ghanem 2001).

In addition to setting the agenda, news media may also frame the discussion around it. Tuchman (1976, 1978) argues that through reporting on an issue, news media select few events out of many and turn them into newsworthy stories. In telling these stories, journalists use frames that are shaped by their viewpoints, experiences and skills, deadlines, media space, and other practical parameters (Hornig 1990). When writing about a new food technology, journalists may choose to emphasize technical features, socioeconomic implications, environmental risks or benefits, human health concerns, and so on (Hornig 1990). Through frames, therefore, news media may highlight certain points of view and marginalize others (Hornig 1993). When risks are emphasized relative to the benefits of a new technology, the theory predicts that a more negative public sentiment can prevail and that the news media can become a means for the social amplification of risk.

The agricultural and food industries have inherent incentives to defend their ability to use new technologies by providing their view of risks and benefits through information campaigns and education activities and by influencing the reports of the news media (Annunziata & Vecchio 2011). However, consumer confidence in information about food products made with new technologies may vary depending on the source (Annunziata & Vecchio 2011, Siró et al. 2008). Several studies indicate that consumers are more confident in information about the potential benefits of foods made with new technologies when it comes from trusted and credible authorities and that consumers are less confident in information provided by industry (Cox et al. 2008, Urala & Lahteenmaki 2007). Yet the difficulties of industry in achieving more positive communication about new food technologies may go beyond a trust deficit. News media have their own objectives and incentives that may lead to biased reports. For instance, the underlying science of new food technologies can be complicated, and the media need to sell stories.

Another key constraint is that, because there are diminishing returns to time spent processing information from media stories and there are increasing amounts of information, consumers may still be rationally ignorant in a world with plenty of information and media (McCluskey & Swinnen 2004)—and are hence less likely to spend the time to become well informed about the benefits of such new technologies. Kiesel et al. (2011) discuss that consumers may not use

nutritional labels because time and effort are required to process the information. The time required to process the information about the potential benefits and risks associated with new food technologies is likely greater than the time required to process information on nutrition labels, so we expect for most consumers to not be experts on new food technologies.

Furthermore, consumers give greater weight to negative information than to positive information. This is interesting because often-heard complaints are that news coverage is too negative and that there is not enough positive news in the stories that media produce. McCluskey et al. (2015) show that this generally recognized tendency of the popular news media is driven by demand. Thus, the news media may be more likely to highlight potential risks associated with new food technologies in their reporting. However, this tendency says little about the impact on perceptions or behavior of consumers. Consumers may realize the existence of bias and may thus discount the information provided by media. In the next sections, we first review potential sources of bias in the media and then review empirical studies that measure the impact of bias on consumers.

3. MEDIA BIAS AND FRAMING

Is the general emphasis of news media on the potential risks over the benefits of new food technologies a systematic bias, and if so, are there specific structural factors that drive this bias? Media bias can take various forms, and there is no generally accepted definition. Anand et al. (2007, p. 637) write, “The phenomenon of bias in the media appears to be quite different than, say, a statistician’s notion of bias—because bias lies in the eyes of the beholder (consumer).” Others define bias as the “absence of balance resulting in one side of a story receiving unwarranted attention” (Baron 2006, p. 4) or, in other words, as “sins of omission—cases where a journalist chose facts or stories that only one side of the . . . spectrum is likely to mention” (Groseclose & Milyo 2005, p. 1205).

Studies have identified several possible theoretical explanations for the existence of bias. Bias can be induced by supply and/or demand factors. On the supply side, it can be due to ideology or partisan politics, in which owners, editors, or journalists present stories that support particular world views. Bias can also result from falsehoods or from information hidden or distorted by sources or journalists eager for a scoop or under pressure to attract attention. Finally, bias can be a response to consumer preferences.

The most obvious source of bias is preferences from owners, editors, or journalists who may affect the news coverage (Bovitz et al. 2002). This bias is most evident in mass media owned by the state (e.g., North Korea) and is present in many developing countries where the state continues to control mass media. In those countries, the media are used by governments to disseminate the political communication of the ruling parties and to control information that may threaten their legitimacy or their hold on power.

However, in less rigorously controlled media regimes, bias can still be significant. In many European countries, until recently, many of the non-state-owned printed media and television stations were owned or were closely related to political parties, and the different media expressed the preferences of their parties. Similarly, public television organizations were often influenced by the parties in government. An interesting illustration is Italy, where the main leader of the right-wing political party, Silvio Berlusconi, owns many of the commercial TV stations, and their political news coverage switches when left- or right-wing parties take over government. Governments can also put strong pressure on media not to publish stories.

