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Scott T. Fitzgerald[a]; Beth A. Rubin[a]
[a] Department of Sociology, University of North Carolina at Charlotte, Charlotte, North Carolina, USA

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RISK SOCIETY, MEDIA, AND POWER: THE CASE OF NANOTECHNOLOGY

Scott T. Fitzgerald
Beth A. Rubin

Department of Sociology, University of North Carolina at Charlotte, Charlotte, North Carolina, USA

Risk society theory posits that the transformation of industrial to postindustrial society corresponded with a transformation of societal power structured by capital, to one structured by the ability to define risk. Perceptions of risk are, in part, socially constructed and created through the framing efforts of various institutional actors. The resulting struggle over meaning is particularly acute when the issues contain many unknown elements—as is the case with emerging technologies. Applying insights from media studies, frame analysis, and organizational theory, we analyze coverage of nanotechnology (NT) in popular press, trade, and general science publications. The findings document the extent to which the risks of this emerging technology are presented or ignored across, between, and within organizational subfields. The analysis empirically assesses a key proposition of risk society theory and reveals how institutional processes reflect and reproduce power differentials. We discuss the implications of the empirical findings for sociological theories of risk and society, power, and collective action.

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Address correspondence to Scott T. Fitzgerald, Department of Sociology, University of North Carolina at Charlotte, 9201 University City Blvd., Charlotte, NC 28223, USA. E-mail: sfitzger@uncc.edu

A perennial focus of sociological theory and debate is the structural origins of power in society. Lukes (2005 [1974]) identified three key dimensions of power: observable conflict, agenda-setting, and nondecision making, and systemic power linked to symbolic meanings and understandings. Focusing on this third dimension, contemporary social theory continues to examine the social structural origins and manifestations of power by documenting and explaining the changing nature of society during the twentieth century. A uniting theme of this body of theory (e.g., Beck 1992; Bell 1999 [1973]; Castells 1996; Giddens 1990) is the significant and widespread *social* transformation caused by the *economic* transition from industrial to postindustrial society.

Specifically, Beck's risk society theory posits that the transformation of industrial to postindustrial society corresponds with a transformation of the basis of societal power from capital to the ability to define risks. In contemporary society, or using Beck's terminology, reflexive modernity, risk definition is paramount because there has been an objective increase in risks caused primarily by technological innovation and, if these risks were to actualize, they would result in widespread catastrophe. At the same time, risks are never *objectively* comprehended; they must be defined and interpreted. Thus, for risk society theorists, the social construction of risk (i.e., definitions of the situation) is a key sociological process that fundamentally reflects power within risk society. This process is especially important in situations such as those surrounding emerging technologies where the terms of the debate and the range of issues are undefined, uncertain, and/or unknown, as is the case with nanotechnology.

Broadly defined, nanotechnology (NT) is "research and development at the atomic or molecular scale" (Bleeker et al. 2004) and can involve manipulating and "manufacturing structures smaller than 100 nanometers (100 billionths of a meter) across" (Whitesides and Love 2002). Developments in NT are expected to have profound social, economic, and environmental implications. As with other technological innovations of this scope, both advocates and detractors recognize the potentially transformative nature of the technology and tend to either celebrate or demonize it (Bleeker et al. 2004). The study of the societal implications of NT is both timely and important. There are over 500 NT-based consumer products currently available (Woodrow Wilson Center Project on Emerging Nanotechnologies 2008). The potential transformation

of everything from manufacturing to healthcare could be "nothing less than the new industrial revolution" (*Scientific American* 2002). Major research funding and private investment in NT is spurring the industry. In 2006, the United States' federal government invested $1.3 billion in NT research and development through the National Nanotechnology Initiative—with an additional $2 billion coming from private and state sources (U.S. Environmental Protection Agency 2007). Globally, according to Lux Research, investment in NT research and development is approximately $9 billion and continues to grow rapidly (U.S. Environmental Protection Agency 2007).

While investment skyrockets, environmental and social justice activists and some NT scientists continue to point out the potential health risks of NT. Scientists don't know, for instance, how nanoparticles affect respiratory health and conclude that scientific understanding of the health and safety issues is still in a very early stage (Warheit 2004). A 2004 report revealed that only $4 million of $3.7 billion (approximately 0.1%) committed in previous years by the federal government for NT research had gone to study negative health and environmental effects of NT (*Washington Post* 2004). As our research below shows, the current discourse clearly emphasizes the positive implications of this new technology, despite the fact that little is known about the potential risks. These findings conform, in large part, to the explanations of power developed by risk society theorists (e.g., Beck). To support this conclusion, we draw together insights from organizational theory, media studies, and the social movements and social problems framing literatures, to interpret data from a systematic content analysis of print media.

Periods of social transformation engender feelings of uncertainty and widening perceptions of risk. The current era is one in which many of those perceptions seem well grounded in a political-economic world in which "all that is solid melts into air" (Marx and Engels 1967 [1888], p. 83) and much of what was presumed secure has been rendered threatened and or dangerous. We seek to advance recent theorizing of risk and society, while shedding light on an emerging technology, by empirically examining the definition of risks. According to Beck (1992, 2006) the ability to define risks is fundamentally about power. If so, the examination of media coverage of an emerging technology is an ideal methodology to reveal power differences. Operationalizing and empirically assessing risk society theory's concept of power requires moving

the level of analysis "down" from grand theorizing and focusing on institutional processes. We link insights from organizational theory, media studies and studies of social problem framing, to identify key actors, interests and processes involved in the struggle over symbolic meaning (i.e., risk definition) as evidenced in print media. In this study we ask: What definitions of risks are provided? What frames are proffered? What set of interests are advanced? The answers reveal important power differentials in contemporary risk society. While Beck and other risk society theorists point to the shift away from capital and towards the ability to define risk as an indicator of power, our expectation is that this ability is still largely attached to business interests rather than, say, populist social change activists.

This study contributes to extant theoretical and empirical knowledge in two important ways. First, few studies of the social implications of NT, including analyses of media coverage of NT, have addressed how NT relates to sociological theorizing about contemporary society and its emergent risks (but see Throne-Holst and Stø 2008). Our analysis employs risk society theory (Beck 1992, 2006; Lupton 1999; Van Loon 2002) to focus on a central sociological concern—power—in media coverage of the of NT. By conceptualizing different sets of print media as organizational subfields we are able to operationalize key arguments of risk society theory that have received little empirical testing. The resulting analysis provides a level of empirical validation often lacking in the grand theorizing of risk society (Alexander 1996; Tulloch and Lupton 2003).

