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The influence of media frames on the public's perception of biofuels

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ABSTRACT

This study analyzes the frames Iowa newspapers used to report on the biofuels issue, and examines the extent to which these media frames are present in the way audience members understand this important topic. Do the frames people hold about the topic match the ones found in the newspaper coverage? Is the valence of media coverage congruent with the orientation of public opinion?

A content analysis of news articles about biofuels from three newspapers—the *Des Moines Register*, the *Cedar Rapids Gazette* and the *Davenport Quad City Times*—published over a one-year period was conducted to determine media frames. A mail survey of residents of the three cities where the newspapers are published—Des Moines, Cedar Rapids and Davenport—was done to elicit audience frames.

The findings show support for the framing theory proposition that media frames influence audience frames, based on the substantial overlap between the two. The news reports, however, were neutral while the respondents were very positive about the topic. The results indicate that while the media may be successful in telling people what to think about and how to think about those topics, they may not be too successful in influencing their attitudes about them.

CHAPTER 1.

INTRODUCTION AND STATEMENT OF THE PROBLEM

"Global climate change may be the greatest environmental risk of our time" (Wilson, 2000, p. 201). Indeed, global warming is fast becoming a worldwide concern now generally acknowledged as an outcome of human behaviors considered not environmentally friendly (Tyner, 2007). These include the emission of unacceptable levels of carbon dioxide and other greenhouse gases into the atmosphere attendant to people's increasing consumption of petroleum.

To alleviate this, the nations of the world gathered in 1997 to propose the Kyoto Protocol, a series of measures countries can adopt to reduce greenhouse gas emissions. These, combined with the uncertain oil supply and fluctuating oil prices, drove the search for alternative sources of fuel. Joining the list of potential alternatives, such as wind, solar, wave, nuclear and geothermal power, is energy that can be derived from biomass, generally referred to as biofuels.

"Biofuels is a liquid form of biomass that can be used as a fuel," according to Miranowski (2007, p. 2). Biofuels are a form of renewable energy that can be employed to partly replace petroleum and improve air quality. An example of this is ethanol derived from corn grains, a primary feedstock in the United States (Miranowski, 2007).

Ethanol as an alternative fuel has had a bit of history. Its use increased during World

War II, but declined after the war due to the increased supply of cheap crude oil. Interest in ethanol rose again in the 1970s when, after suffering from the first global oil crisis, the US passed the 1978 Energy Act that created incentives for research and development efforts meant to develop alternative energy sources. The passage of the Clear Air Act Amendments in the 1990s also prompted researchers such as Miranowski (2007), Tyner (2007), Gallagher (2006), and Hill et al. (2006) to conduct studies of economic efficiency, technical feasibility, the process of converting crops into fuels, as well as regional and experimental applications.

These studies of economic and technical feasibilities notwithstanding (i.e., Rohracher et al., 2004), people are still generally unaware of the process of creating biofuels as well as the benefits and disadvantages that can be derived from them. In the absence of such a knowledge base, it can be surmised that people are unable to evaluate messages about biofuels, especially those that may contain references to risks. Such information may lead to unwarranted fear, dread and eventual resistance to bioenergy research and development efforts. An examination of the current state of biofuels coverage and its impact on audiences is therefore in order.

Wilson (1995), Corbett and Durfee (2004) state that, in general, the media are the main information sources about scientific topics in the United States. Indeed many acquire scientific knowledge mainly from the mass media rather than from scientific

publications or from direct involvement in science or the scientific enterprise (Corbett and Durfee, 2004). If such is the case, what people know of biofuels as a scientific topic should closely resemble what they have read, seen and heard about it from the mass media.

Any issue covered extensively by the media may be framed in several ways. Of these issues, nothing is more prone to the media's ways of presenting risks than those issues with scientific and technological bases. For example, interest in biofuels had been spurred mainly by people's awareness of the risks inherent in climate change, the rather capricious methods of determining oil supply and price, and the general problems accompanying the "greenhouse effect."

Risk communication is defined as "the dissemination of any interpersonal or mediated message containing information about the existence, nature, seriousness, probability and acceptability of risks" (Rodriguez, 2007, p. 481). As such, risk communication skills are critical for successful crisis management (Covello, Minamyer, and Clayton, 2007). Risk perception studies mostly conducted in the late 1980s have been influential in demonstrating that lay persons think of risks as a multi-dimensional concept that includes scientific risk assessments as well as psychological responses to concerns, such as the voluntariness of exposure, the potential for catastrophic consequences, and the newness of technology (Gregory, 1991).

The elaboration likelihood model proposed by Petty and Cacioppo (1986) suggests that when an issue, such as biofuels, is not yet well known and is not familiar to audiences, the details of such messages are considered less critical. Therefore, communication planners suggest, messages intended to drive initial concerns about a relatively unknown topic should be simple, must come from trustworthy sources, but should have attractiveness to draw attention (Rodriguez, 2007).

Many define risks on the basis of personal cost-benefit analyses informed by scientific and technical data (Rodriguez, 2007), but there are also normative and judgmental dimensions to risk perception, an aspect largely drawn from media presentations of an issue. One of the functions of risk communication is to make people aware of some potential adverse effect of an innovation in order to avert panic and prevent unwarranted fear. Covello, Minamyer and Clayton (2007) state that risk communication's objectives are "to enhance knowledge and understanding, build trust and credibility, encourage constructive dialogue, produce appropriate levels of concern, and provide guidance on appropriate protective behavior and actions following a crisis incident" (pp. 1-2).

The news media play a key role in fostering public risk perceptions because the media serve as the primary connection between the technical or scientific findings of scientists and the psychological assessments of those discoveries by lay persons (Gregory,

1991). While communication researchers are still unable to present strong evidence for a causal relationship between media messages and specific audience response, "understanding how the public perceives risk information is directly related to how the media translate scientific information into news coverage about risk" (Durfee, 2006, p. 466).

Biofuels production, processing and marketing pose risks, such as those related to the environment. However, reporting about potential risks, many scientists concur, is not the general forte of most journalists. In fact, many decry the inability of reporters to handle science and risk issues. As Sachsman (1993) and Wilkins and Patterson (1987) note, "journalists do not report environmental risk; they report news" (as cited in Miller and Riechert, 2000, p. 47). News coverage about science, in many cases, tends to be episodic, sensationalist, and generally hides what is really critical, many scientists say (Durfee, 2006).

Because reporters gather information about biofuels from a number of mediated information sources, the extent to which journalists and editors understand the issue affects the reporting angles from which news is presented and how much media time and space should be devoted to an issue. Journalistic values and practices of news gathering and gatekeeping, for example, also influence the number of science topics and the way these topics are discussed in the media and, consequently, how the audience comprehends

those issues. In effect, people's perception and comprehension of biofuels as a topic is an outcome of their interaction with different factors and the back-and-forth of information flows.

Durfee (2006) states that messages are constructed in the process of translating scientific information for popular consumption. This process is called "framing." According to Entman (1993), "to frame is to select some aspects of a perceived reality and make them more salient in a communicating context in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (p. 52). In short, how news is presented influences what audience members think about issues, people and events (Durfee, 2006).

There are a number of framing devices used in media framing. "Using certain words or phrases, making certain contextual references…giving examples as typical, referring to certain sources, and so on" are some examples of techniques which journalists use to frame issues (McQuail, 2005, p. 378-379).

By dint of people's exposure to media frames, Scheufele (1999) suggests that people also develop in their minds what he calls "audience frames" or cognitive schemas about topics and issues. The way people understand the news is a function of the frames they receive from the mass media. Thus, framing theory focuses on *how* people understand issues instead of simply asking *what* topics people learn about from the media. It is clear,

therefore, that framing theory offers an appropriate framework with which to analyze how the media frame biofuels as an issue and how audiences understand this topic based on media reports.

This study analyzes the frames Iowa newspapers used to report on the biofuels issue, and examines the extent to which these media frames are present in the way individual audience members understand this important topic. A content analysis of Iowa newspaper reports was conducted to determine media frames, and a survey of Iowa residents was done to analyze audience frames. Do the frames people hold about the topic match the ones found in the newspaper coverage?

This study is expected to determine the extent to which the general public understands the processes and effects of the current frenetic drive to derive alternative energy from biofuels from information they gather from the media. For scientists who deal with the research and development aspects of this important enterprise, the findings may be useful in ascertaining the extent to which their efforts have been understood and accepted by the public they purport to serve. For reporters, journalists, communication practitioners, and communication strategists, the findings are expected to provide insights as to how to improve the comprehensibility and accuracy of the way they cover this complex topic.

CHAPTER 2.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Today's newspaper readers no longer find biofuels or other bioenergy-related topics novel. The importance of evolving a bioeconomy, and the risks carried by the seemingly frenzied search for alternative energy sources to reduce the country's dependence on foreign oil, are now common fodder for the news media. This topic offers yet another instance in which the mass media can demonstrate their ability to influence what the public considers to be the important issues of the day, and how people understand this multi-faceted issue. Indeed, according to Scheufele (1999), the way the media present or frame these topics can shape audiences' perceptions of issues, the importance they assign to them, and the feasibility of embarking on a national effort to produce fuel from alternative sources, including biomass.

As a topic, biofuels can be framed in the mass media as either a boon or a bane. On the positive side, it can be seen as a solution to the problems engendered by the greenhouse effect, and another way of augmenting income from farming. On the negative side, it can be presented as inherently risky. For example, pundits suggest that harnessing crops for fuel can lead to rising food prices, if not food shortages. The intensive ethanol production process, some suggest, emits more carbon dioxide, a greenhouse gas, into the atmosphere, thus negating the purpose of producing environmentally-friendly energy

alternatives.

Because the mass media offer the most immediate and efficient ways to inform the public of this new energy source (Rogers, 2003), it is pertinent to know how they frame biofuels, and how their portrayal of the topic influences public understanding of the topic, specifically, the public's perception of risks related to it.

The Media, Scientists and Audiences

How the media report science and technology-related topics have been the subject of intense scrutiny by scientists, communication scholars, and audience members alike. Scientists worry about the inaccuracies in news reports that distort scientific findings and consequently, public perceptions of research results and other products of the scientific enterprise. Audiences, on the other hand, need accurate information to make their own judgments about risks or any kind of scientific message. Omissions of relevant information and taking results "out of context" are important criticisms that have been lobbied against media reports about science (Dunwoody and Peters, 1992). For example, it is generally understood in the scientific community that scientists differ in their assumptions about global climate change, and research results will likely vary over time. According to Dunwoody and Peters (1992), good journalistic reports are supposed to reflect such a variance, and audiences should be made aware that risk assessments are also social constructs.

Risk Perceptions

Slovic (1987) defines risk perception as a multi-dimensional concept composed of assessments informed by scientific data and "intuitive risk judgments" on which the majority of citizens rely (p. 280). Many do not experience risk—especially the kind inherent in scientific breakthroughs and other discoveries—first hand. They rely mostly on the news media to tell them about the hazards involved and the probability of their occurrence. According to Gregory (1991), risk perception, in general, is related to public attitudes concerning risks tied to their views about technologies, activities or products.

Sandman (2001) distinguishes between two factors leading to people's responses to risk: "its hazard, which results from and determines the experts' response; and its outrage, which determines the public's response" (p. 3). This explication posits that risk perception, as a concept, has two dimensions: (1) the technical or rational dimension and (2) the normative or value dimension.