Owners of commercial media may wish to impose their personal preferences on their media reporting. In doing so, they may face a trade-off between political objectives (i.e., using the media to express the owners’ ideological bias) and commercial objectives (Mullainathan & Shleifer

2005). First, commercial objectives may be affected by potential consumers' distaste for bias or by the negative utility they get from consuming media products that differ from their personal social and political preferences. Second, commercial media's profitability depends not only on consumers but also, to a large extent, on advertising revenues. Bagdikian (1992) writes, "As mass advertising grew, the liberal and radical ideas—in editorials, in selection of news, and in investigative initiatives—became a problem. If a paper wished to attract maximum advertising, its explicit politics might create a disadvantage." Along the same lines, Gabszewicz et al. (2001) show that the media's incentives to appeal to a larger audience and to hence be more attractive to advertisers may induce editors to moderate the political messages they display to their readers.

Other supply-driven forms of media bias may be related to the availability of potential journalists who are willing to work for lower wages in positions that can advance their careers or who demonstrate influence by exercising the discretion granted by news organizations (Baron 2006). Dyck & Zingales (2002) focus on the relationship between journalists and their sources of information as the reason for media bias. Sources may release partial information that supports their preferences, or journalists may use partial information to reward sources for providing information. Baron (2005) models how the competition between information sources affects the news report. Private information may be held by two sources with opposing views. The sources have incentives to reveal only information that supports their own views, and it is costly for the media to obtain additional information from independent sources. Dyck & Zingales (2002) argue that to induce a source to reveal information, the journal puts a positive spin on stories to reward the source for providing the information.

On the demand side, McCluskey et al. (2015) explain that negative news coverage is likely to dominate positive news stories. Their argument is based on the premise that consumers use the information from positive media stories to take advantage of opportunities from positive shocks and use the information from negative stories to avoid negative shocks. If utility is concave, the marginal loss in utility from not consuming the first bad news story is greater than the marginal gain in utility from consuming the first positive news story. As a result, consumers will choose to consume more negative stories than positive ones.

Spatial models of firm location also provide a consumer-driven rationale for bias based on product differentiation. Mullainathan & Shleifer (2005) argue that readers or viewers have a preference for news that is consistent with their initial beliefs and that media organizations therefore have an incentive to bias their reporting toward confirming their readers' or viewers' initial beliefs. When readers are heterogeneous in their beliefs, accuracy increases due to cross-checking of facts across newspapers. This is a wisdom-of-crowds argument (Surowiecki 2004) that aggregation of signals reduces noise. Anand et al. (2007) assume that facts are not always verifiable and that consumers have heterogeneous ideologies. They find that when facts are verifiable, there is no bias. However, when a news item comprises information that is mostly nonverifiable, then consumers may care about both opinion and editorials, and the media firm's report will contain both of these aspects. The diversity of opinion and editorials results in a differentiated product market. A dynamic version of this type of argument can be made when media organizations attempt to obtain a reputation for accuracy, which induces bias in reporting. Gentzkow & Shapiro (2006) consider the Bayesian consumer who is uncertain about the quality of an information source. The consumer infers that the source is of higher quality when its report conforms to the consumer's prior expectations. Consequently, media may slant their reports toward the prior beliefs of their customers to build a reputation for quality.

The incentive to attract large numbers of readers or viewers may also lead to bias. One mechanism is explained by Strömberg (2004), who argues that media coverage is biased toward large groups, as the media are more likely to cover issues that are of interest to such groups. This bias can

result from the need to attract as many readers as possible or from economies of scale in the media. Kuzyk & McCluskey (2006) provide empirical support for Strömberg's (2001) theoretical model with content analysis.

An interesting empirical study on these issues is by Gentzkow & Shapiro (2010). They analyze text from a large set of US media and come to the conclusion that “newspapers’ actual slant is neither to the right nor to the left of the profit maximizing level, on average.” They conclude that the slant (or bias) in newspapers is strongly related to the political distribution of their potential readers, much more so than to the political preferences of their owners or the journalists.