Second, while recent studies assess expert and public opinion regarding NT (Besley et al. 2008; Cobb and Macoubrie 2004; Scheufele and Lewenstein 2005; Siegrest et al. 2007) and attend to media coverage of NT (Anderson et al. 2005; Cobb 2005; Ebeling 2008; Faber 2006; Kulve 2006; Radin and Lewenstein 2003; Stephens 2005; Stephens and McKissick 2004; Wilkinson et al. 2007) extant research has not fully examined whether various *types* of print media differ in the presentation of the benefits and risks of NT. This project addresses these shortcomings by examining the symbolic packaging of NT *across, between,* and *within* three particular types of print media (popular press, general science, and trade journals) and also answers the persistent call for media studies to examine the presentation of potential risks over time (Taylor-Gooby and Zinn 2006, p. 61). Thus, our descriptive empirical findings augment the extant studies on media coverage and NT.

RISK SOCIETY AND POWER

Risk has long been part of social life and understanding, managing and controlling it are at the heart of many social institutions[1] (Taylor-Gooby and Zinn 2006). Since the 1990s, grand social theory has focused on the unique characteristics of risk in the contemporary world as a way of understanding the apparent breaks from earlier "modern" society (Beck 1992, 2006; Cable et al. 2008; Giddens 1990). For these analysts, the moniker for contemporary society is not "post-modern" but "risk."[2] While theorists working within this perspective emphasize different components, there are five identifiable, and interrelated, features of "risk society" relevant to our study: (1) the ubiquity of large-scale and uncertain risks, (2) the social construction of risk, (3) power relations based on the ability to define risks, (4) competing risk definitions, and (5) a growing distrust of expert knowledge.

Risk society is characterized by the ubiquity of risks resulting from, among other things, technological innovation (Beck 1992; Lupton 1999; van Loon 2002).[3] The dangers associated with contemporary society are historically unprecedented in scale. In early periods, hazards were largely spatially or locally limited (such as weather and local conflicts). In the modern era, many are global and open-ended (Lupton 1999) and result not from nature but from industrialization, science, and the concentrated power of organizations as sites of technological development and proliferation (Beck 1992; Perrow 1984; Clarke and Short 1993). Moreover, these new risks are often invisible (e.g., gas leaks, chemical spills, radiation, the fictional nanobots of Michael Crichton's NT thriller, *Prey*) and if the anticipated dangers were to come to fruition the effects would

[1]The sociological contribution to the study of risk and its framing on which we build theorizes both its ubiquity and its social construction. While there is a long tradition of studying "risk management" that takes the risk as given and proceeds with the calculus of containment, sociologists argue that a phenomena or "risk" must first be perceived and constructed as such, a process that precedes studies of lay perception of new risks. Two other major ways in which sociologists investigate risk are in the Science, Technology, and Society (STS) field and in organizational inquiry into the "dark side of organizations" and organizations as the routine producers of potentially catastrophic risks (see Diane Vaughan's 1999 review in the *Annual Review of Sociology*; Perrow 1984).

[2]Beck also refers to this era as "second modernity" and/or "reflexive modernity" (Beck and Lau 2005); Giddens uses "high modernity" and/or "late modernity" (Giddens 1990).

[3]Of course, this view is consistent with organizational research that argues that increased risk accompanies technological innovation because it is "complex, uncertain, and thus inherently risky" and occurs in organizations that routinely create increased risk as their systems become more complex and tightly coupled (Vaughan 1999, p. 27: Perrow 1984).

be catastrophic; the consequences would be irreparable and there would be little that any institution could do to "fix" it (Beck 1992; Lupton 1999; van Loon 2002).

Second, risk society theorists argue that risks are real and *also* socially constructed (Adam and van Loon 2000; Beck 1992, 2006; Zinn and Taylor-Gooby 2006). For example, chemical spills, radiation, and ecological degradation have, or would have, "real" (read: objective) consequences. At the same time, whether these issues are perceived to be likely/unlikely, containable/catastrophic, acceptable/unacceptable, etc. is the result of social construction processes and definitions of the situation. Third, as a result, in risk society, power is manifest in the ability to define risks (Beck 2006). Beck writes,

> **Risk "is not reducible to the product of probability of occurrence multiplied with the intensity and scope of potential harm." Rather it is a socially constructed phenomenon, in which some people have a greater capacity to define risks than others. Not all actors really benefit from the reflexivity of risk—only those with real scope to define their own risks. Risk exposure is replacing class as the principle inequality of modern society because of how risk is reflexively defined by actors: "In risk society *relations of definition* are to be conceived analogous to Marx's relations of production." The inequalities of definition enable powerful actors to maximize risk for "others" and minimize risk for "themselves." Risk definition, essentially, is a power game. (2006, p. 333)**

Fourth, the enactment of this "power game" produces competing definition of risks that enter the public sphere as different individual and collective actors advance their claims. Precisely which actors and which claims are successful in risk definition reflect, and is a function of, structural power. Cable, Shriver, and Mix (2008) identify the linking of risk with power and knowledge as key feature of risk society, where:

> **. . . prominence is granted to scientists in decision-making processes; and symbiosis characterizes relationships among scientific experts who seek research funding and prestige, corporate actors who seek ever-higher profits, and state actors who seek continued economic growth to maintain a nation's wealth and to fund popular public services. (Cable et al. 2008, p. 382)**

We argue that while risk definition is a "power game" the social relations of risk definition remain epiphenomenal of the social

relations of production. As our findings demonstrate, in the case of NT, power indeed continues to be tied to business and capital interests.

A final feature of the contemporary era, according to risk society theory, is that the lay public has experienced a decline of trust in expert knowledge. That loss of trust results, in part, from the failures of experts and policy makers to prevent environmental and technological disasters (e.g., Chernobyl). Arguably, then, a constitutive feature of social life and of the perception of the ubiquity of risk is this decline of trust in abstract systems (Giddens 1990). In an increasingly complex and technologically mediated world, lay-persons learn about risk from experts or their representatives (Giddens 1990). The decline in trust creates new vulnerabilities to nonexperts. Yet, current failures of expert knowledge have undermined faith in these systems leading to calls to democratize risk management (Giddens 1998; Montpetit and Rouillard 2008).

Taken together, these guiding propositions of risk society theory provide the framework for an empirical analysis of media coverage of NT focusing on definitions of risk and power. As discussed below, NT has the potential to create large-scale catastrophic events and, as such, is an appropriate case for risk society theory. In part because of its newness, struggles over definitions and meaning regarding NT take place primarily through mass media; therefore, it is possible to delineate the proliferation of the preferred frames of certain institutional actors, providing an empirical measure of power.

EMERGING TECHNOLOGIES AND THE MEDIA

In contemporary society, media are pervasive and the source of information about new technology for all sectors of society. The media represent the lay public's "access points" (Giddens 1990) to experts. Given the role of organizations in society, the information is unlikely to be evenly weighted to the interests and perspectives of all stakeholders. As Short (1984) noted, large organizations often set the terms of debate about societal risks and despite the media's role as watchdogs, analysts have long questioned the true independence of media from the business interests of which they are part. As knowledge grows increasingly complex and plays a pervasive role in organizing social life, individuals rely on representatives of experts to play a translational role for them, which contribute to the centrality of the media to debates about science policy.