The technical/rational dimension is akin to how Sandman (2003) conceptualizes "hazard," which he illustrates as resulting from experts' judgments and evaluations of risk. This implies that public resources are allocated following objective measures of probability and magnitude of harm arising from risk and risk events as defined by experts.

The normative or value dimension of risk perception, on the other hand, suggests that there are individual psychological and social variables that mitigate risk perception.

Thus, individuals differ in their risk perceptions, which mirror their individual concerns and the way they understand undesirable effects. These aspects of risk perception, therefore, may be factors that technical risk analyses would easily miss (Renn, 1992). Based on this psychometric framework, "risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional, and cultural factors" (Slovic, 1992, p. 120). Slovic (1992) suggests that people "invent" or "construct" their concept of "risk" to assist them in dealing with uncertainties. The information they receive from the mass media forms a vital part of their construction of meaning.

In the case of biofuels, the hazard dimension to risk perception deals with risk-associated mortality, morbidity, or ecosystem damage to which scientists respond. On the other hand, the outrage dimension deals with the extent to which people think that the risk posed by the drive to produce more biofuels is voluntary, within their control, has a high dread factor, is familiar and memorable, among others. The public gets a sense of both dimensions of risk in mass media reports.

When it comes to biofuels, experts have talked about risks related to the potential of re-allocating crops for fuels to create food shortages, raise food prices, and cause environmental damages. According to Hill et al. (2006), the world demand for food is expected to double in 50 years; the demand for transportation fuels is also anticipated to increase exponentially. But devoting all US corn and soybean acres to ethanol and

biodiesel production would offset only 12 percent and 6 percent of the country's gasoline and diesel production, respectively. In other words, crop-based biofuels can meet only a small portion of projected transportation and energy needs. Thus, turning large tracts of land once devoted to crops for food and feed in the service of biofuels has a strong potential to raise food prices (Lamb, 2007).

Thus, this shift from food and feed to producing energy for vehicles can adversely impact the food situation worldwide (Aho, 2007). According to the *Christian Science Monitor*, before 2005, only one percent of global transportation fuel supply was derived from biofuels. Shifting the use of crops from food to biofuels will raise grain and vegetable oil prices, threatening the food security of people, especially those in developing nations (Lamb, 2007). Indeed, according to economists, the US ethanol policy can increase the number of undernourished people the world over from 830 million to 1.27 billion (Runge and Senauer, 2007; Aho, 2007). Agricultural expansion into forests and grasslands on which people rely for a stable climate is also considered an important threat (Lamb, 2007).

Understanding how people perceive such scientific risk assessments is important to formulate responsible policies. To this end, it is important for risk managers and risk communicators to understand public concerns and offer indicators for public policy preferences (Renn, 1992).

Theoretical Framework: Framing

Each news item has a theme that structures it (Gamson and Modigliani, 1989; Pan and Kosicki, 1993). This theme connects different semantic components of a story into a coherent whole (Pan and Kosicki, 1993). Pan and Kosicki (1993) call these themes "frames" due to their structuring function. In functional terms, Dunwoody and Peters (1992) define a frame as "a knowledge structure that is activated by some stimulus and then employed by a journalist throughout story construction" (p. 213).

The mass media construct or interpret social realities through framing (McQuail, 1994; Scheufele, 1999; McQuail, 2005). Employed widely in television news, framing is also seen in the way the print media assign stories to prime pages, and the way they repeat or use culturally familiar symbols in news discourse (Entman, 1993; McCombs and Ghanem, 2001).

"Framing refers to the methods by which the mass media organize and present issues and events" (Dimitrova and Strömbäck, 2005, p. 404). Scheufele (2000) defines a frame as "an idea that supplies a context and suggests what the issue is through the use of selection, emphasis, exclusion and elaboration" (p. 523). Framing goes beyond *what* issues the audiences think about to guiding them *how* they should think about these issues (Craft and Wanta, 2004).

Frames, therefore, are properties of a news story that encourage those who perceive

and think about events to elaborate particular understandings of them (Entman, 1991). News frames are composed of and are imbedded in the metaphors, concepts, keywords, symbols, and images that may reinforce some ideas but not others. Frames work to enable some ideas to stand out in texts, others less so, or others even entirely invisible (Entman, 1991).

"Frames that paradigmatically dominate news are also believed to dominate audiences" (D'Angelo, 2002, p. 876). One of a frame's functions for audiences is to make individuals act without putting much cognitive energy to the task (Dunwoody and Peters, 1992). Specifically, a frame functions to affect the audience's perceptions of topics or issues by addressing certain values, considerations or facts with more obvious relevance to the topic than they might have under another frame (Nelson, Clawson and Oxley, 1997; Scheufele, 2000). Scheufele (2000) also suggests that framing is based on "the assumption that subtle changes in the wording of the description of a situation might affect how audiences think about issues" (p. 309).

According to Pan and Kosicki (1993), framing analysis approaches news texts in at least three ways. First, framing analysis considers news texts as being composed of organized symbolic devices that interact with individuals' memory to construct meanings. Second, it maintains a systematic procedure of gathering messages to identify significant elements that might be selectively received by audiences. Finally, frames in a news text

are not likely to be independent of the interpretations of the readers of that text.

Types of Frames

Scheufele (1999) suggests two kinds of frames—media frames that are characteristics of the news text, and individual frames that are mentally stored principles audience members use for information processing. These two types of frames can be examined either as a dependent or as an independent variable. This study positions media frames as an independent variable that influences individual or audience frames.

Media discourse, according to Gamson and Modigliani (1989), is composed of a set of interpretive packages that give meaning to an issue. The core of this package's internal structure is "a central organizing idea, or frame, used to make sense of relevant events, suggesting what is at issue" (p. 2). Gitlin (1980) states that media frames organize the world both for journalists who report it, and for the general public who relies on their reports. The sources cited in mass media reports also exert a great deal of influence on how journalists and reporters choose to frame an issue.

Scheufele (1999) writes that individual frames are cognitive devices that serve as folders of major subjects into which future media content can be filed. According to Entman (1991), the mental representations resulting from exposure to a news frame can be conceived as an "event-specific schema," an understanding of what is in the news coverage that guides an audience member's interpretation of initial information. "There is

a reciprocal relationship between frames in the text and the event schema and frames in the audience's thinking" (Entman, 1991, p. 7). Valkenburg et al. (1999) define audience frames "as a schema of interpretation that enables individuals to perceive, organize, and make sense of incoming information" (p. 551).

Studies in which frames serve as independent variables focus on framing effects (Scheufele, 1999). In other words, media frames could find their way into audience frames (Huang, 1995; Scheufele, 2000). When media and audience frames overlap, the media and the audience weigh differently on those frames (Scheufele, 2000).

There are different perspectives researchers apply to examine frames. D'Angelo (2002) suggests three paradigms in news framing. The cognitive paradigm discusses how individuals' encounters with a news frame becomes an interpretation, how they are stored in memory and are activated in future encounters with similar frames. Scholars who apply the critical paradigm see frames as products of the newsgathering process by which journalists and reporters disseminate information about issues and events from political and economic elites' perspectives and values. The constructionist paradigm analyzes how individuals articulate their views after exposure to news frames.

Dunwoody and Peters (1992) posit that media frames seem to activate knowledge structures about physical things and events in the environment. In this cognitive process, individuals activate parts of prior knowledge that assist them to form interpretations;

therefore, perception occurs at the point of contact of frames and individuals' prior knowledge (Iyengar and Kinder, 1987; D'Angelo, 2002). "Prior knowledge is believed to mediate the power of frames in an evaluative context" because the schemata, activated by frames, function to direct how an individual recognizes and uses framed information (D'Angelo, 2002, p. 875; McLeod and Detenber, 1999; Rhee, 1997; Wyer and Srull, 1981).

Cultural and Contextual Considerations

The mass media interpret and frame information within a cultural context (Arno, 1984; Lee, Maslog, and Kim, 2006). Certain media packages have natural advantages because their ideas and languages resonate with culture-related topics (Gamson and Modigliani, 1989). Cultural resonance increases the appeal of a news package, making it look natural and familiar (Gamson and Modigliani, 1989). In the current study, cultural context is tapped by paying close attention to how the media outlets serving the state of Iowa frame the biofuels topic (the media frames), and to how Iowans perceive the issue (the audience frames). It is no surprise that biofuels constitute an important issue in the media agenda of a premiere agricultural state. The lives of Iowa's residents, closely linked to agriculture, are expected to be closely tied to current and future research and development efforts related to the biofuel industry.

Iowa's cultural and economic attachment to biofuels may have a bearing on how

people make judgments about the risks discussed concerning its production and use (Gregory, 1991). Indeed it can be said that the biofuels industry, which involves the production of ethanol and biodiesel, is an Iowa-specific energy industry. The state's vision to create a model bioeconomy attests to this (ISU, 2002). As such, the bioeconomy, as a multi-faceted and multi-dimensional topic, is expected to receive the continuous attention of the Iowa media and their audiences.

Framing Biofuels

Valkenburg et al. (1999) point to four ways by which news is commonly framed: (1) by emphasizing conflicts between individuals or groups; (2) by focusing on emotions or an individual as an example; (3) by attributing responsibility, crediting or blaming certain institutions or individuals; and (4) by focusing on economic outcomes. The biofuels issue can also be framed strongly in terms of the latter category, its *economic consequence*s. "The economic consequences frame presents an event, problem, or issue in terms of its economic impacts on society, a region or an individual" (Valkenburg et al., 1999, p. 552) that conform to journalists' notions of issues that have "news value" (Neuman et al., 1992; Gamson, 1992; Graber, 1993, Valkenburg et al., 1999).

Biofuels discussed in American newspapers are occasionally connected to technologies, including biotechnology, genetic engineering or mass production methods for current crops such as corn or sugar cane (Thompson, 2008). Because biofuels can be

considered an innovation in the energy industry, the *technology* frame can also be used in related news coverage. The technology frame might be present in discussions of this innovation's relative advantage, compatibility, complexity, trialability and observability as suggested by Rogers (2003). These attributes of the biofuels innovation have been examined by Miranowski (2007), Tyner (2007), Gallagher (2006) and Hill et al. (2006), among others, who have investigated the efficiency (a relative advantage) of biofuel production, its technical feasibility as an alternative energy source (compatibility), the process of converting crops to fuels (complexity), its regional and experimental applications in states such as Iowa (trialability), and its manifest advantages as an energy source (observability).

The International Food Policy Research Institute based in Washington, D.C. estimates that the increasing global biofuel production will push global corn prices up by 20 percent by 2010 and 41 percent by 2020. The anticipated price increases may be mitigated if crop yields grow substantially or if ethanol production from other raw materials, such as trees and grasses, reaches economic scale (Runge and Senauer, 2007). Therefore, the frame *food vs. fuel* may be one of the frames journalists can employ to report on this topic to their audiences.

Biofuels can be framed by the media or perceived by audiences as being positive as being negative, or anywhere in between. This could be conceived as the media and the

audience's valence or orientation toward biofuels as an issue.

For example, *The Wall Street Journal* reports the following on Nov. 5, 2007:

> The rising costs of biofuels and other alternative energies are making them less viable as substitutes for crude oil, a development that could frustrate efforts to bring oil prices down in the years ahead (Barta, 2007).

This lead paragraph of a straight news story reveals a negative valence toward the pursuit of biofuels as an alternative energy source.