Competition may also play an important role in media organizations’ trade-off between ideology and profits. Some researchers, such as Baron (2006), show that bias can persist in the face of competition. Gentzkow & Shapiro (2006, 2008b) argue that competition reduces supply side-induced bias because it increases the likelihood that erroneous reports will be exposed *ex post*, but these researchers argue that the impact of competition on demand side-induced bias is less clear. Mullainathan & Shleifer (2005) in their two-firm location model show that price competition results in greater product differentiation—e.g., more slanting of news. When advertising revenues are included in the product differentiation models of media, minimum differentiation can result (Barros et al. 2004, Gabszewicz et al. 2004, Gal-Or & Dukes 2003).

Hence, many supply and demand factors have been identified in the literature as potential sources of bias and framing in news media reporting. In the next sections, we review evidence on bias and framing in media reporting of new food technologies, especially agricultural biotechnology and GM foods, which have been widely studied.

4. EMPIRICAL STUDIES OF MEDIA COVERAGE OF NEW FOOD TECHNOLOGIES

For more than 25 years, news media reporting on biotechnology and GM foods has been closely examined in many parts of the world, including various European countries, the United States, Japan, China, Australia, the Philippines, Kenya, and Turkey. Studies have compared media coverage across two or more countries (e.g., Bauer 2005b, Botelho & Kurtz 2008, Lewison 2007, Listerman 2010, Marks et al. 2003, Vilella-Vila & Costa-Font 2008); across different biotechnology applications, including medical as well as crop and livestock improvements (e.g., Hibino & Nagata 2006, Marks et al. 2007, Marques et al. 2015, Müller et al. 2010); across different types of news media, including elite press, tabloids, and television (e.g., Carver et al. 2013, Maesele & Schuurman 2008, Vicsek 2013); and over time. These comparative analyses have demonstrated systematic differences in the amount of coverage and tone across geographies, in types of media, and in biotechnology applications and systematic differences over time and have teased out some of the underlying causes of such differences. Furthermore, they have often linked media coverage of biotechnology and GM foods to public attitudes and perceptions toward them.

4.1. The Agenda Setting Role of News Media

Mazur (1981) proposes that the quantity of coverage, independent of tone, would tend to lead to a conservative bias or increasingly negative attitudes toward a technology. As such, a large number of published studies have measured the frequency of news media reporting on biotechnology and GM foods, and many have described changes in the amount of coverage over time.

Building on Downs's (1972) idea of issue attention cycles, Nisbet & Huye (2006) describe cycles of increased and then decreased media attention to plant biotechnology and propose underlying social mechanisms that lead to cyclical media coverage. Several other studies document

the cyclical nature of media coverage of biotechnology and GM foods. For instance, Listerman (2010) observes an increase, peak, and decrease in US, UK, and German media coverage of biotechnology over the 2000–2002 period. Similar media attention cycles are also visible over longer time periods when data from various studies across many countries and news media are pieced together. From early studies in European countries (e.g., Bauer & Gaskell 2002, Bonfadelli et al. 2002, Durant et al. 1998, Jesuino et al. 2001, Kohring & Matthes 2002, Wheeler et al. 2002), it can be inferred that in France, Austria, the United Kingdom, the Netherlands, Sweden, and other countries, news media attention to biotechnology was quite low in the early 1990s and increased between 1995 and 1997. Shanahan et al. (2001) show further growth in media coverage of agricultural biotechnology until 2000, with a dramatic increase in attention occurring between 1997 and 2000. McNerney et al. (2004) examine patterns of media coverage of biotechnology and GM foods between 1992 and 2002 and report a peak in the coverage in 2000. Marks et al. (2003) and Marks et al. (2007) report similar results.

The dramatic increase in media attention to biotechnology in the late 1990s and the observed peak in the early 2000s was driven mostly by events (Botelho & Kurtz 2008; Cook et al. 2006; Flipse & Osseweijer 2013; Marks et al. 2002, 2003, 2007) that were triggers to jump-start media coverage and public attention. Abbott & Eichmeier (1998) term this phenomenon the hoopla effect. Trigger or flash point events were both global and local in nature.

Two scientific controversies in the late 1990s attracted global media attention. First, in 1998, Árpád Pusztai claimed, on national television in the United Kingdom, that biotech potatoes fed to laboratory rats had caused damage to their organs and overall development. Although his work was disputed by scientific societies and his institution, it was published in *The Lancet* and attracted media attention in a large number of countries. Then in 1999, Losey and his colleagues reported in the journal *Nature* that monarch butterflies could be harmed by biotech corn pollen. Although the study's findings proposed a potential hazard that was more real in the lab than in the field, it quickly attracted international media attention. On the heels of the monarch butterfly controversy, another one centered around a market disruption unfolded and maintained the attention of global media to biotechnology. The discovery of StarLink corn in the US food supply (a biotech corn approved only for animal consumption) led to recalls of hundreds of food products and to trade disruptions in international corn markets, leading to numerous media reports across the globe.