Prior research on the introduction of biotechnology, nuclear power, and other technologies has demonstrated the importance of media framing on public understanding of new technologies (Ungar 1998; Wagner et al. 2002; Nisbet and Scheufele 2007; Nisbet and Goidel 2007). Nisbet and Goidel (2007, p. 434) argue that "mass media provide an important part of the social context by which citizens judge controversial science." Public understanding about the potential risks involved in new technologies can affect the level of support and adoption of these technologies. This dynamic has been evident, for example, in the case of the public's response to genetically modified organisms (GMOs). Given the widespread resistance to GMOs in Europe, policy makers and others interested in the development of NT recognize the importance of public opinion (Mnyusiwalla et al. 2003; Zachary 2003; Nisbet and Scheufele 2007). In one of the first systematic studies of NT and framing, using data from an experiment embedded within a nationally representative phone survey, Cobb (2005) demonstrated how the framing of NT issues affects respondents' perceptions of risk.

Although scientific progress has been rapid, public knowledge of NT issues is low and public debates are in early stages. The relative lack of public knowledge makes NT an ideal case to analyze the media framing of its relative risks and hazards. Though the jury is still out on how much media does shape public perception (Dunlap 1998; Hughes et al. 2006), assessing its role in the early stages of the public's exposure can be particularly illuminating about the framing process and the definition of risk and help answer Heimer's (1988) question about the origins of frames.

FRAMING

To interpret media coverage of NT we draw on the conceptual tools of frame analysis. Frame analysis identifies the processes by which new issues that enter public discourse are shaped by the "frames" that actors employ to interpret experiences, identify the sources of problems, and develop responses. The central concepts of frame analysis draw from Goffman's definition of frames as "schemata of interpretation" that enable individuals to "...locate, perceive, identify, and label occurrences within their life space and the world at large" (1974, p. 21). Social movement scholars often employ the conceptual tools of frame analysis to examine the struggle over the production of mobilizing and countermobilizing ideas and meanings in the context of collective action (e.g., Adair 1996; Babb 1996;

Fitzgerald 2009; Snow and Benford 1992, 2000; Snow et al. 1986; Steensland 2008).

Gamson and colleagues build on this conceptualization of frames and apply it to the examination of political and media discourse in the public arena (e.g., Gamson and Modigliani 1989; Gamson et al. 1992; Gamson and Stuart 1992). When issues enter the public discourse they are shaped by "symbolic packaging" attempts made by diverse actors in various institutional settings. In the case of NT, these actors broadly include the general public, research science, funding agencies, regulators, industry, politicians, and media. At the heart of these symbolic packages are the frames (i.e., words, ideas, values, arguments, and rhetoric) that actors employ to interpret experiences, identify the sources of problems, and develop responses to these problems (e.g., Gamson and Modigliani 1989; Gamson and Stuart 1992; Krogman 1996; Stryker et al. 1999).

An examination of the struggle over meaning is especially pertinent to cases such as NT where the terms of the debate and the range of issues are undefined, uncertain, and/or unknown. Journalists, scientists, government officials, politicians, and social movement activists participate in this ongoing battle. Empirically, the struggle over meaning can be assessed by systematically examining media content. The media serve as a "series of arenas in which symbolic contests are carried out among competing sponsors of meaning" (Gamson et al. 1992, p. 385). Participants in these symbolic contests assess their relative success or failure by the prevalence and articulation of their preferred message in various media (Gamson and Stuart 1992).

Analyses of print media have documented competing "symbolic packaging" of a wide-ranging set of issues including affirmative action (Stryker et al. 1999), the arms race (Gamson and Stuart 1992), global warming and the ozone (Ungar 1998), breast cancer (Brown et al. 2001), and genetic engineering (Khoring and Göering 2000). More recently scholars have begun to document media coverage and framing of NT (Anderson et al. 2005; Cobb 2005; Ebeling 2008; Faber 2006; Kulve 2006; Radin and Lewenstein 2003; Stephens 2005; Stephens and McKissick 2004; Wilkinson et al. 2007). For the most part, the general public receives its knowledge about NT (and other new technologies) from the popular press. Until recently, though, there has been little systematic sociological research on the role of media in formation of risk perception (van Loon 2002) (for an exception, see the special issue of *New Genetics and Society, 19*(3), 2000, on biotechnology; see also Cobb 2005; Stephens 2005). Diverse media outlets frame NT in a variety of ways, from highly technical and/or laudatory, to sensationalist and apocalyptic (Joy

2000; Rotman 1999). Media provides, then, copious information to the public, but does not necessarily adjudicate between technological innovation as boon or detriment.

Types of Print Media as "Organizational Fields"

Organizational scholars employ the concept of "fields" or "sectors" to identify important components of the societal landscape (DiMaggio and Powell 1983; Fligstein 2001; Scott 2003). Scott (2003, p.130) defines organizational fields as a "collection of interdependent organizations operating with common rules, norms, and meaning systems." Fligstein (2001, p. 15) writes,

> **Fields contain collective actors who try to produce a system of domination in that space. To do so requires production of a local culture that defines local social relations between actors. These local cultures contain cognitive elements (i.e., they are interpretative frameworks for actors), define social relationships, and help people interpret their own position in a set of social relationships.**

While these concepts are generally employed to conduct intra- and inter-organizational analysis, we assert that print media can be conceptualized as representing distinct "fields" at two different levels. At the broadest level all of the print media analyzed in this study are a part of a "media field." That is, they are the product of individual and organizational action "operating with common rules, norms and meaning systems"—for example, journalistic norms regarding reporting. At the same time, within this broad field, there are recognizable niches (i.e., target audiences) that publications serve. For clarity, we refer to these as subfields.[4]

In short, we posit that there are three relevant subfields, within the "field" of print media: (1) industry (trade journals), (2) science (general science), and (3) general (popular press). The specific print media within each subfield will, to a great extent, provide news and coverage consistent with the constellation of values, beliefs, and symbols that comprise the symbolic boundaries of the subfield. Our guiding premise is that the distinctive symbolic boundaries of industry are technological advancement and product development, while the subfield of science is bounded by notions of scientific discovery and cumulative

[4]From the neoinstitutional perspective these groupings represent "fields" as well. However, to highlight the differing levels of analysis (i.e., print media as a whole and different types of print media) we call them subfields.

knowledge, and the general subfield encompasses both of these prior sets of ideas as well as anything else that might be deemed new and interesting (i.e., sensationalism).