Hypotheses and Research Questions

Based on the axioms of framing theory, the two dimensions of risk perception, and the cultural implications of framing effects, the following research questions and hypotheses are posed:

RQ1: What are the frames Iowa newspapers used to structure their stories about biofuels? What valence did Iowa newspapers carry in their coverage of biofuels?

RQ2: What are the frames Iowa residents hold about biofuels? What valence did Iowa residents hold toward biofuels?

H1: Media frames present in newspaper coverage about biofuels will be congruent with audience frames about this topic.

H2: The valence toward biofuels carried in newspapers will be congruent with the valence toward the issue exhibited by audiences.

CHAPTER 3.

METHODS

This study aims to determine whether the frames present in newspaper reports about the biofuels issue have found their way into the frames audience members hold about the same issue. To examine media frames, a content analysis of Iowa newspapers was conducted. To investigate audience frames, a cross-sectional survey of Iowa residents in three cities was done.

Determining Media Frames Through Content Analysis

Content analysis is an efficient means to investigate media content. Kerlinger (2000) defines it as "a method of studying and analyzing communication in a systematic, objective, and quantitative manner for the purpose of measuring variables" (as cited in Wimmer and Dominick, 2006, p. 150).

The sample and unit of analysis

The universe of this part of the study is composed of all Iowa daily newspapers. Because the corollary survey entails an examination of the opinion of a cross-section of the population in three major cities within the state, only the most widely circulated newspapers, or those newspapers with the widest reach were content analyzed. Based on the Iowa Newspaper Association's data collected from July to December 2007, the top three Iowa daily (including Sunday) newspapers in terms of circulation are the *Des*

Moines Register, the *Cedar Rapids Gazette* and the *Davenport Quad City Times*, in that order.

From July to December 2007, the *Des Moines Register*'s circulation reached 151,448 throughout much of Iowa. The *Cedar Rapids Gazette* had a circulation of 61,488 and serves Cedar Rapids, Iowa City and eastern Iowa. The *Davenport Quad City Times*, with a circulation of 57,307, serves Scott, Rock Island, Clinton and Muscatine counties.

Only straight news reports and feature articles were analyzed to eliminate the framing bias present in highly opinionated editorials, commentaries, and letters to the editor. Articles that discussed the topic in a tangential way, and those that made only superficial references to biofuels were excluded from the sample.

To arrive at the sample, the News Bank-Access World News Service was used to reach the archives in each newspaper's website for articles containing the key words "biofuel," "biodiesel," "bioeconomy," and "bioenergy."

The unit of analysis is the complete article. Photographs, illustrations and other visuals that accompany the text were not included in the analysis. The timeframe for the analysis was from September 2007 to September 2008. This one-year period saw a number of scientific and technological developments in the biofuels area, including changes in legislation and policy. Within this period, journalists and reporters were able to discuss this multi-faceted issue from different angles, and gave the public enough

exposure time to learn about the topic.

Conceptual and operational definitions of variables

The story headline and the section of the newspaper where the article was found were coded. The newspaper **section** indicates the importance of the story based on the extent to which it was prominently displayed or featured in the paper. An article can be found in the front page, the national news section, the section on local news, the international news section, the section on the economy, finance or business, or the section on science and technology issues.

The **frame** is the overarching thematic structure applied to present the story. To determine frames, coders were guided by the following questions as suggested by Huang (1995): What special angle or perspective was brought to present the story? What ideas were repeatedly mentioned in the story? What conceptual or content theme can be abstracted from the story?

To identify frames, deductive and inductive approaches may be deployed as suggested by Vreese (2005). Frames can be identified based on a review of studies completed about a specific topic. Informed by previous studies, scholars have thus arrived at "generic" frames that have helped portray specific issues. Some of these broad frames distilled from studies that have examined biofuels and other science-based topics include economic consequences, technology, food vs. fuel and risk:

1. The **economic consequence** frame conveys an event, problem, or issue in terms of its economic impact on society, a region or individuals and groups. The following paragraph is an example of part of a straight news report that exhibits the economic consequence frame:

> The rising costs of biofuels and other alternative energies are making them less viable as substitutes for crude oil, a development that could frustrate efforts to bring oil prices down in the years ahead (*The Wall Street Journal*, 2007).

2. The **technology** frame appears in discussions of biofuels' relative advantage (efficiency of biofuels production), compatibility (technical feasibility as an alternative energy source), complexity (the process of converting crops to fuels), trialability (regional and experimental application in trial plots and other pilot places), and observability (its manifest advantage as an energy source). The following paragraph demonstrates this frame:

> Michigan State University scientists have identified a protein required for photosynthesis that could ultimately lead to plants designed for biofuel production (*The Capital Times* [WI], 2008).

3. **The food vs. fuel** frame appears when a story considers the dilemma regarding the risk of diverting farmland or crops for biofuels production and use to the detriment of the

food supply on a local or global scale. The following paragraph is an example of one that demonstrates this frame:

> If all American corn and soybean production were dedicated to biofuels, that fuel would replace only 12 percent of gas demand and 6 percent of diesel demand, the study notes (*New York Times*, 2006).

4. The **risk** frame refers to information about the existence, nature, severity, or acceptability of potential injury, damage, danger, harm or loss to the environment and to human and animal health due to biofuels production. The following paragraph is an example of a news report that demonstrates this frame:

> …the conversion of the Southeast Asian or Latin American grasslands, savannas, peatlands or forests into biofuel plantations would result in a net increase in greenhouse gas levels for decades or even centuries (*Natural News*, 2008).

5. **Other** frames that do not fall under any of the three categories listed above were coded as "others."

Frames can also be identified as the coding process ensues. Vreese (2005) refers to these as "emergent" frames. Such frames contain more nuanced takes on or deeper interpretations of issues associated with a topic, and usually appear as a consequence of prolonged media coverage. This study employs both the "literature" and "emergent"

frames as proposed by Vreese.

Valence refers to the story's orientation—whether the article depicts biofuels as a positive or negative innovation. There are three potential types of valence:

1. **Positive** valence is displayed by articles that mainly discuss the advantages of and the benefits derived from harnessing biofuels. These articles see biofuels as a solution to the problem of accumulating greenhouse gases, as an alternative renewable energy outside of traditional sources, or an initiative that will boost economic development and employment.

2. **Negative** valence is displayed by articles that mainly discuss the risks and disadvantages that relate to biofuels, such as food production inefficiency, potential food shortages, rising food prices, or agricultural encroachment into forests, grasslands, and other natural habitats.

3. **Neutral** valence is displayed by articles that are mainly event-oriented and do not mention advantages, benefits, disadvantages, drawbacks or risks.

To cross-validate valence and to provide a richer description of frames, the advantages and disadvantages of embarking on the creation of a bioeconomy through the increased production and use of biofuels specified in the articles were also determined.

Because of the inverted pyramid style of news writing, the first two sources cited in the story were coded to determine who or what individuals, organizations or groups are

trying to influence or shape the media frames. These sources may be the governor of Iowa or other policy-makers at the national and local levels, scientists and scientific and research institutes, farmers, biofuels production managers, and member of the general public.

Intercoder reliability

To achieve an objective and reliable content analysis, an intercoder reliability test is necessary. Intercorder reliability refers to the level of agreement within coders who use the same instrument to code the same content (Wimmer and Dominick, 2006).

In the frame and valence identification, Holsti's (1969) formula was used to determine the reliability of nominal data in terms of percentage. Here,

$$\text{Reliability} = 2M/(N1+N2)$$

where M is the number of coding decisions that the two coders agreed on; and N1 and N2 are the numbers of coding decisions by the first and second coder, respectively. The average inter-coder reliability for all nominal (newspapers, headline, section, frames, story valence and sources) using two trained coders (including the author) are shown in Table 1.

Table 1. Inter-coder reliability for nominal variables

Variable	Inter-coder reliability
Newspaper	1.00
Headline	1.00
Section	1.00
Frame1	1.00
Frame2	0.67
Frame3	0.93
Frame4	1.00
Valence	0.87
Source1	1.00
Source2	0.73
Average	0.92

Determining Audience Frames Through a Survey

A survey aims to examine the interrelationships between or among variables and to develop explanatory inferences (Wimmer and Dominick, 2006). The measurement of audience frames in this study was based on the respondents' answers to a self-administered questionnaire sent by mail.

Sample selection

The population for this part of the study was composed of adult Iowa residents 18 years of age or older. To arrive at the sample, a simple random sampling technique was used. Because the content of three newspapers—the *Des Moines Register*, the *Cedar Rapids Gazette* and the *Davenport Quad City Times*—were analyzed in the first part of this study, the survey sample was limited to the residents of the three cities where the

newspapers are published and primarily circulated—Des Moines, Cedar Rapids and Davenport, respectively.

According to the official website of the state of Iowa, in 2006, the population of Des Moines stood at 196,857 (47% of the study population that comprises the three cities combined), Cedar Rapids had 123,944 residents (30% of the study population), and Davenport had a population of 97,558 (23% of the study population). Based on probabilities proportional to size, a sample of 470 residents was randomly picked from Des Moines, 300 from the Cedar Rapids, and 230 from Davenport. This produced a sample size of 1,000.

The respondents in each city were selected using the city telephone directory as the sampling frame. The names were selected by applying random sampling using a skip interval technique with a random start.

The questionnaire with a cover letter was sent in the middle of November 2008. A reminder postcard was mailed out two weeks after the first wave was delivered. A follow-up letter with another copy of the questionnaire—the second wave—was sent in January 2009 to those who failed to return the questionnaire by the second week of January.

To increase the response rate, the names of those who had completed and returned their questionnaires were entered into a drawing for a cash prize of $50.

The questionnaire

The questionnaire (Appendix C) is four pages in length, consisting of three sections. The first section contains questions that aim to elicit the respondents' newspaper reading habits (frequency of exposure and amount of information read), the extent to which they think they have read or have been exposed to stories that discuss biofuels and the extent to which they understand the topic. Questions in this section are all close-ended and are posed to produce nominal and interval measurements.

The second section aims to determine the respondents' perspectives on specific aspects of the biofuels issues. The seven Likert-scale items in this section were intended to measure the extent to which the respondents agree to several statements about biofuels. These statements indicate strong advantages and disadvantages of producing and using this alternative energy source. Those who "agree" to "strongly agree" with the items that pertain to the positive aspects of biofuels were considered as having a positive disposition toward the topic (akin to story valence). Those who "agree" to "strongly agree" with the items that pertain to the negative or risky aspects of biofuels were considered as having a negative disposition toward the topic. From this section, the valence of the audience's opinion about biofuels was elicited.

In the third section, respondents were asked what comes to mind when they hear the term "biofuels" and what they know or have learned about this topic. They were also

asked what they think is likely to happen with the increased production and use of biofuels. This section allows respondents to freely write down what they understand about the topic. From these open-ended discourses, the audience frames were elicited.

Operationalization of variables

To identify audience frames about biofuels, coders were guided by the same questions that helped them determine the newspaper or media frames as suggested by Huang (1995). In this case, however, there were no restrictions on the number of frames that can be identified. All frames that can be detected in the audience's open-ended response were coded.

To identify audience frames, the open-ended responses were analyzed using the following questions: (1) What is the main idea present in the respondents' discourse about biofuels? (2) What aspects of biofuels were emphasized by the respondent? (3) What ideas were generally shared by most audience members? (4) Did the respondent express concern about risks related to biofuels? What are these? What aspects do they find risky?