Local events also played a role in the increased media attention to biotechnology and GM foods in the late 1990s and early 2000s. For instance, in May 2000, the Prince of Wales publicly condemned GM foods while in the same month Scottish farmers discovered that they had mistakenly sowed unapproved GM seeds in their fields. These events were heavily reported in the United Kingdom, but not elsewhere. In contrast, the US president's statement on biotechnology and the first field trial destruction were widely reported in the Philippines, while other local events signaling controversies attracted similar media attention in other countries.

Overall, increased media attention has heightened public attention to biotechnology and GM foods and has had an agenda setting role in fueling public debate. Within this context, many studies have examined what sort of information was provided to the public through the media and what kind of balance this information flow assumed over time.

4.2. The Framing Role of News Media

News stories are constructed realities that pull together facts and information within a narrative structure, or frame, which communicates an event or story to the reader (Tuchman 1976). Fresh

information about new food technologies, especially in fast-changing scientific fields like biotechnology, is ongoing and continuously shapes the balance of risks and rewards of such technologies. There is extensive research on how reporters have interpreted and narrated such information, that is, how they have framed the public debate. The definition of a frame tends to vary from one study to another, depending on the research interest. Pan & Kosicki (1993) explain that frame analysis in news media text must be operationalized not only through examination of syntactic and script structures, but also through the media's themes and rhetoric. Empirically detecting specific frames and objectively measuring the messages that such frames communicate are not straightforward, however.

Story frames might include cognitive elements, which convey specific information about certain aspects of the technology, or affective elements, which carry a positive or negative tone in the overall representation of the technology. Entman (1991) suggests that story frames can be detected in practice by probing for particular words and visual images that consistently appear in the narrative. Researchers have therefore surveyed news media articles for the presence of both affective and cognitive elements through textual or content analysis—a systematic method for analyzing and quantifying message content and message handling in news stories (Budd et al. 1967). For instance, Gaskell & Bauer (2001), Marks et al. (2007), and others have looked for frames consistent with certain alleged risks or benefits by using content analysis of news media articles.

Researchers have also been interested in general frames as well as issue-specific frames used in the news media coverage of biotechnology and GM foods. For instance, Augoustinos et al. (2010) analyze newspaper articles published in the United Kingdom, with an interest on how media, in general, framed the position of major stakeholders in the national debate on GM foods: the British public, the British government, and biotechnology companies. The authors find that a pervasive representation of the British public as uniformly opposed to GM foods served rhetorically to position the British government as undemocratic and beholden to industry. In contrast, Veltri & Suerdem (2013) examine news media framing of biotechnology and GM foods in Turkey in relation to the introduction of the national biosafety law in 2010. Within this issue-specific context, the authors find that some media outlets framed their discussion on biotechnology by emphasizing political controversies, although this discussion was ideologically nuanced. For example, some Islamist and extreme nationalist outlets characterized the issue as a conspiracy by Jewish multinational companies for world domination, whereas left-leaning outlets characterized the law as a product of capitalist development with potential future hazards. Other news media framed biotechnology and the introduction of the biosafety law as a technical issue that should be placed under government supervision.

Despite the variety of the frames selected by researchers or the words and syntactic features of the articles examined, most published studies have ultimately assessed the overall tone and balance of news media coverage on biotechnology and GM foods. In this context, a number of researchers have concluded that reporters across the globe have consistently drawn parallels between agricultural biotechnology and other known food hazards (e.g., mad cow disease and dioxins) and have continued to raise the possibility of unknown long-term health effects—essentially framing biotechnology as a food safety risk. Similarly, a number of studies have established that reporters have emphasized potential environmental and social risks over benefits.

For instance, Hagedorn & Allender-Hagedorn (1997) examine media coverage of agricultural biotechnology (microbes, modified plants, animals, and foods) from 1987 to 1994. They find that the popular press focused mostly on social risks associated with biotechnology: health and ethical issues, the labeling of biotech foods, and public safety and regulatory input.