Risk society theory leads to several expectations regarding the framing of NT across, between, and within these subfields. First, risk society theory explanations of risk definition emphasize the importance of power differentials. Thus, we expect that media coverage will disproportionately frame NT in ways that are consistent with powerful actors and interests. Those interests are likely to cohere to business and government rather than populist concerns. Second, we expect the framing of NT to celebrate progress and technological development. Technology and innovation have long been engines and products of the economic growth that has been a driving mechanism of capitalism. Thus, if media framing disproportionately celebrates new technologies and their boon to society rather than their potential risk to society, it is consistent with the view of risk society theorists. In contrast, if the framing were to emphasize risk, harm, and threats to sustainability, or if discussions of NT were presented as relatively open, national conversations and debates, then the expectations derived from risk society theory would not be supported.

Finally, given risk society theorist's claims about the loss of trust in experts, framing that is consistent with the interests of dominant powers should mask the voice of scientific discourse and debate; these should be relatively absent from popular forms of media and debate should be relatively muted in the science and trade subfields. If, on the other hand, the framing is not about creating a meaning system that reinforces entrenched powers, then we would expect a balanced presentation of NT in popular as well as in scientific and trade journals.

METHOD AND DATA

Data were collected and analyzed following standard content analysis procedures (Gamson and Modgliani 1989; Misra et al. 2003; Stryker et al. 1999). First, drawing from current media studies of NT (e.g., Radin and Lewenstein 2003; Stephens and McKissick 2004) and in consultation with research scientists active in the field,[5] we developed a list of print media with coverage of NT. As noted in Table 1, the

[5]Personal communication with Dr. Kenneth Gonzalvez, a chemist specializing in polymer materials and organic chemistry and Dr. Amy Ringwood, a biologist, specializing in environmental toxicology and the biology and ecology of aquatic invertebrates.

Table 1. Nanotechnology media coverage sample, 1/1/1998 to 5/1/2005

Print media type	Source	# of Articles	Circulation
Popular press	*The New York Times*	96	1,118,565
Popular press	*The Wall Street Journal*	38	1,857,050
Popular press	*The Washington Post*	35	732,872
Trade journal	*Materials Today*	152	unknown
Trade journal	*Technology Review*	114	327,562
General science	*Science News*	80	160,000
General science	*Scientific American*	61	555,000

popular press sample contains *The New York Times*, *The Wall Street Journal*, and the *Washington Post*. The trade periodicals selected are *Technology Review* and *Materials Today*. Finally, the general science periodicals selected are *Science News* and *Scientific American*.

Widespread media coverage of NT did not begin until the late 1990s (Stephens and McKissick 2004); therefore, we examine media coverage beginning in 1998 and ending in 2005. Over 600 articles were identified by conducting an electronic keyword search on "nanotechnology" for the sampled publications and the specified time period. These articles include a wide range of items including news stories, news-in-brief, features, editorials, and letters. After identifying and removing articles that met the search criteria but did not actually address issues related to NT, the final sample contained 576 print media articles.

Coding the articles followed a multiphase process. First, a coding instrument, identifying key themes and issues, was created based on published reports on NT by major organizations (e.g., National Science Foundation, Greenpeace); popular texts and novels (e.g., Crichton's *Prey*; Drexler's *Engines of Creation*); and academic journals and online sources. A wide net was cast in order to identify as many different issues and arguments as possible. Next, we randomly selected approximately ten percent of the sample to conduct a pilot study to assess the coding instrument. After two coders individually coded these articles, the coding instrument was further refined. In the event that the created categories were not exhaustive additional space was provided to write in new or emerging themes. The second phase of coding entailed each coder reading and completing a code sheet for every article in the sample ($N = 576$). The data contained in the respective code sheets were entered in a spreadsheet and saved as a SPSS file. Syntax was then written to identify discrepancies between the two sets of codes. Intercoder reliability (i.e., the ratio of coding agreements to the total number of coding

decisions) was .98.[6] Once discrepancies were identified the coders met once again and reread each article that contained a discrepancy in the assigned codes. A decision was made on each case as to the final code(s) to be used.[7]

The empirical data we analyze are from daily newspapers, general science periodicals, and trade periodicals. Sampling from three different forms of print media facilitates three sets of analysis. First, data gathered from the three media types, conceptualized as organizational subfields, allows for a robust analysis of the framing efforts of the various institutional actors involved in the symbolic struggle over definitions and perceptions of risk (Dietz et al. 1989) and NT. These data directly relate to our broad theoretical questions drawn from risk society theory's proposition of definitions of risk as a power game. First, we examine data from *across* all subfields and ask: what are the dominant frames regarding NT? What risks are presented? What benefits are presented? What other themes and/or frames are addressed? Second, we narrow our focus by examining the framing of NT *between* institutional subfields. Thus, we can ask, to what extent does the presentation of NT and risks vary by organizational subfield (i.e., industry news, science news, or general news)? If so, do these patterns reflect values and symbolic boundaries associated with each subfield? Or, instead, do they cohere around a single set of dominant interests that transcend all three subfields? Third, we analyze NT coverage *within* organizational subfields by testing a proposition, drawn from prior media studies, relating to news reporting. Specifically, we test whether there is evidence of institutionalized reporting practices producing a "balance norm" in print media coverage, and whether this takes place within individual articles or at an aggregate level within organizational subfields. Arguably, if the balance norm is evident within and between articles, this would also challenge the idea that the definition of risks results from and reproduces powerful interests. That is, rather than constructing a coherent package of meaning, evidence of a balance norm within and between media types would suggest that the media are presenting a full, rather than a single "packaged" set, of concerns.

[6]Each decision to mark or not-mark a given topic as being mentioned in a given article is treated as a coding decision. By this measure there were a total of 26,220 coding decisions made (46 categories $\times$ 576 articles) by each coder. The independent reading and coding resulted in agreement on 25,626 of these decisions.

[7]Upon close inspection 46 articles were removed from the analysis as not relevant (e.g., the term "nano" was used but simply in passing, rather than having *any* substantive role in the article). The sample size used in the analysis reported below is 530.

FINDINGS

Consistent with the expectation that media presentation of an emergent risk socially constructs that risk in ways that conform to dominant powers—which is not surprising given the technical and scientific nature of NT—"scientific advancement" in the field of NT is the single most prevalent theme across the media types. Seventy-six percent of the articles in the entire sample report on a specific study or development. The prevalence of this theme is not surprising given the fact that what makes NT a newsworthy subject is the promise of scientific discovery and exciting applications. In fact, fifty-six percent of articles in the entire sample report *only* scientific advancement—without a single mention of any benefits or risks. The remaining topics addressed in articles from this sample are grouped into three broad headings (see Table 2).