The literature frames identified in previous studies and literature reviews used in the content analysis portion were also applied in the coding for audience frames. Considering the various aspects encompassed by the biofuels issue, it is possible that other frames may emerge from people's discourse. These emergent frames were also identified in an analysis of respondents' open-ended responses.

Methods of Data Analysis

To determine whether there is a relationship between media frames and audience frames, coders were asked to answer the following questions: (1) Which of the audiences' frames correspond to the newspaper frames? (2) Which audience ideas did not appear in the newspaper discourse? Frequency distribution tables were analyzed to compare the frames detected in the newspaper articles and those observed in the survey responses.

Hypothesis 1 posits that the frames identified in the survey will mirror the frames identified in the content analysis. Hypothesis 2 posits that the valence conveyed in newspaper reports will correspond or will be congruent with the survey respondents' perceptions of the same topic. These two hypotheses were tested using frequency distribution tables and descriptive statistics.

CHAPTER 4.

RESULTS AND DISCUSSION

The results presented in this chapter reveal the frames the newspapers used to report on the biofuels issue and the audience frames elicited from the respondents' answers to survey questionnaire items. The valence toward biofuels as a topic demonstrated in the newspaper articles were compared against survey respondents' assessments of the same topic. The results of these media-audience comparisons are also discussed.

Content Analysis Results

The sample. A total of 145 articles that discussed the biofuels issue in depth were collected from the three newspapers over a one-year period. Of these, 98 were from the *Des Moines Register*, 37 came from the *Cedar Rapids Gazette*, and 10 were published by the *Davenport Quad City Times*.

Among the 98 articles from the *Register*, 64 (47.4%) were found in the business section, 16 (12%) were published on the front page, 10 were located in the section on local (or Metro) news, and eight were found in other pages. The sections where the articles appeared in the *Gazette* and the *Times* were not specified in the electronic news archives. The positions of the stories in the *Register*, however, indicate that the topic received top priority treatment from the newspaper's gatekeepers.

Frames

RQ1 asked: "What are the frames Iowa newspapers used to structure their stories about biofuels?" The literature cites four frames other researchers have identified before: economic consequences, technology, food vs. fuel, and the risk frames. Aside from these four frames, eight more were identified following an emergent coding scheme. These were (1) environmental benefits, (2) public policy, (3) impact on agricultural activities, (4) consequences to the ethanol industry, (5) politics and political debate, (6) the need for energy security, (7) trade competition, and (8) national security. Each of these is described below:

1. The **environmental benefits** frame specifically discusses direct impacts on the environment as a consequence of the different ways by which the state plans on pursuing a bioeconomy. The following are examples of parts of straight news reports that exhibit the environmental benefits frame:

Example 1. Environmental advocates gathered on the steps of the state Capitol on Saturday amid signs of "We're ready. Green jobs now!" to emphasize how Iowa can benefit from growth in renewable energy, such as ethanol and wind power.

The rally, organized by the 1Sky Campaign, was one of more than 660 events held nationwide Saturday as part of an effort to rally the federal government to build an environmentally friendly economy (*Des Moines Register*, 2008).

Example 2. "As the world seeks to reduce greenhouse gases and other forms of pollution, demand for clean, renewable energy will continue to increase rapidly," Snow said (*Des Moines Register*, 2008).

2. The **public policy** frame conveys the discussions, announcements, legislations or effects of policies related to biofuels, such as the 2007 Farm Bill or the ethanol mandate. The following paragraphs are examples of portions of straight news reports that demonstrate this frame:

Example 1. The Bush administration raised objections Monday to a sweeping new energy bill that would dramatically increase biofuel usage while boosting auto efficiency requirements and renewable electricity generation.

The legislation is expected to require the use of 20.5 billion gallons of biofuels annually by 2015 and 36 billion gallons by 2022 (*Des Moines Register*, 2007).

Example 2. An energy bill that will guarantee a growing market for biofuels and boost auto fuel efficiency cleared the Senate on Thursday after Democrats gave up on a tax increase on oil companies.

The legislation, designed to reduce US oil consumption and greenhouse gas emissions, would require refiners to use 36 billion gallons of ethanol and other biofuels by 2022, an increase of nearly six times over this year's production (*Des Moines Register*, 2007).

3. The **agricultural activities** frame focuses on the immediate and potential changes to agricultural activities resulting from the drive to harness fuels from biomass. These changes to agricultural production practices include crop switching and "acres seeking," among others. The following paragraphs demonstrate this frame:

Example 1. Economists at the University of Missouri who forecast agricultural production for Congress estimate farmers will seed nearly 166 million acres to those two crops, four million acres more than this year.

A key reason why that extra acreage will be needed: Demand for corn by the ethanol industry is expected to increase by nearly 700 million bushels or about 17 percent (*Des Moines Register*, 2008).

Example 2. Assuming the government's latest crop forecast is right and this fall's corn and soybean harvests are sufficient to meet demand, stocks of corn and soybeans are still expected to fall to historically low levels. That's even as biofuel production and global grain consumption are likely to keep growing (*Des Moines Register*, 2008).

4. The **ethanol industry** frame specifically discusses the operation, profit margins, the markets for, and the challenges facing ethanol plants. This frame conveys the concerns and the hope that this Iowa-based industry survives the tough economic time, especially the fluctuating oil prices. The following paragraphs are examples that exhibit

the ethanol industry frame:

Example 1. The slowdown in the ethanol industry is taking some pressure off the nation's corn supplies.

Several ethanol projects have been put off in recent weeks because of falling ethanol prices (*Des Moines Register*, 2007).

Example 2. Des Moines venture capitalist John Pappajohn pulled the plug Tuesday on an ethanol venture designed to pump money into rural areas by shifting control of farmer-owned ethanol plants to a publicly owned company.

Pappajohn's plan was to raise at least $800 million from investors to buy control of six to ten farmer-owned ethanol plants and place them under unified management and marketing (*Des Moines Register*, 2007).

Example 3. With ethanol market prices down 30 percent in recent months and evidence of a slowdown in the industry—even as more plants are built—some have wondered if the corn-based ethanol industry has already peaked (*Des Moines Register*, 2007).

5. The **political debate** frame zeroes in on the political debates and arguments surrounding the biofuels or bioenergy issue as pronounced or instigated by politicians, government officers or candidates for public offices. The following paragraphs are examples of parts of straight news reports that exhibit the political debate frame:

Example 1. More than 20 Republican senators—including Republican presidential candidate John McCain—asked the Environmental Protection Agency this week to cut in half the requirement that nine billion gallons of fuel sold this year must come from renewable sources.

Farm-state senators from both parties, including Iowa's Charles Grassley and Tom Harkin, wrote a letter to the EPA in response.

"We strongly disagree with the assumption that the renewable fuels mandate is harming the US economy or that it is primarily responsible for the global escalation of food costs," according to the letter, which will be sent later this week (*Davenport Quad City Times*, 2008).

Example 2. An energy bill passed in December required nine billion gallons of ethanol to be blended into gasoline from Sept. 1 to Aug. 31 of next year. Perry asked the EPA in April to drop the Renewable Fuels Standard requirement to 4.5 billion gallons because demand for ethanol is raising corn prices for livestock producers and driving up food prices.

Sen. Chuck Grassley, R-Iowa, called the decision a "victory for clean energy, rural America and national security," saying it will allow farmers to "continue to plan for and meet the fuel and food needs of the future."

Sen. Kay Bailey Hutchison, R-Texas, who filed legislation that would freeze

future ethanol production at this year's level, criticized the agency's decision (*Cedar Rapids Gazette*, 2008).

Example 3. Republican presidential candidate John McCain used the nation's leading corn-producing state as his backdrop Thursday to announce he opposed new federal farm legislation.

Democratic candidates Hillary Clinton and Barack Obama have both spoken favorably about the farm bill. Clinton on Thursday, in a news release, urged McCain to join her in supporting the bill (*Des Moines Register*, 2008).

6. The **energy security** frame focuses on the need for a more diverse source of energy for the nation and the world, and the goal of creating a stable supply of energy preferably from biomass. The following paragraphs are examples of news portions that exhibit this frame:

Example 1. "Having a dedicated ethanol pipeline running from the Midwest to the Eastern markets will help bridge the gap between the Midwest and the East, aiding America's energy security," said Sen. Tom Harkin, D-Ia., chairman of the Senate Agriculture Committee (*Des Moines Register*, 2008).

Example 2. The green slime or pond scum that comes from algae could be valuable after all. The Renewable Energy Group of Ames says it has developed a process that takes the oil from algae and turns it into biodiesel fuel.

"Algae oil would give us a third option as a biodiesel feedstock after soybean oil and animal fats," said Daniel Oh, chief operating officer of Renewable Energy Group (*Des Moines Register*, 2008).

7. The **trade competition** frame strongly discusses the role and position of biofuels in international trade, and the competitiveness of American biofuels in the global market. The following paragraphs are examples that show the trade competition frame:

Example 1. Ethanol producers are certain to press the next president to keep the 54-cent-per-gallon tariff on imported ethanol that protects US producers from foreign competition. Brazil is arguing at the World Trade Organization that ethanol is an environmentally beneficial product that should be exempt, or nearly exempt, from tariffs (*Des Moines Register*, 2007).

Example 2. Two tariffs apply to ethanol imports, which are intended to shelter US ethanol plants from foreign competition and to deny the benefits of US domestic ethanol subsidies to foreign ethanol producers (*Des Moines Register*, 2007).

Example 3. It's economical to export biodiesel because US taxpayers subsidize the fuel additive and it also benefits from tax incentives in Europe and the relative weakness of the dollar against the euro. The weak dollar makes US products cheaper compared with European goods (*Des Moines Register*, 2008).

8. The **national security** frame considers exclusively the country's current over

reliance on the Middle East—where some nations are not so friendly toward the US— for oil. The following paragraphs demonstrate the application of this frame:

> The United States needs to support viable alternative fuels, including corn-based ethanol, Sandalow said. Other possible alternatives include plug-in cars and more fuel-efficient vehicles, he said.
>
> And doing those things will strengthen national security, allowing the United States to have a better bargaining position with countries it now depends heavily upon for oil, other experts said last night during the panel discussion (*Cedar Rapids Gazette*, 2007).

The pre-defined and emergent frames exhibited by the news reports were coded. As shown in Table 2, the economic consequences frame made up the bulk of the first and the second frames observed across the three newspapers. In the first frame detected, the economic consequences frame was followed by the technology frame (22%), which was the most observed frame in the *Quad City Times* (three of ten articles). Of the stories that used this frame, 40 were published by the *Des Moines Register*. The economic consequences frame was also the dominant frame in the *Cedar Rapids Gazette* with 19 articles exhibiting it.

The public policy frame was the third commonly observed (17%) first frame across all newspapers. Twenty-three of the *Register*'s 98 articles, three of the 37 in the *Gazette*,

and two of the ten stories published by the *Times* were framed using the public policy angle. Stories depicting this frame primarily discussed the Farm Bill and the ethanol mandate. Another identified frame specifically talked about the ethanol plants' profit forecasts (8%). The food vs. fuel and risk frames were the least observed in the three newspapers.