Bonfadelli et al. (2002) measure the balance of risks and benefits in Swiss media reporting from 1997 to 1999. They find that 25% of articles on biotechnology and GM foods reported only risks,

25% covered risks and benefits, 21% focused only on benefits, and 29% mentioned neither risks nor benefits. The authors then conclude that the overall tone of media coverage was slightly negative. Similarly, Marks et al. (2002, 2003) examine media frames of GM crops in US and UK newspapers, finding that environmental risks (e.g., irreversible transgenes) were emphasized over environmental benefits (e.g., reduced pesticide use and associated benefits from land savings).

Lewison (2007) examines the risk frames used by 14 news media in six countries (Canada, France, Germany, Spain, the United Kingdom, and the United States) between 2002 and 2004. The author finds that environmental, financial, health, and political risks (listed in order of magnitude) were broadly covered in the media narratives and concludes that UK news media tended to be the most “scary,” whereas Spanish media were the most “robust.”

Media coverage of biotechnology and GM foods has not been uniformly negative, however. For instance, Navarro et al. (2011) report that biotechnology media coverage in the Philippines over the 2000–2009 period was generally positive and that, although the coverage was marked by occasional peaks brought about by local controversial events that triggered attention, the volume of coverage remained low and reporting balanced. Still, such findings have become exceptional in recent years.

4.3. Changes in the Frames Used over Time

Whereas recent studies describe a predominantly negative media view of agricultural biotechnology and GM foods across most countries, earlier analyses indicate that news media coverage was more positive in the 1980s and the early 1990s and became more negative during the late 1990s and 2000s (Abbott & Lucht 2000; Bauer & Gaskell 2002; Besley & Shanahan 2005; Bonfadelli et al. 2002; Gaskell & Bauer 2001; Marks et al. 2002, 2003; Ten Eyck & Williment 2003). Hence, as with the frequency of reporting, the narrative has been cyclical in nature. This result is not surprising, however. Because both the volume of articles and the frames used for biotechnology and GM foods have been driven by media attention to the same controversial events, they should be expected to coevolve and to demonstrate similar cyclical patterns. More than anything, these cyclical effects emphasize what a large number of studies have demonstrated: News media have limited their communication on biotechnology and GM foods mostly to controversies and have frequently chosen words and images to emphasize potential risks over benefits. In deciding which issues to emphasize and which to ignore or which arguments to publish and how to frame them, news media in many parts of the world have shed an increasingly negative light on this new food technology.

5. IMPACTS OF MEDIA COVERAGE ON PUBLIC PERCEPTIONS AND CONSUMER DEMAND

5.1. Heterogeneity and Bidirectional Impacts

Citizens may anticipate that information from media may be biased or framed. They can take this possibility into account in evaluating the information. There is evidence from media impact studies on political behavior that voters adjust their media (information) consumption to the expected bias in the information provision and discount the information that is provided by different media sources (Chiang & Knight 2011, Durante & Knight 2012, Gentzkow & Kamenica 2011). Yet some behavioral studies suggest that, even when audiences know that the media sources are biased, they insufficiently discount the information and do not fully take into account the bias. Exposure

to media can thus systematically alter beliefs and consumer behavior (Della Vigna & Gentzkow 2010).

However, the impact is likely heterogeneous. Both social and individual factors amplify or dampen perceptions of risk (Flynn et al. 1998, Koné & Mullet 1994). Gender and education are consistent demographic predictors of perceived food risk; the nature of the perceived threat, trust, communication sources and channels, and health and environmental concerns are the most relevant nondemographic predictors (Ellis et al. 2009).

The decision about how much information to process depends on consumers' ex ante risk perceptions. Van Ravenswaay & Hoehn (1991), in one of the first surveys on consumer perceptions of health risks in food, conclude that most consumers acknowledge the existence of food risks but that most consumers perceive the risk to be quite small. Slovic (1987) suggests that risk is influenced by two major factors: dread risk and unknown risk. Dread risks are those judged as uncontrollable and involuntary, potentially impacting large numbers of people with consequences that are potentially catastrophic. New food technologies typically rate highly on unknown risks. Thus, variations in levels of knowledge across consumers may influence their risk perceptions.