The first category identifies those topics or issues that focus on the *benefits* of NT. In this sample, there were 479 "benefits" mentioned in the articles from 1998–2005. Within this category we identify three groupings: environmental/health issues, economic issues, and privacy/security issues. A *New York Times* article from January 21, 2000 provides an overview of potential benefits:

> **Shrinking the entire Library of Congress into a device the size of a sugar cube; assembling new materials from the "bottom up"—from atoms and molecules; developing ultralight materials that are ten times as strong as steel; creating a new class of computer chip millions of times as fast as today's Pentium 3; doubling the efficiency of solar cells; using gene and drug-delivery technologies to detect and target cancerous cells, and developing new technologies to remove the smallest contaminants from water and air.**

The most frequently cited current or future benefits of NT are related to (1) enhanced quality of goods and services and (2) disease preventions and cures. NT is currently being used to produce stain-resistant clothing, improved sunscreen, and more efficient light-emitting diodes. It also facilitates the production of smaller and smaller gadgets and electronic devices. NT is seen as providing an avenue to radically change the manufacturing of goods, "[r]ather than hacking our much-desired little things out of bigger lumps of material like steel or silicon, we could simply build them from the ground up, one atom at a time" (*Wall Street Journal* 1999). As a result, "[t]echnology based on molecular manufacturing will lead to computer systems a billion times more powerful than what we have

Table 2. Frequency of topics identified in total sample, 1998–2005

Category/Topics	Frequency
Scientific Advancement	402
Benefits	479
Environmental/Health Issues	
Disease Prevention/Cures	132
Environmental Clean-up/Management	34
Natural Resource Alternatives	25
Human Performance	21
Other	1
Economic Issues	
Enhance Quality of Goods/Services	159
Lower Goods/Services Costs	36
Lower Production Costs	23
Increased Employment Opportunities	8
Other	7
Targeted Marketing	2
Privacy/Security Issues	
Weapons	14
Surveillance (Government/Espionage/Terrorism)	12
Surveillance (Inter-Personal)	3
Targeted Marketing	1
Other	1
Risks/Costs	121
Environmental/Health Issues	
New Health Problems	42
Environmental Degradation	39
Safety of Workers	11
Human/Animal Testing	1
Other	0
Economic Issues	
Increase Production Costs	8
Displace Workers	5
Increase Goods/Services Costs	4
Lower Quality of Goods/Services	1
Other	0
Privacy/Security Issues	
Weapons	8
Surveillance (Government/Espionage/Terrorism)	2
Targeted Marketing	0
Surveillance (Inter-Personal)	0
Other	0
Other	318
Property Issues	
Funding Public/Private	137
Ownership/Patent Rights	32
Development Rights	2
Other	1

(*Continued*)

Table 2. Continued

Category/Topics	Frequency
Political Issues	
Regulation	29
Maintaining Leadership	4
Government Obligations	3
Other	0
Equity Issues	
Access to Education/Training	4
Dispersion of Risks	4
Obligation to Other Countries	3
Obligation to Displaced Workers	0
Other	0
Topoi	
"Grey Goo"/Nanobots/*Prey*	50
GMOs/Nuclear Power/Biotech	49

today, aerospace vehicles with 98 percent less structural mass, and medical tools that can repair tissues, organs, and cells at a microscopic level (*New York Times* 2004). These advances will improve the performance of goods (e.g., microchips) and reduce the costs of producing goods. "'With the electronics that we are talking about, we're going to make a computer that doesn't just fit in your wristwatch, not just in the button in your shirt, but in one of the fibers of your shirt,' says Philip Kuekes a computer architect at Hewlett-Packard Laboratories" (*Technology Review* 2002).

In the realm of healthcare, NT may eventually allow doctors to create a tiny robot-like device that can travel within the body to detect illness, administer drugs, and monitor patients: "Perhaps the most exciting goal is the molecular repair of the human body. Medical nanorobots are envisioned that could destroy viruses and cancer cells, repair damaged structures, remove accumulated wastes from the brain, and bring the body back to a state of youthful health" (*Scientific American* 2001). For example, Nanospectra Bioscience, a Rice University spinoff has "developed gold-coated glass nanoparticles capable of invading a tumor and—when heated remotely—killing it" (*Technology Review* 2004).

NT developments are also expected to provide natural resource alternatives that produce less pollution than coal, oil, and natural gas. Further, "nanoscale particles could play an important role in environmental cleanup, dramatically reducing the costs associated with remediating Superfund sites" (*Washington Post* 2004b).

Interestingly, this particular framing of the potential benefits of NT focuses on the use of technology to address the ecological degradation (caused primarily by technological advancement) identified by Beck (1992).

On a different front, the United States Army has been developing uniforms "capable of acting like exterior support muscles for soldiers, with tiny sensors to monitor health" (*New York Times* 2003b). Manufacturing companies are working to provide these advancements to consumers. One company is developing a "'Smart shirt' cotton and spandex cloth interwoven with conductive fibers that can receive and transmit data from embedded sensors to a special receiver the size of a credit card... Baby pajamas could be fashioned with a cell-phone, so anxious parents could call home from the theater to listen to their infants breathing, check his heart rate or even sing a lullaby" (*Wall Street Journal* 2001). Other surveillance and security applications of NT are expected to aid in the early detection of bioterrorism attacks by providing the ability to detect individual viral particles or "it could produce weapons with the power of a supercomputer embedded in the head of a bullet" (*New York Times* 2001).

In contrast to the plethora of "benefits" proffered, there were only 121 "risks or costs" mentioned.[8] The most frequently mentioned *risks or costs* were (1) new health problems and (2) environmental degradation. Because nanoparticles are so small, there is concern that they could find their way into the lungs and bodies of workers working with NT products and the public at-large and cause unknown harm. "Early research has raised troubling issue. DuPont and others, for example, found evidence that the cells that break down foreign particles in rodent lungs have more troubling detecting and handling nanoparticles that have long been studied by air pollution experts" (*New York Times* 2003a). Other health concerns include the possibility that NT-enhanced skincare products, such as sunscreen, engineered to penetrate the skin could produce unanticipated side effects as nanoparticles "...enter the bloodstream, and wind up in organs for which they were not intended" (*New York Times* 2005). A frequently cited environmental concern is that attempts to use nanoparticles to clean up chemical spills or other pollutants might lead to further (and greater) environmental degradation. The health and environmental concerns were generally attributed to individuals

[8]These numbers are calculated by summing the respective categories of identified topics within articles in the full sample. If a topic was identified within a given article the frequency of that topic for that article is one—regardless of how many times that topic was mentioned in the article. A single article can include more than one topic.

and organizations, such as the Science and Environmental Health Network, who adopt a skeptical view of rapid scientific and technological advancement and advance the "precautionary principle":

> **The most conservative backers of the principle tend to look for proof beyond a reasonable doubt that the potential risks have been examined, as well as evidence that less risky ways of reaching the same or similar goals have been weighed. And such critics do not necessarily accept industry's definition of accepted science. For instance, the Science and Environmental Health Network gives much more weight than do most industry scientists and government regulators to theories that chemicals in the environment are disrupting the human endocrine system and contributing to a wide range of ailments. (*New York Times* 2002a)**