Table 2. The first and second frames observed in newspaper reports

First frame	**Frequency**	**Valid percent**
Economic consequences	61	36.5
Technology	36	21.6
Food vs. fuel	8	4.8
Risk	10	6.0
Environmental benefits	1	0.6
Public policy	28	16.8
Agricultural activities	1	0.6
Ethanol industry	14	8.4
Political debate	3	1.8
Energy security	1	0.6
Trade competition	3	1.8
National security	1	0.6
Total	167	100.0
Second frame		
Economic consequences	32	38.1
Technology	19	22.6
Food vs. fuel	19	22.6
Risk	8	9.5
Environmental benefits	0	0.0
Public policy	0	0.0
Agricultural activities	1	1.2
Ethanol industry	4	4.8
Political debate	1	1.2
Total	84	100.0

The economic consequences frame also was the dominant second observed frame

(38%), followed by the technology frame (although absent in the *Gazette* stories) and the food vs. fuel frame, both of which constituted close to 23 percent of the second framed observed (Table 2). The risk frame only appears in eight articles featured in the *Register* at 10%. The ethanol industry frame constituted 5% of the second frames observed. The agricultural activities frame and the political debate frame both composed one percent of the second frame detected in the three newspapers combined (Table 2). The *Register* and the *Times* both displayed the ethanol industry frame, but the *Gazette* did not show any dominant overarching theme.

Valence

RQ1 also asked: "What valence did Iowa newspapers show in their coverage of biofuels?" Among the 145 news stories analyzed, 56 (38.6%) were found to be neutral toward the biofuels issue; 46 articles (31.7%) were positive, and 43 stories (29.7%) were evidently negative toward the topic (Table 3).

Table 3. Valence toward biofuels shown in newspaper coverage

	Frequency	**Percent**
Negative	43	29.7
Neutral	56	38.6
Positive	46	31.7
Total	145	100.0

Sources

Who were most frequently cited as sources of information throughout the coverage?

As shown in Table 4, politicians at the state and federal levels, such as senators, the presidential candidates, and President Bush, were the main sources quoted in the news reports, comprising 27.3% of the first cited source. Industry representatives, such as spokespersons for the ethanol plants and engineering companies, were the second most frequently cited sources, making up 25.9 percent of the total. Non-government scientists and researchers who work for non-academic institutions were the third most cited first source. The least observed first sources were farmers (0.7%).

Industry representatives dominated the second source of information cited, comprising 28.2% of all cited second sources. They were followed by scientists who work in groups or organizations not affiliated with the government or academic institutions (19.4%). Politicians were the third most frequently cited second source (16.1%). Lobbyists were rarely quoted as a second source.

The findings indicate that the views politicians, industry groups and non-government and non-academic scientists dominated the biofuels debate. Rarely consulted were farmer groups, an important biofuels stakeholder. These three groups, therefore, were the most successful in helping newspaper journalists frame the topic, and were aggressive enough to have influenced coverage. For example, industry representatives may have a lot to do with the significant presence of economic consequences and ethanol industry frames in news reports. Organization, institutes or scientists other than government agencies and

universities would have facilitated the formulation of technology, environment or economic consequences frames. Politicians, evidently, have played an important role in the heavy use of the public policy and political debate frames. The voice of lobbyists and unaffiliated individuals were muted in the general coverage.

Table 4. Sources cited in the newspaper coverage

First cited source	**Frequency**	**Valid Percent**
Lobbyist	3	2.1
Scientist, researcher in government	7	4.9
Scientist, researcher and professor in university	20	14.0
Representative from industries	37	25.9
Farmer	1	0.7
Politician	39	27.3
Staff of government or politician	7	4.9
Organization, institute, or scientists other than government agencies and universities	24	16.8
Unaffiliated individual	5	3.5
n	143	100.0
Second cited source		
Lobbyist	1	0.8
Scientist, researcher in government	10	8.1
Scientist, researcher and professor in university	19	15.3
Representative from industries	35	28.2
Farmer	3	2.4
Politician	20	16.1
Staff of government or politician	8	6.5
Organization, institute, or scientists other than government agencies and universities	24	19.4
Unaffiliated individual	4	3.2
n	124	100.0

Survey Results

Sample demographics

Of the 1,000 questionnaires mailed out, 253 were completed and returned for a response rate of 25.3%. Of these, 51% came from Des Moines, 31% from Cedar Rapids, and 18% from Davenport. Those who are 65 years old or older made up 28.2% of the respondents, followed by the 55 to 64 (26.2%) age group. Male respondents constituted 75.4 percent of those who participated in the survey.

Media exposure habits related to biofuels

The vast majority of the respondents (229 or 90.9%) claimed they have indeed heard about biofuels and know something about it. Asked what source of information they access to learn about biofuels, 72.6% said they depended primarily on television. Another 71.3% reported newspapers as their main source of information regarding the topic. Close to 48% listened to the radio; another 46% said they read stories about biofuels in magazine reports. Advertisements from various media were mentioned as a source of biofuel information by a little more than 42% of the respondents. Only 31% referred to the Internet, and 26% sought information from friends or relatives. Other sources included discussions in classrooms and other formal education venues, conversations at work, and interactions with farmers (Table 5).

Table 5. Sources of information about biofuels

Sources	Frequency	Valid percent
Friend or relative	60	26.1
Television	167	72.6
Radio	109	47.4
Newspapers	164	71.3
Magazines	105	45.7
The Internet	71	30.9
Advertisements	97	42.2

Of those who returned their questionnaire, 45 claimed they read newspapers often (19.7%), 116 (50.9%) said they read newspapers almost always, and only three (1.3%) said they never read newspapers at all. The second major group (71.3%) claimed newspapers as their major source of biofuels information; among them, 70.6% reported they read newspapers often to almost always (Table 6). These findings suggest that the respondents were avid newspaper readers. Because of this, the medium is therefore a highly probable source of cognitions about the biofuels issue.

Table 6. Frequency of reading newspapers

	Frequency	Valid percent
Never	3	1.3
Very seldom	23	10.1
Sometimes	41	18.0
Often	45	19.7
Almost always	116	50.9
n	228	100.0

The *Des Moines Register* was the newspaper read most regularly by 48.7% of the respondents. About 27.5% subscribe to the *Cedar Rapids Gazette*, and 13.5% regularly

read the *Davenport Quad City Times*. These distributions went proportionally with the response rates from the three cities (at 51%, 31% and 18%, respectively), which suggests that residents support or are loyal to the major newspaper published in their city. This further supports the contention that newspapers are the most likely source of overarching frames audiences apply to understand this rather complicated issue.

The respondents also said they turn to other nationally circulated newspapers for information regarding the biofuels issue. For the majority of them, these newspapers are *USA Today*, the *New York Times*, and the *Wall Street Journal* (Table 7). These publications presumably provide broader perspectives about the topic, looking at the biofuels issue from a more national and global standpoint.

Table 7. Newspapers read regularly

Newspapers	**First mentioned newspaper**		**Second mentioned newspaper**	
	Frequency	Valid percent	Frequency	Valid percent
Des Moines Register	104	48.4	6	9.7
Cedar Rapids Gazette	59	27.4	6	9.7
Davenport Quad City Times	29	13.5	6	9.7
USA Today	4	1.9	13	21.0
New York Times	5	2.3	10	16.1
Wall Street Journal	7	3.3	8	12.9
Other	7	3.3	13	21.0
Total	215	100.0	62	100.0

How often do people read newspaper articles about biofuels? Of those who regularly read newspapers, 17.7% said they encounter such stories “often;” another 13.3% said they

"almost always do." However, many (27.4%) stated they "very seldom" read articles about biofuels; 5.3% said they "never" read about the topic at all. Those who read about the topic "sometimes" constitute 36.3% of newspaper readers in the sample (Table 8). These results indicate that although the topic has received moderate newspaper attention, and that the articles about the issue were prominently displayed in their newspapers of choice, the majority of newspaper readers (63.7%) peruse these stories "very seldom" to "sometimes."

Table 8. Frequency of exposure to articles that discuss biofuels

	Frequency	**Valid percent**
Never	12	5.3
Very seldom	62	27.4
Sometimes	82	36.3
Often	40	17.7
Almost always	30	13.3
n	226	100.0

Iowans were also asked how much of the biofuels topic they think they understand. Close to 42% said they "understand it somewhat," 12.7% said they understand the topic "enough to get by," and 13% reportedly understand the issue "very well" (Table 9). That only a quarter of the respondents confidently reported understanding the topic at all alludes to the often technical nature of the issue, especially those that report on scientific findings replete with figures and hard data. These information, however, are rarely contextualized, and may therefore look challenging to the average reader.

When speaking of biofuels, many were reminded immediately about ethanol and biodiesel. The respondents also noted several sources of ethanol other than corn, including the cellulose-based switchgrass, sugarcane and other biomass sources. They also know that biodiesel can be derived from soybean and other grains. Some pointed out that biofuels can be extracted from leftover vegetable oils or fats. Others talked about specific kinds of fuels, such as E-85, or other biologically-formed energy sources such as methane.

Table 9. Iowans' self-evaluation of their degree of knowledge about biofuels

	Frequency	**Valid percent**
Close to nothing	12	5.3
Very little of it	30	13.2
Understand it somewhat	95	41.7
Enough to get by	62	27.2
Understand very well	29	12.7
n	228	100.0

Frames

The first part of RQ2 asked: "What are the frames Iowa residents hold about biofuels?" The four pre-identified literature frames (economic consequences, technology, food vs. fuel, and the risk frames) detected in content analysis also showed up in the survey respondents' open-ended responses. Aside from these, four more frames were elicited through the survey. These were: (1) alternative energy sources, (2) the environment, and (3) public policy.

1. The **alternative energy source** frame generally sees biofuels as one of the transportation fuels and highlights its role as an alternative energy source.

2. The **environment** frame discusses the environmental benefits that can be derived from using biofuels.

3. The **public policy** frame is found in stories that feature discussions, legislations or the effects of policies related to biofuels, especially the 2007 Farm Bill and the ethanol mandate.

As shown in Table 10, the economic consequences frame was the most frequently elicited frame, making up 42.1% of the first mentioned audience frames. This frame encompasses the respondents' notions that increased production might bring about continuously rising assessments of biofuels tariffs. This frame also includes comments that highlighted the hope that the bioeconomy will substantially promote the country's independence from foreign oil. The technology frame constituted 28.7% of the open-ended responses. The alternative energy sources frame was the third most frequently mentioned, particularly in the way respondents saw the role of biofuels in diversifying the country's energy sources (14.9%). Many also saw the issue through the environmental benefits lens, the fourth most repeated frame (8.7%). The food vs. fuel and risk frames made up 2.6% and 2.1%, respectively, of the first mentioned frames.

The economic consequences frame also dominated the second frame mentioned

(43.7%) (Table 10). The technology frame came in a distant second (20.7%). The environment frame made up 15.6% of the second mentioned audience frames. There was little mention of the food vs. fuel and risk frames, which constituted only 7.4% and 4.4 %, respectively, of the second mentioned frames. In the emergent coding scheme, the public policy frame that pertains to the government's ethanol subsidy or the ethanol mandate made up 4.4% of the total number of second frames observed. The alternative energy source frame came in as the least with 3.7%.