The nature of information matters as well. As we discuss above, consumers may give greater weight to negative information than to positive information (McCluskey & Swinnen 2004). Siegrist & Cvetkovich (2001) conducted experiments and find that people place greater trust in research results indicating health risks and that the confidence in the results increases with an increasing indication of health risks.¹

Some criticize these studies, warning about possible confusion between pure negativity bias and confirmatory bias in exploring the impact of new information and media reports on citizens' perception. Prior beliefs may play an important role in selecting and processing the information provided by media. Poortinga & Pidgeon (2004) performed an experiment focusing on the perception of British people toward GM food and find that confirmatory bias was strong, as people with clear positive or negative beliefs interpreted the same events in line with their existing attitude position. Frewer et al. (1999) also determine that one's initial attitude toward genetic engineering is the most important determinant of attitudes after information provision. These attitudes remain fairly stable even after persuasive arguments regarding the technology are provided. In fact, initial attitudes also affect perceptions of informational quality: Respondents with a more negative view are likely to perceive positive information about the technology as less accurate and informative and are more biased than those who hold more positive views. However, after this confirmatory bias is controlled for, negativity bias still plays a role: Negative items still have greater impacts than do positive items.

The source of information may matter as well for risk perceptions, although there is some dispute about the importance of this factor. Some studies find that source credibility plays a key role in determining the impact of a message on public opinion (Renn 2005). However, others find that source credibility appears to have a limited impact and that it is far less important than initial attitude as a determinant of individual reactions to incoming information. Kumkale et al. (2010) show through a meta-analysis that the credibility of the source matters mostly for attitude-formation conditions, whereas its impact in attitude-change conditions is lower. In contrast, recent

¹The authors suggest three possible explanations: diagnosticity (i.e., negative information may be given greater weight because it is more diagnostic than positive information), loss aversion (i.e., for most people avoiding losses is more important), and credibility (i.e., negative information may be more credible than positive information because positive information can be self-serving, whereas negative information often lacks this quality).

studies show that Internet users pay little or no attention to source credibility when seeking out health information on the web (Bates et al. 2006, Benotsch et al. 2004, Eysenbach & Köhler 2002).

Hence, the impact of bias in media reporting on consumer attitudes may be substantial under some conditions but also bidirectional and complex. Consumer personal preferences and beliefs affect media reporting strategies to convince these consumers to buy informational products. In turn, consumer perceptions, attitudes, and behaviors may be affected by media reports. In the rest of this section, we review key insights from specific studies on food technologies: first studies on perceptions and then studies on behavior and regulation.

5.2. Impact on Perceptions

Whatever the underlying causes or cognitive processes, there is some empirical evidence that broad and often negative media coverage of new food technologies has raised public awareness and has influenced public perceptions. This is especially the case for biotechnology and GM foods (e.g., Bauer 2005a,b; Bauer & Gaskell 2002; Durant et al. 1998; Marks et al. 2007).

In one of the most data-rich studies, Bauer (2005b) examines the impact of news media coverage on public perceptions of biotechnology across 12 European countries (Austria, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Sweden, Switzerland, and the United Kingdom). Using a longitudinal design, the author examines changes in public attitudes toward medical and agricultural biotechnology recorded through large surveys carried out across all 12 countries from 1996 to 1999 in the presence of sharp increases in media coverage and a progressively negative narrative. Bauer (2005b) concludes that media coverage and public perceptions about biotechnology converged over time and that such convergence was apparent among readers of news media but was not present among nonreaders.

Cook et al. (2006) evaluate, in an even more direct way, the mechanism by which public attitudes could be shaped by news media stories about GM foods in the United Kingdom. Using focus groups, the authors show that participants, who were largely unaware of the ongoing public debate, formed views on biotechnology on the basis of the narratives of the articles they were given to read. References to entities such as Monsanto acted as framing devices. Participants also made explicit some of the obscured cultural associations in newspaper articles, linking GM foods to historical narratives about power relations and the trustworthiness of institutions.

Vilella-Vila & Costa-Font (2008) examine whether news media coverage and reporting influenced public attitudes toward GM foods in Spain and in the United Kingdom for the period 1999 to 2004. Their analysis indicates that press coverage in the United Kingdom focused on risks for and potential hazards to public health, essentially framing GM foods as a highly controversial issue. The authors also find that differences in media reporting along with attitudes toward journalism correlated with attitudes to and risk perception of GM food in the two countries. Marques et al. (2015) also examine how the amount and tone of media coverage might have influenced public attitudes in Australia over a 10-year period, and they report that Australians were less positive toward GM animals compared with GM plants for food, especially in years when media coverage of biotechnology was high.