The dangers of developing weaponry and tiny surveillance devices are mentioned (although less frequently than the benefits of these same advancements):

> **It could provide tiny robots to go into blood vessels and clean out plaque—or microscopic robots that could kill instead of heal, and in ways far more predictable and precise than anything envisioned in germ warfare. One nanotechnology expert, Glenn H. Reynolds, a law professor at the University of Tennessee, said that someday it might even be used to make tiny robots that would lodge in people's brains and make them truly love Big Brother. It is a technology whose consequences could be so terrifying that one scientist, Dr. K. Eric Drexler, who saw what it could do, at first thought that he should never tell anyone what he was imagining, for fear that those dreadful abuses might come to pass. (*New York Times* 2001)**

The remaining themes, lumped together under the generic heading "other," stand outside the simple classification of benefits or risks. Identification of the public or private organization funding research, development and production of NT is cited in 137 articles in this sample. The frequency of this category reinforces key role played by public (state) and private (market) actors in the development of this emerging technology. Issues of regulation—often discussions of what role governments should play in regulating production and monitoring potential hazards—emerged in 29 of the 576 articles. Discussions of what role governments should play in leading and shaping the direction of NT, as well as whether governments have certain obligations to citizens regarding the impact of NT are rarely mentioned.

Issues raised, primarily by social justice activists, that deal with equity issues (e.g., who will have access to the education and training required to work with these advanced technologies? Will uneven economic development reinforce demographic and regional inequalities?) are rarely mentioned. Perhaps most striking, in relation to risk society theory arguments, is that questions regarding the unequal dispersion of risks—where certain segments of the population might be exposed to greater risks than other segments—was mentioned in only 4 out of 576 articles. The unequal distribution of risks is a central theoretical (Beck 1992, 2006) and empirical (Auyero and Swistun 2008; Cable et al. 2008) concern of recent scholarship. This finding is also consistent with risk society theory. The ability to define risk is similarly the ability to obscure or highlight the most likely recipients of risk. The one-sided presentation of minimal risk and the absence of considerations of the most vulnerable categories in the frame cohere with risk society theory arguments.

The mention of what we categorize as topoi took place in approximately 17% of the articles. The first theme within this category focuses on "science fiction speculation." In 1986, Dr. K. Eric Drexler, a researcher and lecturer at the forefront of the NT field, published *Engines of Creation* where he imagined, among other things, a world in which "self-reproducing nanobots run amok, a 'gray goo' that would consume everything" (*New York Times* 2002b). Drexler's book was the first to bring together state of the art knowledge regarding the scientific and technological capacities of the NT field and speculation as the implications of this developing technology. A *#1 New York Times Best Seller,* Michael Crichton's 2002 thriller, *Prey*, developed this scenario and provided a popular and provocative vision of nanotechnology.[9] In this novel, scientists are able to create self-replicating nanobots that ultimately form an intelligent, self-sustaining swarm. The potential dangers of the developing technology are downplayed and ignored in the name of corporate profits and greed. In the 50 articles that referenced either of these works, it was typically done as an eye-catching, provocative reference point, or tag, to the reader—as a way to situate the reader with respect to the issues at hand. At times these referents were used to raise particular concerns or risks' while at others they were used to deride critiques of NT development by equating concerns with "science fiction

[9]We considered including referents to these authors and scenarios in the "risks" category—because there is a clear apocalyptic message embedded in these scenarios—but decided, based on closer reading of the articles, to treat it as a separate category.

speculation''—as such they did not consistently represent either laudatory or cautionary tones.

A second important topos, was a comparison between current issues in NT with previous developments and public responses to genetically modified organisms (GMOs), biotechnology and nuclear power. Risk society theorists have paid particular attention to these issues in academic and popular writings largely because they represent precisely the types of risks that are a defining characteristic of risk society—the technological advancement have the potential for widespread, catastrophic disasters that, if realized, would be impossible to contain. Additionally, well-documented social movement activism against nuclear power, biotechnology, and GMOs, particularly in Europe, has shaped how proponents of NT frame their issues. For example,

> **Both sides agree that the stakes are huge. Government officials have called nanotechnology the foundation for the "next industrial revolution" worth an estimated trillion dollars in the coming decade. But if nano's supporters play their cards wrong, experts say—by belittling public fears as "irrational" or blundering into a health or environmental mishap—the industry could find itself mired in a costly public relations debacle even worse than the one that turned genetically engineered crops into "Frankenfood." (*Washington Post* 2004b)**

Articles dealing with NT issues, in the total sample containing all three print media types, overwhelming reported on the benefits of NT as compared to the risks. Figures 1 and 2 present data from *across* all organizational subfields. As illustrated in Figure 1, in every year from 1998 to 2005 *each* of the first three bars (representing environmental/health benefits, economic benefits, and privacy/security benefits respectively) are larger than *any* of the next three (representing, conversely, the risks or costs associated with each of these categories. These findings are consistent with the risk society theory arguments we presented above. This general trend holds across the time as well. In 1999, approximately 77% of the articles mentioned economic benefits, 58% mentioned environmental/health benefits, and 42% privacy/security benefits. In the same year the highest percentage of any of the risk categories was 8%. In 2002 (the year with the highest volume of NT articles) approximately 39% report privacy/security benefits, 36% of the articles mention economic benefits, and 32% mention environmental/health benefits. Environmental/health risks or costs were mentioned in only 5% of

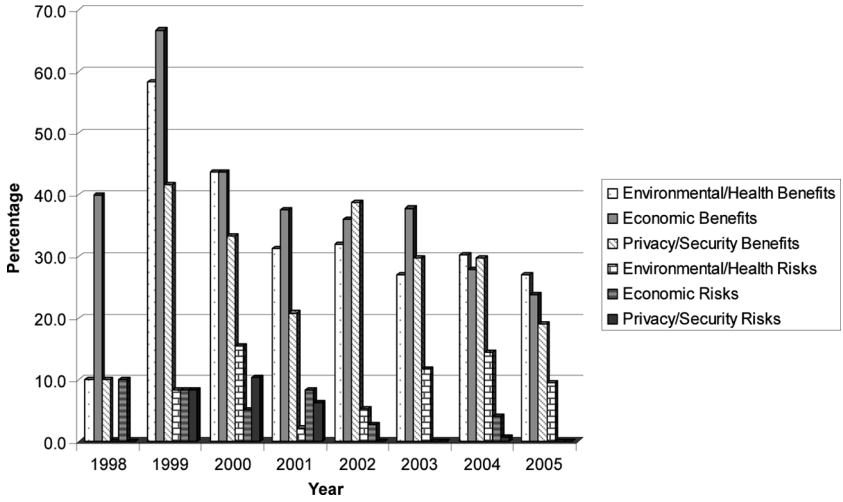

Figure 1. Major themes by year: Risks and benefits.

the articles, economic risks or costs a mere 3%, and privacy/security risks were not mentioned in single article.