Table 10. The frames identified in the open-ended answers of survey respondents

First frame	**Frequency**	**Valid percent**
Economic consequences	82	42.1
Technology	56	28.7
Food vs. fuel	5	2.6
Risk	4	2.1
Alternative energy source	29	14.9
Environment	17	8.7
Public policy	2	1.0
n	195	100.0
Second frame		
Economic consequences	59	43.7
Technology	28	20.7
Food vs. fuel	10	7.4
Risk	6	4.4
Alternative energy source	5	3.7
Environment	21	15.6
Public policy	6	4.4
n	135	100.0

There were some media frames—such as agricultural activities, the ethanol industry, political debate, trade competition and national security—missing in the audience frames.

Judging by the frequency with which these frames were applied as found in the content analyses, the absence of these frames in audience discourse may have been due to limited number of times the same frames were employed in media reports. Another reason could be that respondents' inability to articulate cognitions in written responses.

Valence

The audiences' attitudes toward specific aspects of the biofuels issue were measured through the use of seven Likert-scale items. Table 11 shows the extent to which the respondents agreed with these biofuels-related statements, measured on a scale of 1 to 5 where 1 means "strongly disagree" and 5 means "strongly agree."

Those who agreed to strongly agreed with the statement "biofuels will create more jobs for Iowans" altogether made up 74.3% of the total valid responses. Only 11 respondents disagreed with this statement.

The majority (44.1% or 101 respondents) disagreed to strongly disagreed that "biofuels will cause environmental problems." However, a sizeable chunk (24% or 56 respondents) said they agreed to strongly agreed with this statement, indicating that many are concerned about the environmental impact of intensified biofuels production.

An overwhelming majority (75.8%) of the Iowans surveyed agreed to strongly agreed that "biofuels will boost Iowa's economy." Of the 228 valid responses, only 4.3% reported they disagreed to strongly disagreed with this statement.

The majority also was in agreement that "producing biofuels will help solve the country's energy problem" (46.5% agreed and 7% strongly agreed with it). However, 57 respondents doubted the ability of biofuels to answer the nation's energy needs. Of the 230 valid responses, 19.1% said they disagreed and 5.7% reported they strongly disagreed with the prediction that biofuels will solve the nation's energy crisis.

Among the 230 valid responses, 116 or 50.4% showed agreement with the notion that "more land devoted to biofuels will increase the cost of food items." About 24%, however, disagreed or strongly disagreed with the statement.

The majority (44.3%) also disagreed with the statement, "I consider biofuels production rather risky" while 23.7% said they agreed to strongly agreed with this statement of risk. These evaluations indicate that the origins of these risk perception must be understood to develop a more informed citizenry.

Over half of the respondents (51.7%) agreed to strongly agreed that "the ways Iowa is producing biofuels are technologically feasible." Those who do not subscribe to this statement made up 14.1% of the total number of respondents (Table 11).

Table 11. Iowans' attitudes toward biofuels

	Frequency	Valid percent	Means	Standard deviation
1. Biofuels will create more jobs for Iowans.				
Strongly disagree	0	0.0		
Disagree	11	4.8		
Neutral/no comment	48	20.9		
Agree	142	61.7		
Strongly agree	29	12.6		
n	230	100.0	3.28	0.705
2. Biofuels will cause environmental problems.				
Strongly disagree	11	4.8		
Disagree	90	39.3		
Neutral/no comment	72	31.4		
Agree	49	21.4		
Strongly agree	7	3.1		
n	229	100.0	2.79	0.938
3. Biofuels will boost Iowa's economy.				
Strongly disagree	1	0.4		
Disagree	9	3.9		
Neutral/no comment	45	19.7		
Agree	141	61.8		
Strongly agree	32	14.0		
n	228	100.0	3.85	0.718
4. Producing biofuels will help solve the country's energy problem.				
Strongly disagree	13	5.7		
Disagree	44	19.1		
Neutral/no comment	50	21.7		
Agree	107	46.5		
Strongly agree	16	7.0		
n	230	100.0	3.30	1.037

Table 11. (continued)

	Frequency	Valid percent	Means	Standard deviation
5. More land devoted to biofuels will increase the cost of food items.				
Strongly disagree	6	2.6		
Disagree	48	20.9		
Neutral/no comment	60	26.1		
Agree	79	34.3		
Strongly agree	37	16.1		
n	230	100.0	3.40	1.068
6. I consider biofuels production rather risky.				
Strongly disagree	7	3.1		
Disagree	94	41.2		
Neutral/no comment	73	32.0		
Agree	46	20.2		
Strongly agree	8	3.5		
n	228	100.0	2.80	0.917
7. The ways Iowa is producing biofuels are technologically feasible.				
Strongly disagree	2	0.9		
Disagree	30	13.2		
Neutral/no comment	78	34.2		
Agree	110	48.2		
Strongly agree	8	3.5		
n	228	100.0	3.40	0.793

Note: Response items ranged from 1 to 5, where 1 means "strongly agree" and 5 means "strongly disagree."

In general, these evaluations indicate a positive appraisal of the role of biofuels in the economic development and the energy future of the state.

The valence of people's perceptions of biofuels was measured by first reverse-coding the responses to Items 1, 3, 4 and 7 above. This produces a coding protocol in which the greater the number, the greater the degree of agreement. Those who

answered 4 or 5 (agree to strongly agree) were categorized as having positive attitudes toward the topic. Those who answered 1 or 2 (strongly disagree to disagree) were categorized as having negative attitudes toward the topic. An analysis of the frequency of responses to the seven items indicate that those with a positive attitude made up 52.5% or 842 of the valid responses (n=1,603). About 21.0% (336) showed a negative attitude toward the issue (Table 12).

Table 12. Valence of audience perception toward biofuels

	Frequency	Valid Percent
Negative	336	21.0
Neutral	425	26.5
Positive	842	52.5
n	1603	100.0

Comparisons Between the Content Analysis and the Survey Results

Hypothesis 1 posits that media frames present in the newspapers' coverage of biofuels will correspond with the audience frames about this topic. To test this hypothesis, the frames observed from the three newspapers were matched against the frames elicited from the readers' open-ended responses.

Media frames and audience frames compared

As shown in Table 13, economic consequences was the most dominant first frame observed in the newspaper reports and in the survey responses (36.5% and 42.1%, respectively). The technology frame was a distant second, constituting 21.6% of the first

observed frames in the media and 28.7% of the audience frames gleaned from survey responses.

The economic consequences frame was also the most frequently occurring second frame observed in the newspaper articles (38.1%). It was also the most frequently detected second frame in audience responses (43.7%). The technology frame, which showed up in close to 23% of the newspaper frames, also appeared in 20.7% of audience answers. The food vs. fuel frame, seen more frequently in newspaper reports (22.6%), was observed in 7.4% of audience responses (Table 13).

Table 13. Newspaper frames and audience frames compared

Frames	**First observed (valid percent)**		**Second observed (valid percent)**	
	Media	Audience	Media	Audience
Economic consequences	36.5	42.1	38.1	43.7
Technology	21.6	28.7	22.6	20.7
Food vs. fuel	4.8	2.6	22.6	7.4
Risk	6.0	2.1	9.5	4.4
Environmental benefits	0.6	8.7	0.0	15.6
Public policy	16.8	1.0	0.0	4.4
Energy security/alternative energy source	0.6	14.9	0.0	3.7

These findings suggest a strong correspondence between media frames and audience frames, indicating that what the media carry in their reports on biofuels have found their way into the cognitions of audiences. Further evidence to support this is the congruence in the intensity of frame use or the percentages of frames present in the media reports and

in audience responses. For example, the food vs. fuel frame constituted 4.8% and 22.6% of the first and second observed frames, respectively, in the content analysis. This distribution is mirrored in the public's frames about biofuels that showed the food vs. fuel frame at 2.6% and 7.4% of the total number of first and second frames mentioned. The risk frame that discusses potential damages to the environment, human and animal health comprised 6% and 9.5% of the first and second frames observed in news reports, respectively. This low visibility is echoed in the readers' responses (Table 13).

Media and audience frames also overlap for the emergent frames listed in Table 13. In both newspaper reports and audience discourse can be found the environmental benefits, public policy, energy security and alternative energy source frames. The public policy frame, appearing significantly (16.8%) in the first observed frame in the news reports but absent in the second, and occurring rarely in the audience's frames (1% and 4.4%, respectively), talks about the energy bill, the ethanol mandate, the ethanol subsidy, or Iowa's bioeconomy plan. The energy security frame or alternative energy source frame seriously discussed the need to maintain a sufficient energy supply and the imperative of diversifying energy sources to offset fossil fuel shortages. These topics were more present in the first and second observed audience frames than in the media frames. Audience members also fashioned their understanding of the issue using the environmental benefits frame, which constituted 8.7% and 15.6% of the first and second observed audience

frames, respectively. This frame highlights the positive effects of biofuels, such as cleaner burning fuels and less carbon dioxide emitted into the atmosphere that can help alleviate global warming.

Valence held by the media and the audience

Hypothesis 2 posits that the valence toward biofuels carried in newspaper articles will be congruent with the valence exhibited by audiences. In the content analysis, the newspapers' orientation toward biofuels was categorized as negative, neutral or positive. In the survey, audience valence was measured through Iowans' responses to the seven Likert-scales items meant to tap people's attitudes toward biofuels.

As Table 14 shows, 29.7% of the newspaper stories analyzed (n=145) was negative toward biofuels while only 21% of the survey responses (n=253) considered biofules to be so. Close to 32% of the newspapers articles were coded as positive toward the topic while 52.5% of the responses exhibited a positive stance. Over a quarter of the respondents were neutral on biofuels while 38.6% of the articles were coded the same. The findings show that readers had a more positive perception of the issue while the newspapers were more neutral toward the topic judging by their relatively balanced reports.

Table 14. Comparison of the valence of newspaper stories and valence of audience's opinions about biofuels

Valence	Story orientation (valid percent)	Audience's orientation (valid percent)
Negative	29.7	21.0
Neutral	38.6	26.5
Positive	31.7	52.5

Positive and negative remarks in the media coverage and audience assessments

The newspaper articles were analyzed to distill positive and negative remarks about the biofuels topic that may have helped shape people's understanding of it. Many newspaper reports demonstrated a balanced depiction of the issue, displaying scientific findings, opinions and comments by sources. Some of these sources lauded the biorenewable energy initiatives; others were worried about a number of potential adverse impacts.

The positive aspects of biofuels portrayed in news reports mainly touted the need for "green" energy, specifically the potential of an emerging bioeconomy to generate more green jobs. That biofuels offer a means of offsetting the country's dependence on foreign oil was also frequently mentioned. Reducing the use of fossil fuels from the Middle East where some nations are known for their hostile stance toward the US, many articles underscored, will strengthen national security.

The news reports also discussed major concerns that go with embarking on the biofuels train. Reporters pointed out a potential outcome that going full bore on biofuels

will raise the cost of crops and consequently, the prices of food items, a phenomenon that will adversely affect the food and livestock industries as well as consumers. Raising crops for fuel may also substantially diminish the global food supply, many news reports emphasize. Intensive cultivation of crops for biofuels may also lead to water shortages and other environmental damages. The reports also echoed the concerns of some sectors that the processes entailed in biofuels production are technically inefficient in that corn-based ethanol can only replace a small percentage of the country's transportation fuel needs. The whole effort will, contrary to the assertions of many, release more greenhouse gases into the atmosphere.