Kasperson et al. (1988) describe a mechanism by which broad and negative media coverage of biotechnology and other new food technologies can create negative public perceptions and attitudes. The authors propose that news media can act as so-called amplification stations by focusing on potential risks. In turn, the amplified risk can lead to behavioral responses that cause secondary impacts and ripple effects. In this context, minor risks, as assessed by technical experts, may elicit strong public concerns and responses. Kasperson et al. term this mechanism risk amplification. Frewer et al. (2002) provide empirical support for risk amplification in the context of media

coverage of GM foods in the United Kingdom. By collecting attitude data before, during, and after an increase in reporting of potential risks of GM foods in the United Kingdom in the spring of 1999, Frewer et al. demonstrate that people's risk perceptions increased and decreased in line with media coverage and the narrative of the time. Public perceptions of benefits from GM foods, however, appeared to be permanently depressed from negative news media reporting.

5.3. Impact on Behavior and Regulation

Although the impact of media coverage of biotechnology on public perceptions is well established, whether changes in perceptions translate into changes in consumer behavior is not clear. There is only limited evidence from analysis of media coverage of new food technologies. There is, however, more evidence from the media coverage of food scares. The evidence in this regard suggests that short-run consumer reactions are strong but that the long-run effects are minor. The most important long-run effects are indirect, e.g., by inducing changes in public regulation.

The short-term impacts of media coverage of food scares on consumer demand can be significant. A prime example is the coverage of bovine spongiform encephalopathy (BSE). The discovery of BSE was broadly covered in mass media, and such coverage had a significantly negative effect on consumer demand for beef. Verbeke & Ward (2001) find that there was considerable misperception by consumers, lack of knowledge, and bias between perception and scientific-indicator criteria related to the health and safety characteristics of meat. Television coverage on meat safety had a negative effect on the demand for red meat after the BSE outbreak (Verbeke et al. 2000). Younger people were the most susceptible to such negative media coverage.

However, in the longer run, consumption and sales typically recover after a food scare (Piggott & Marsh 2004). Studies find that there is little or no long-term demand response to food safety concerns (Henneberry et al. 1999). An example is the 1993 *Escherichia coli* outbreak in the Jack in the Box restaurant chain, during which 144 people were hospitalized and 3 died. Jack in the Box almost went out of business in the wake of the event, but after 2 years sales recovered to their pre-food scare levels (Entine 1999).

The limited empirical evidence available on the impacts of media coverage of biotechnology and GM foods seems to be consistent with the above findings. Kalaitzandonakes et al. (2004) examine consumer response to two kinds of biotech media coverage environments. In the first environment, media coverage of biotechnology and GM foods was substantial and sustained over a 5-year period. The tone of generally negative reporting frequently raised the possibility of health risks. In this environment, Dutch consumers could choose between food products that were labeled as containing GM ingredients and unlabeled food products containing only conventional ingredients. Under these circumstances, the authors find that consumers did not respond to the media coverage and did not change their purchasing patterns for the duration of the analysis. In the second environment, media coverage was acute but was brief, negative, and focused almost exclusively on potential food safety risks related to the unauthorized presence of StarLink corn and food product recalls in the US market. In this environment, consumer demand for identified products was affected by the media coverage, but the overall consumer response was limited.

Indeed, the most significant long-term effect of mass media is likely through their impact on public policy. One mechanism is the agenda setting effect of the media, which has sometimes been referred to as the CNN factor (Hawkins 2002). It refers to the process by which the media influence policy by invoking responses in their audiences through concentrated and emotionally based coverage, which in turn applies pressure to governments to react. Similarly, the absence of media coverage reduces priority in agenda setting. Robinson (2001) suggests that the media can be a powerful source in leading policy makers, especially when there is great uncertainty or limited

information. For example, following the media frenzy surrounding the Jack in the Box *E. coli* outbreak in 1993, President Clinton called congressional hearings regarding the safety of the food supply. The US Food and Drug Administration raised the recommended internal temperature of cooked hamburgers to 155°F. Ordering a hamburger cooked less than “medium” at US restaurants is now difficult.

More closely related to the issue of food technologies is the change in the use of the precautionary principle in regulation in the European Union and the United States. The precautionary principle is now used as a major regulatory principle in food regulation, in particular for GM food, in the European Union. However, historically, the precautionary principle was used much more in the United States from the 1960s through the mid-1980s (Vogel 2003). Several European food scares in the 1990s, heavily publicized in the mass media, changed this trend. Such events pushed politicians to introduce a series of new regulations and caused consumers to be much more concerned about food safety issues. Although ex post studies showed that several of these food safety problems turned out to be exaggerated, the massive press coverage induced strong political reactions, leading to regulations and shifts in consumer preferences that are having long-lasting effects on European food risk perceptions and on the regulation of the entire food system. Yet the induced change in policy had major implications for consumer behavior in a dynamic perspective, as it influenced the use of food technologies in the long run in the United States versus the European Union (Swinnen & Vandemoortele 2010, Swinnen et al. 2012).