As shown in Figure 2 the overwhelming majority of NT articles reported a scientific advancement—ranging from a low of 70% of the articles in 2003 to 90% of the articles in 1998. Property issues consistently showed up in NT articles hovering around 30% of the

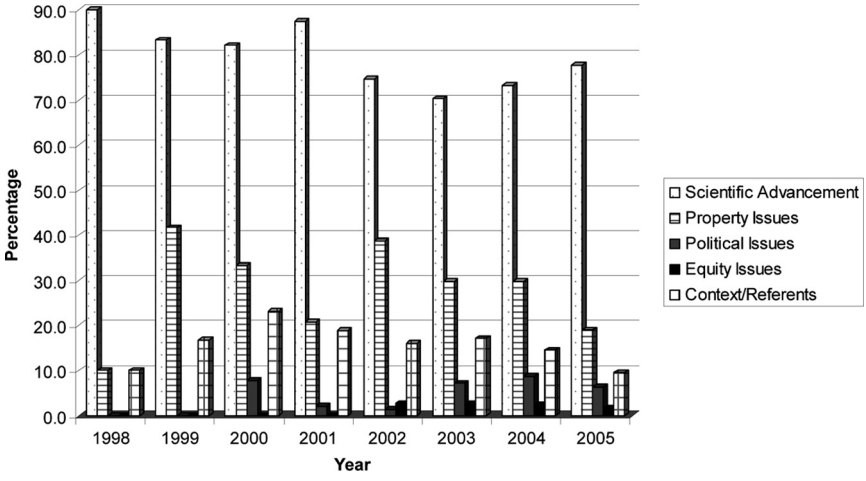

Figure 2. Major themes by year: Other categories.

articles across the time periods. Political issues peaked in 2004 with 9%, yet in four of the years these issues were mentioned in less than 2% of the articles. Equity issues were not mentioned in a single article from 1998–2001 and were only mentioned in 3% of the articles in both 2002 and 2003.

Figures 3 and 4 present the reporting of each theme by each of the three types of print media. These findings allow us to identify in these data patterns of reporting and the maintenance of symbolic boundaries within organizational subfields (i.e., we ask, "Are there are differences *between* different types of media?"). The mention of benefits at a much higher rate than reporting risks or costs is clear within each of the three organizational subfields. The popular press mentions environmental/health benefits in 39% of the articles, 55% mentioned economic benefits, and 45% addressed privacy/security benefits. The risks or costs associated with these issues were mentioned 21%, 5%, and 4%, respectively. A similar pattern emerges with the trade periodicals. Twenty-eight percent address environmental/health benefits, 25% mention economic benefits, and 24% address privacy/security benefits. The risks or costs are mentioned only 7% for environmental/health, 3% for economic, and not even 1% for privacy/security. Finally, the general science periodicals follow the same trend—almost mirroring the trade periodicals in percentages. These patterns demonstrate that celebration of economic, scientific, and technological progress was not merely an artifact of a particular

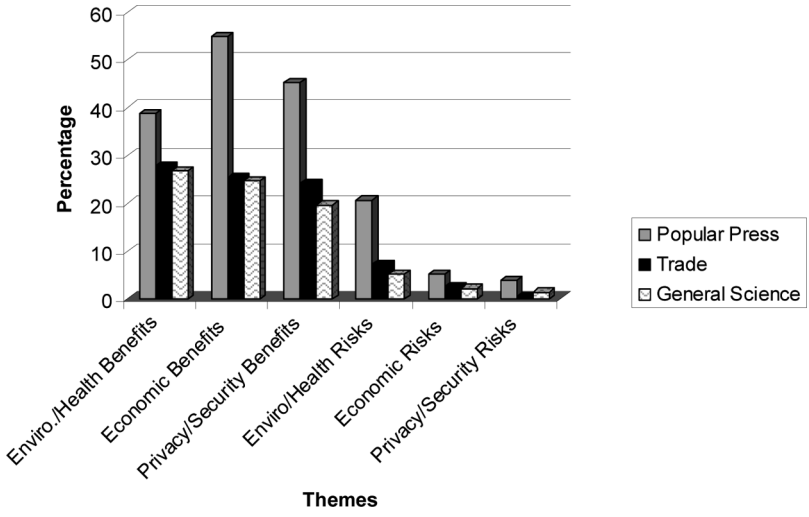

Figure 3. Major themes: Risks and benefits by media type (1998–2005).

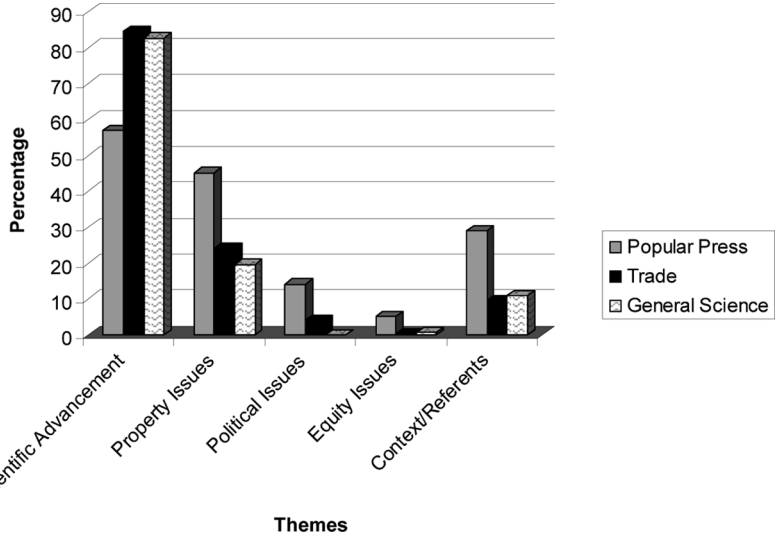

Figure 4. Major themes: Other by media type (1998–2005).

organizational subfield's emphasis. Rather, this focus is consistent across all three subfields and, as such, confirms our expectations derived from risk society theory.

Figure 4 illustrates the other major NT themes reported by each of the three organizational subfields. Reporting scientific advancements in the field of NT took place in 84% of the trade periodical articles, 83% of the general science articles, and 57% of the popular press articles, and, as mentioned above, was the most frequently mentioned category. The popular press reported on property issues and political issues at least twice as often other two media types. The popular media was also more likely to mention topos such as "grey goo," "nanobots" as well as GMOs, nuclear power, and biotechnology. Within popular media, articles that mentioned topoi are associated with mentioning risks ($r = .43$, $p < .001$), whereas there is no statistically significant relationship between topoi and benefits of NT. This finding demonstrates that these themes, apocalyptical and conflict-laden implications of technological advancement, are used to speculate on possible risks of NT and is consistent with claims that mass media reporting gravitates towards "problem frames" and "fear" (Altheide 2006, p. 60).