People's positive and negative comments were discerned from their open-ended responses to Questions 10 and 11 of the questionnaire that elicited what they understand about the topic in general. These syntheses of cognitions showed a preponderance of positive remarks. The survey respondents mostly mentioned the national need to be less dependent on foreign oil (32.3% of the first positive comments observed) and stressed the benefits accruing from significant reductions in greenhouse gas emissions (23.6%). These arguments are in agreement with statements found in newspaper reports. The need to be less reliant on fossil fuels was also a common theme of audience discourse (12.6%). People were also hopeful that the initiatives in this area will result in a more robust economy because they will generate more jobs (7.9%) (Table 15). The congruence

between the positive discussion in the media reports and the audience's positive remarks indicate that media themes may have helped readers crystallize their understanding of this complex topic.

Table 15. Positive remarks about biofuels from audience responses

Positive aspects	**Frequency**	**Valid percent**
Biofuels will help strengthen the economy; will help create more jobs	10	7.9
Biofuels production is technically efficient and feasible	3	2.4
Biofuels reduces the country's dependence on foreign oil	41	32.3
Biofuels will improve the state of the environment; releases less greenhouse gases	30	23.6
Biofuels will produce cheaper fuel	9	7.1
Biofuels reduces the country's dependence on fossil fuels	16	12.6
Biofuels adds to energy diversity	1	0.8
Other	17	13.4
Total	127	100.0

In terms of the drawbacks, the survey responses mostly mentioned the potential of rising food prices (27%), an outcome related to fears of shortages in food supply (12.4%). These arguments are in agreement with newspaper reports. The newspaper reports' concerns that current biofuels production processes are not technically efficient in that it consumes large amounts of water were raised by the survey respondents (19.1% and 3.4%, respectively) who worried that diverting water for this purpose will reduce what it needed to grow grains. Iowans also mentioned the possibility that converting forests or grasslands

to corn areas for ethanol may cause environmental damages (10.1%), a possibility that was also mentioned in newspaper reports. Some respondents also doubted the ability of biofuels to solve the country's energy and environmental problems (10.1%). These audience remarks clearly subscribe to the negative aspects of the issue found in newspaper reports (Table 16).

Table 16. Negative remarks about biofuels from audience responses

Negative aspects	**Frequency**	**Valid percent**
Biofuels threaten water security	3	3.4
Biofuels will bring about environmental damages	9	10.1
Biofuels cannot really solve energy/environmental problems	9	10.1
Biofuels production processes are technically inefficient	17	19.1
Biofuels will lead to higher food prices	24	27.0
Biofuels will lead to shortages in food supply	11	12.4
Other	16	18.0
Total	89	100.0

CHAPTER 5.

CONCLUSIONS

This study aims to provide evidence to support the contention that how the mass media depict an issue with the use of thematic frameworks or frames help shape audience's understanding of the same issue. The current study thus analyzed how newspapers used frames to report on the biofuels issue to their publics, and how the audiences of such coverage came to understand or interpret the multiple facets of this fairly complicated topic. The orientation of the newspaper coverage and that of the audiences regarding this topic were also compared.

A content analysis of three Iowa daily newspapers—the *Des Moines Register*, the *Cedar Rapids Gazette* and the *Davenport Quad City Times*—was done to elicit media frames. To determine audience frames, a mail questionnaire was administered to a random sample of residents in the three major cities served by the newspapers listed above—Des Moines, Cedar Rapids and Davenport.

Media Frames and Audience Frames

The findings show congruence between the frames the newspapers used to report on the topic and the audience frames regarding the same issue elicited from their open-ended responses. The economic consequences frame was the most frequently occurring frame in the newspaper articles and in audiences' responses. The next most dominant frame in the

news reports, the technology frame, is also present in the public's discourse about this topic. Also present in the media coverage and in audience remarks is the food vs. fuel frame. The risk frame was employed less frequently by the newspapers and was also found rarely in the audiences' discourse. These four frames were previously identified through literature review.

There were differences between the media and the audience, however, in terms of the other frames observed using an emergent coding scheme. Generally, the media displayed more diverse aspects of the biofuels issue and more frames to report on the topic than the audiences. For example, from media reports were gleaned the environmental benefits, public policy, energy security, political debate, agricultural activities, trade competition, national security, and the ethanol industry frames. Although some of the audience frames overlap with those observed in the newspapers (i.e., the environment, public policy, and alternative energy sources frames), they were less diverse.

According to Gamson and Modigliani (1989), certain media packages have natural advantages because their ideas and language resonate with some aspects of the audience's culture. The dominance of the economic consequences frame in the media seems to respond to gatekeepers' assessments of the relevance of the topic to the state of Iowa and its economic imperatives. The coverage, in general, appears very supportive of the state

leadership's vision to create a model bioeconomy. These positive facets of the drive toward energy self-sufficiency, in turn, are mirrored in the audiences' attitudes and understanding of the issue.

According to Craft and Wanta (2004), framing effects go beyond *what* issues the audiences think about toward guiding them *how* they should think about these issues. These frames are discerned by audiences in news stories that encourage those who perceive and think about events to elaborate particular understandings of them (Entman, 1991). In the current study, the three Iowa newspapers employed frames that stressed economic consequences, the attributes of the technology, and public policy that triggered the drive toward the search for more sources of renewable energy. The stories also highlighted the dynamics of the ethanol industry to inform and guide readers as to how they should think about the issue. Thus, the similarity of and the overlaps in frames observed in the content analysis and the survey results lend support to the argument that "frames that paradigmatically dominate news also dominate audiences" (D'Angelo, 2002, p. 876).

The Valence of Newspapers Reports and Audience Perception

There was no direct match found between the valence of the newspaper coverage and the valence of audience perceptions of the topic. The results of the content analysis reveal that 31.7 % of the articles analyzed were positive toward biofuels, 29.7% were

negative, and 38.6% were neutral. These findings suggest that the media presented a balanced coverage of the issue, a characteristic common in the way American journalists report on science and technology topics, especially those that are likely to engender strong public debate.

The respondents' responses to the seven Likert-scale items intended to measure their attitudes about the topic show that 52.5% of them were positive toward biofuels, 21% were negative, and 26.5% were neutral. This finding indicates that Iowa residents were generally positive toward biofuels and are aware of the important role this may play in strengthening the state's economy.

These results suggest a discrepancy between the valence toward the biofuels topic observed in media content and the valence audience members hold about that topic.

Positive and Negative Remarks in the Media and Audience Discourse

The positive remarks found in the newspapers were also observed in the survey responses. The most frequently occurring positive statements about biofuels in both the media and audience discourse discussed the benefits the state and the nation can derive from being less dependent on foreign oil, the ability of a new energy source to enhance environmental quality by reducing greenhouse gas emissions, and the role biofuels can play in diminishing the country's reliance on fossil fuels.

Negative aspects of the issue found in the newspaper articles were also seen in the

survey responses. These include the fear of escalating food prices, food shortages, environmental damages, and the concern that biofuels will hardly make a dent in solving recurring energy problems.

The findings suggest that frames not only carry specific perspectives but also provide ways by which audiences can be oriented toward issues. Iowa has been aggressively promoting its role as a pioneer in the biofuels industry and has thus developed the necessary infrastructure that will put its vision of a stable bioeconomy in motion. These aspirations have found support in news media coverage of the topic, which resonated with the free responses of media audiences.

Implications of the Findings to Theory

The findings support the axioms of framing theory, which posits that the way the media apply frames to package, include or exclude some aspects of social reality can find their way into audiences' perceptions and understanding of important issues.

In this study, certain frames—in the media and in the audience discourse—did stand out. For example, the economic consequences and the ethanol industry frames, which have a lot to do with agriculture and the occupation of most Iowans, dominated the media and the public frames. The public policy frame with its focus on the 2007 Farm Bill and the ethanol mandate are also closely linked to the major concerns of Iowa residents. Meanwhile, the environmental benefits, energy security or the alternative energy source

frame evidently echoed the issues in the current national agenda, such as the identified need to reduce greenhouse gas emissions and the national imperative to maintain a stable and diverse energy supply.

However, the valence of the newspapers' coverage and readers' responses were found not congruent. Almost one third (31.7%) of the newspaper stories were evaluated to be positive toward biofuels, less than a third (29.7%) was negative, and the rest was neutral (38.6%). This distribution does not match the respondents' orientations. This finding suggests that it is possible for the news media to convey objects, persons or events into the audience's minds, but that the media may not be that successful in transporting attitudes or in telling readers exactly how to feel about an object, person or event. In other words, audiences may "buy" the frames they encounter in the media, but they may not readily assimilate the valence implicitly or explicitly stated in the coverage. Instead, they appear to overlay media reports with their own encounters with and interpretations of biofuels.

Implications of the Findings to Journalistic Practice

Although the stories about biofuels occupied prime slots in the news holes in terms of number of stories published, the coverage can be considered moderate at best. On the other hand, 71% of the respondents reported they have learned or heard of biofuels from newspapers. Of these, only 30% said they read articles discussing biofuels often; the

majority (36.3%) read about the topic sometimes.

Despite the moderate intensity of media coverage and the low audience exposure to biofuels stories in newspapers, the frames present in the media narratives were observed in people's understandings of the issue. This suggests that the effects of framing need to be teased out in a more quantified manner to determine what aspects of media frames are more efficiently recalled, and which aspects have a lesser propensity to influence audience cognitions.

Audience members' open-ended responses also reveal gaps in knowledge about the issue, especially those related to the technical and scientific aspects of production. This suggests journalistic reports could strengthen informational areas. The alleged environmental impacts, and the influence of growing more acres for fuel instead of food also need to be explained in greater detail and in more clear terms.

Implications of the Findings to Policy

Judging by the people's discourse, government policies related to biofuels were understood only in very vague terms. A recap of government mandates and a simplified overview of the bioeconomy blueprint are therefore in order.

Any government policy stands the chance of benefiting some sectors and marginalizing others. A more thorough analysis of how different segments of society are differently affected by the biofuels policy will go a long way toward clarifying to the

public how the state government intends to go about pursuing this goal.

Whether biofuels will actually produce more greenhouse gases, raise food prices, or lead to food shortages can be more easily predicted when longitudinal data are subjected to risk analysis. Such studies, however, are part of a long-term research plan known only to policymakers. This plan should be communicated and widely shared so that the public is made aware of what the challenges the scientific community faces to provide appropriate backstopping to the nascent bioeconomy. Transparent interactions among the government, the media and the public sectors will narrow the gaps in people's comprehension of the complicated topic.

Limitations of the Study and Suggestions for Future Research

This study had to contend with the uneven and small sample size of newspaper articles that discussed the biofuels issue. Over the past year, only ten articles were found in the *Quad City Times*. These did not allow for an even comparison of straight news reports across newspapers. The content analysis portion of this study excluded editorials, letters to the editor/newspaper and other commentaries, textual pieces that are rich in opinions. Stronger audience valences may have been missed because these materials were excluded in the analysis. A study that examines content for more than a year may also uncover trends in newspaper performance. This is also likely to be the case in studies that aim to analyze how the topic was treated in more in-depth magazine articles, which a

large proportion of the respondents (45.7%) indicate is an important source of framing and related information—as well as broadcast news reports, online postings, and other electronic discussions.

The survey response rate was low even after two questionnaire waves were sent and a participation incentive of $50. The small sample size obtained, therefore, cannot provide enough statistical power to detect differences. More importantly, the predominantly nominal measurement of variables could not reveal correlations or cause-effect relationships. Future studies should use ordinal or ratio measures to better illuminate the relationship between media content and audience perception.