A fascinating case on the turnaround of public opinion in a highly mediatized public debate is Zilberman et al.’s (2014) analysis of California’s Proposition 37, which would have instituted mandatory labeling on food containing GM ingredients. The debate was widely covered by many media outlets, including newspapers, television, social media, and editorial blogs. Celebrity food author Michael Pollan wrote an opposition piece for *The New York Times Magazine* (Pollan 2012). Proponents, who spent approximately \$8.7 million, made the arguments that consumers had a right to know whether their food contained GM ingredients and that GMOs did not provide real benefits and may introduce unknown risks. Opponents, who spent \$45.6 million, made the case that the debate should be between mandatory labeling and voluntary labeling and that mandatory GM labeling would increase food prices for all. With voluntary labeling, consumers who are indifferent about GM will not have to pay for information they do not value. Zilberman et al. (2014) document how, after high initial support, the measure was narrowly defeated as support declined with extensive media coverage and opponents’ advertisements of new economic studies showing that mandatory GM labeling could cause economic losses for California.²

6. CONCLUSIONS AND FUTURE RESEARCH

A conclusion from our review is that the interactions between mass media, public perceptions of new food technologies, and consumer behavior are bidirectional and complex. Consumers’ preferences and beliefs, and consumers’ disproportionate interest in negative news, affect media reporting strategies to attract these consumers to buy certain products. Media market conditions, competition, and other supply side factors may also augment the biased coverage of new food technologies by mass media. In turn, citizens who receive information from the media anticipate

²Opinion polls showed a rise in opposition from 22% to 51% and a decline in support from 65% to 39% in the final month of the campaign (Zilberman et al. 2014).

that this information from media sources may be biased. Yet citizens only partially discount this bias, so there is real influence.

News coverage tends to be concentrated around events that are often controversial in nature. The volume and the tone of the coverage tend to be affected by such events with significant agenda setting and framing effects. The impact of such agenda setting and framing effects on public perceptions may be durable, as the effects on consumption appear to be important in the short run, even if they are more limited in the long run. The same underlying demand and supply conditions that lead early on to an intensification of media attention also lead to a rapid decline in attention afterward. The most important long-term effects of media attention seem to be indirect via media influence on changes in public policy.

There are implications for risk communication, education, and management. First, the public's initial beliefs affect its overall risk perceptions and how consumers process new information provided by the mass media (or other sources). Therefore, it is important to enhance consumer understanding of the benefits and objective risks associated with new agricultural and food technologies through proactive education and early information to establish a strong framework for people to assess risk when certain events occur. Preemptive risk communication and development of institutions that are responsive to problems can mitigate the negative long-term consequences. Second, firms, scientists, and governments should be prepared to provide information when crises occur. The media will report on the issues either way. If firms, scientists, and government officials are not ready to put events and facts into perspective, the media will draw on whatever "expert" they can find.

Finally, this field is an exciting area for further research because progress can be made on various fronts. The emergence of improved research methodologies (such as improved understanding of laboratory and field experiments) and new media technologies (such as web-based media applications; social media; and, especially, much better, digitalized, and personalized media databases and consumer databases, such as databases that include retail scanner data, and store loyalty cards) should allow for greater quality and variety of research in this field.

The availability of data on the use of content created on social media platforms creates new opportunities to understand media content demand and impact. For example, Smith & Wooten (2014) analyze a billion tweets and find that the popularity of a political pundit hinges more on whether she is confident than on whether she is correct. Blogs and social media represent a change in the way people receive information. McKenzie & Ozler (2014) find evidence that a blog can increase knowledge of the topics it covers for the average, but not the marginal, reader. Researchers should also consider the influence of charismatic authors and journalists and the impacts of blogs and other newer forms of media on acceptance of new technologies. This was a factor in the Proposition 37 policy debate over mandatory GM labeling.

There is also room for enhanced insights from more interdisciplinary research on consumers and media choice and the factors that affect such choice. Future directions could include insights from sensory sciences about the factors affecting taste and perceptions and how experience affects perceptions of technology and the product. Psychology could be integrated into studies to understand how values, social norms, identity, and personality affect choices of food made with new technology. We expect research to increasingly draw upon findings of behavioral economics to learn more about the interaction of media and consumer choice.

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