There was also unevenness in the survey's response rate across the three cities and in the response rate by age. Future studies should try harder at soliciting the opinions of citizens 18 to 54 years old through the use of other survey channels, such as e-mails or other electronic means.

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APPENDIX A
CONTENT ANALYSIS CODING SHEET

Variable name	Variable label	Instructions and coding values	Code
ID		Number each news article consecutively	
Coder	Coder's first name	Enter as string variable	
Date1	Date of coding.	Enter as mm/dd/yy.	
Date2	Date of publication.	Enter as mm/dd/yy.	
Newspaper	Name of newspaper	1= The Des Moines Register 2= Cedar Rapids Gazette 3= Davenport Quad City Times	
Headline	Story headline	Enter as string variable	
Section	Section where the article appears	1= Front page 2= National 3= Local 4= International 5= Economy/finance/business 6= Science/technology 7= Other	
Frame1	First frame observed	1= Economic consequences 2= Technology 3= Food fuel 4= Risk 5= Other	
Frame2	Second frame observed	1= Economic consequences 2= Technology 3= Food fuel 4= Risk 5= Other	
Fame3	Specify first frame identified as "other"	Enter as string variable	
Frame4	Specify second frame identified as "other"	Enter as string variable	
Valence	Orientation of the story toward biofuels	1= negative 2= neutral 3= positive	

Source1	First source cited	Enter name of person or group. If person, enter position or title and agency affiliation	
Source2	Second source cited	Enter name of person or group. If person, enter position or title and agency affiliation	

APPENDIX B
CODING GUIDE FOR CONTENT ANALYSIS

Instructions for identifying frames based on literature and those newly identified:

1. How was the news story conveyed by the news media?
2. What special angle or perspective was brought to present the story?
3. What kinds of idea were repeatedly mentioned in the story?
4. What concept or content theme could be abstracted from the story?

Operational definitions of frames:

1. **Economic consequence.** The economic consequence frame conveys an event, problem, or issue in terms of its economic impacts on society, a region, or individuals or groups. Example:

   > The rising costs of biofuels and other alternative energies are making them less viable as substitutes for crude oil, a development that could frustrate efforts to bringoil prices down in the years ahead (*The Wall Street Journal*, 2007).

2. **Technology.** The technology frame appears in discussion of biofuels' relative advantage (economic efficiency of biofuel production), compatibility (technical feasibility as an alternative energy source), complexity (the process of converting crops to fuels), trialability (regional and experimental applications such in Iowa), and observability (manifest advantages as an energy source). Example:

> Michigan State University scientists have identified a protein required for photosynthesis that could ultimately lead to plants designed for biofuel production (*The Capital Times* [WI], 2008).

3. **Food fuel.** The food fuel frame appears when a coverage considers biofuels mainly as a food derived energy or coming from edible materials. The following paragraph exemplifies this frame:

> If all American corn and soybean production were dedicated to biofuels, that fuel would replace only 12 percent of gas demand and 6 percent of diesel demand, the study notes (*New York Times*, 2006).

4. **Risk.** The risk frame refers to information about the existence, nature, severity, or acceptability of potential injury, damage, danger, harm or loss to the environment, the national, state and local economies, and to human and animal health due to biofuels productions. Example:

> …the conversion of the Southeast Asian or Latin American grasslands, savannas, peatlands or forests into biofuel plantations would result in a net increase in greenhouse gas levels for decades or even centuries (*Natural News*, 2008).

5. **Other.**

Valence

1. **Positive.** Biofuels can be seen as a solution to the greenhouse effects, an alternative renewable energy or a boost for economic development and employment. Example:

   > …added that biofuels are projected to generate $280 million to $1 billion for the state's economy by 2025, in part by creating new jobs (*The Boston Globe*, 2008).

2. **Negative.** Biofuels-related risks might relate to food production inefficiency, potential food shortages, rising food prices, and environmental damages, such as agricultural encroachment into forests and grasslands. Example:

   > The rising costs of biofuels and other alternative energies are making them less viable as substitutes for crude oil, a development that could frustrate efforts to bring oil prices down in the years ahead (*The Wall Street Journal*, 2007).

3. **Neutral**

Sources: People, authorities, organizations, or governments cited and/or were used as references in newspapers reports.

APPENDIX C
SURVEY QUESTIONNAIRE

Introduction and purpose

My name is Shin-Heng Chang, a graduate student in journalism and mass communication at Iowa State University. I am currently working on my thesis which examines how Iowa newspapers covered the biofuels issue and how readers perceive this issue. Will you please assist in this study by completing the attached questionnaire?

Instructions

This questionnaire includes items that seek demographic information, your newspaper reading habits, and your general knowledge about a topic of which you may be familiar, biofuels. It is estimated that this questionnaire can be completed in 15 minutes. We seek your voluntary participation in this study. You may skip questions or items to which you may feel uncomfortable responding.

The names of those who have completed and returned their questionnaire will be entered into a drawing for a cash prize of $50.

Contact Information

For further information, please contact Shin Heng Chang, graduate student, Greenlee School of Journalism and Communication, Iowa State University; Tel: 515-xxx-xxxx; e-mail: xxx@iastate.edu.

Confidentiality: Your responses will be kept confidential and no comments will be attributed to any individual in any report that may be produced from this study. However, we do ask you to provide your name and e-mail address so we can monitor our responses rate and inform you of the results of the drawing.

Questionnaire:

1. Have you ever heard about the term biofuels?
    1) Yes *(Please proceed to Q2)*
    2) No *(Please proceed to Q12)*

2. There are many kinds of biofuels. What kinds of biofuels do you know or have heard about?

3. How did you learn about biofuels? *Please circle all answers that apply.*
    1) From a friend or relative
    2) I saw it on television.
    3) I heard about it in the radio.
    4) I read about it in newspapers.
    5) I read about it in magazines or other publications.
    6) I read about it in the Internet
    7) I saw or read about it on commercials or advertisements
    8) Other *(Please specify)* _____

4. About how much of this topic (biofuels) do you think you understand? (*Please circle the best answer.)*
    1) Close to nothing
    2) I understand very little of it.
    3) I understand it somewhat.
    4) I understand enough to get by.
    5) I understand this topic very well.

5. How often do you read newspapers?
    1) Never
    2) Very seldom
    3) Sometimes
    4) Often
    5) Almost always

6. What newspaper do you read regularly?

7. When reading newspapers, how often do you read articles that discuss biofuels?

1) Never
2) Very seldom
3) Sometimes
4) Often
5) Almost always

8. The following are statements people make about biofuels. To what extent do you agree with these statements?

Biofuels will create more jobs for Iowans.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

Biofuels will cause environmental problems.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

Producing biofuels will boost Iowa's economy.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

Producing biofuels will help solve the country's energy problem.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

More land devoted to biofuels will increase the cost of food items.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

In general, I consider biofuels production rather risky.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

The ways by which Iowa is producing biofuels now are technologically feasible.

1) Strongly agree
2) Agree
3) Neutral/no comment
4) Disagree
5) Strongly disagree

9. In general, how would you evaluate the way newspaper articles have covered biofuels?

1) Negative
2) Neutral
3) Positive

10. In general, what comes to your mind when you hear the term biofuels? What are the things you know or have learned about this topic?

11. In general, what do you think will happen with the increased production and use of biofuels?

12. What is your age?
    1) 18-24
    2) 25-34
    3) 35-44
    4) 45-54
    5) 55-64
    6) 65+

13. What is your gender?
    1) Male
    2) Female

Thank you very much for participating in this survey.

APPENDIX D
IOWANS' PERCEPTIONS OF BIOFUELS

Survey Coding Sheet

Question No.	Variable name	Variable label	Values	Missing values
	id	Respondent's id number		
1	hear	Ever heard about biofuels	1= Yes 2= No	9
2a	Kind1	First kind of biofuel mentioned	Enter as string variable	99
2b	Kind2	Second kind of biofuel mentioned	Enter as string variable	99
2c	Kind3	Third kind of biofuel mentioned	Enter as string variable	99
3a	friends	Learned about biofuels from friends or relatives	0=not checked 1=checked	9
3b	tv	Saw info on tv	0=not checked 1=checked	9
3c	radio	Heard info over the radio	0=not checked 1=checked	9
3d	papers	Read about biofuels on newspapers	0=not checked 1=checked	9
3e	mags	Read about biodfuels on magazines	0=not checked 1=checked	9
3f	internet	Read about biofuels on the Internet	0=not checked 1=checked	9
3g	ads	Saw or read about biofuels on ads	0=not checked 1=checked	9
3h	other	Other sources of biofuel information	0=not checked 1=checked	9
3i	Other1	First mentioned other source of information	Enter as string variable	9
3j	Other2	Second mentioned other source of	Enter as string variable	9

		information		
4	understd	How much is understood about the topic	1=Close to nothing 2=Very little of it 3=Understand it somewhat 4=Enough to get by 5=Understand very well	9
5	oftread	Frequency of reading newspapers	1=Never 2=Very seldom 3=Sometimes 4=Often 5=Almost always	9
6a	Paper1	First newspapers read regularly	Enter as string variable	9
6b	Paper2	Second newspapers read regularly	Enter as string variable	9
7	bioread	Frequency of reading articles about biofuels	1=Never 2=Very seldom 3=Sometimes 4=Often 5=Almost always	9
8a	job	Biofuels will create more jobs for Iowans	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
8b	envmprobl	Biofuels will cause environmental problems	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
8c	iaecon	Producing biofuels will boost Iowa's economy	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9

8d	engprobl	Producing biofuels will help solve the country's energy problem	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
8e	fdcost	More land devoted to biofuels will increase the cost of food items	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
8f	risky	I consider biofuels production rather risky	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
8g	techfeas	The ways Iowa is producing biofuels are technologically feasible	1=Strongly agree 2=Agree 3=Neutral/no comment 4=Disagree 5=Strong disagree	9
9	newseval	What orientation toward biofuels in newspaper article?	1=Negative 2=Neutral 3=Positive	9
10	comind	What comes to your mind when hearing the term biofuels?	Open-ended	
11	result	What do you think will happen with the increased production and use of biofuels?	Open-ended	
Recode	Frame1	First frame mentioned in "10&11"	1=Economic consequences 2=Technology 3=Food fuel 4=Risk 5=Other	9
Recode	F1other	First identified as other	Enter as string variable	99

Recode	Frame2	Second frame mentioned in “10&11”	1=Economic consequences 2=Technology 3=Food fuel 4=Risk 5=Other	9
Recode	F2other	Second identified as other	Enter as string variable	99
Recode	Frame3	Third frame mentioned in “10&11”	1=Economic consequences 2=Technology 3=Food fuel 4=Risk 5=Other	9
Recode	F3other	Third identified as other	Enter as string variable	99
Recode	Frame4	Fourth frame mentioned in “10&11”	1=Economic consequences 2=Technology 3=Food fuel 4=Risk 5=Other	9
Recode	F4other	Fourth identified as other	Enter as string variable	99
Recode	Pos1	First positive remark about biofuels	Enter as string variable	9
Recode	Pos2	Second positive remark about biofuels	Enter as string variable	9
Recode	Neg1	First negative or risk-related remark about biofuels	Enter as string variable	9
Recode	Neg2	Second negative or risk-related remark about biofuels	Enter as string variable	9
12	age		1=18-24 2=25-34 3=35-44	9

			4=45-54 5=55-64 6=65+	
13	gender		1=Male 2=Female	9

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