Our third and final empirical analysis focuses on NT coverage *within* print media subfields and assesses whether there is evidence of a "balance norm" in reporting. Stryker, Scarpellino and Holtzman

(1999), drawing from the work of Gamson and Modigliani (1989), note that mass media have multiple institutionalized routines including a "balance norm" that reflects journalists' attempts to provide objective, value-free reporting by providing different, and often competing, perspectives (see also Bennett 1996). This argument leads us to ask: Is there evidence of a balance norm in these data? If so, does it take place within individual articles or at an aggregate level within organizational sub-fields?

We produce bivariate correlations in order to assess whether the balance norm in reporting is apparent in media coverage of nanotechnology.[10] Across the three media types there is evidence of a statistically significant relationship between reporting benefits and risks within a single article ($r = .35$, $p < .001$). The strongest correlation is found within the general science periodicals ($r = .50$, $p < .001$) and the weakest is found in the popular press ($r = .26$, $p < .001$). In other words, articles in general science periodicals contain the most "balance" of benefits and risks and the popular press provides the least.[11] Moving from individual articles as the unit of analysis to organizational subfields we see even less evidence of balance. As a whole, in the popular press sample, 119 articles contained mention of at least one benefit while 36 articles contained mention of at least one risk (3.3 times more benefits than risks). The same pattern holds, and is amplified, in the other two media types. More benefits are mentioned than risks—at a rate of 10.3 for trade journals and 11.5 for general science periodicals.

DISCUSSION

Our analysis of these data examines the symbolic packaging of NT across, between, and within organizational subfields. Across popular press, trade, and general science publications (collectively representing the "print media field") the actual or potential benefits of NT

[10]Heuristically, "perfect balance" would produce a correlation of +1 (i.e., the number of benefits and risks mentioned are either both high or both low); "perfect bias" would produce a correlation of −1 (i.e., when one is high the other is low); and a correlation of zero represents no relationship between reporting benefits and risks.

[11]Note that in our coding scheme, if a specific theme (e.g., health benefits) was mentioned it was coded as "1" for that article; regardless of the number of times that specific theme was mentioned within that article. For example, if three different health benefits were mentioned the article would still be coded as "health benefits = 1." If economic benefits were also mentioned the coding would also include "economic benefits = 1." As a result the summary measure of benefits would be "benefits = two."

are by far the most frequently cited. Actual or potential risks and costs are mentioned much less frequently. These results are consistent with prior empirical research and with our theoretical arguments above. For example, Stephens' examination of major U.S. and non-U.S. newspapers found that while the tone and the location of NT articles within newspapers changed over time, most of the articles present an "overwhelming lean towards the positive" regarding benefits and risks (2005, p. 196). Media are an arena where "symbolic contests are carried out among competing sponsors of meaning" (Gamson et al. 1992, p. 385). In these data we see that, broadly speaking, the "winning" frames are the ones that are *consistent with business interests and/or celebrate scientific advancement*. The twin pillars of economic and scientific progress provide cultural supports for understanding developments in NT and the definition of risk (or, perhaps more accurately, defining nanotechnology in ways that avoid, ignore, bracket, or downplay potential risks).

Interestingly, the pattern of a preponderance of benefits mentioned (rather than risks) holds for each type of print media—trade publications, general science, and popular press. Of course, it is not surprising that trade publications, such as *Materials Today* and *Technology Review*, which are created for and by the NT industry, provide an overwhelmingly positive view of NT. The industry is driven by scientific advancement, technological innovation and product manufacturing. Nor is it particularly surprising that general science publications provide an overwhelming positive view of emerging science and technology. Cumulative knowledge and scientific discovery are hallmarks of the Enlightenment project and the scientific community. The fact that *The New York Times*, *The Wall Street Journal*, and *The Washington Post* provide the most overwhelming positive view of NT is noteworthy. Why is it that the popular press, which is often derided for being fear-mongering and/or sensationalist (Johnson-Cartee 2005, p. 286), discuss the benefits of NT at considerably *higher* rates than either trade or general science publications?

Part of the explanation lies in the "common rules, norms and meaning systems" (Fligstein 2001, p. 15) of the different organizational subfields: different types of print media have different types of audiences and publish stories deemed relevant to those audiences. At the risk of oversimplifying: trade journals cater to researchers, technicians, and business leaders active in the field; general science journals are designed for readers with above-average scientific knowledge and broad scientific interests; and popular press publications target the broadest range of readers and interests. What is relevant

and "newsworthy" for readers of trade and general science publications is scientific and technological advancement. In contrast, what makes NT "newsworthy" at this point for the general population is the potential for exciting new and improved (smaller, faster, cheaper) products. Consequently, the general press focuses on these aspects because it is assumed that is what the readers/consumers are most interested in. This focus is "sensationalism" (Johnson-Cartee 2005) but with a positive spin rather than a negative (i.e., cultivating fear).

A second part of the explanation is that the overwhelming focus on the positive aspects of NT also conforms to theoretical ideas about the role of media framing as a reflection of powerful, in this case - business, interests in society. While global business investment in nanotechnology may create the possibility of global catastrophe, the general framing in the media highlights the positive economic outcomes of this technology. Of course, at this very early stage, the media does not possess much by way of independent knowledge. They receive their knowledge from those experts most invested in NT and in whose interest a positive interpretation is most obvious. We speculate that until something disastrous "happens," there is little reason to expect that the media would discover and/or develop alternative frames. Rather than focus on the decreased reliability of experts and policy makers, the dominant frame highlights the wide-spread economic benefits of NT development. It is a framing that remains consistent with the concerns of risk society theorists and favors the more powerful interests invested in NT. Drawing from research on media coverage of risk (see Singer and Endreny 1993, p. 445), we suspect that this focus would likely quickly shift if a dramatic event occurs—such as multiple nanotechnology related deaths.

Even if a dramatic event were to occur, there are reasons to suspect that the framing of NT might still be heavily influenced by powerful interests. Stallings (1990) posited that when dramatic events occur that are new or unforeseen, reporters often use "keynoting" to make sense of the event. This process involves relying predominately on "official" sources to frame the event which, in turn, will advance the frames of certain institutional actors. Freudenburg and colleagues (1996, p. 33) note that the use of keynoting can produce a "subtly pro-technology" bias in reporting. This particular finding has implications for scientists concerned with the implications of nanotechnology as well as environmental and social justice activists seeking to shape the debate around NT through collective action. Organizations such as Greenpeace and the etc group that have been attempting to raise awareness about the potential risks and costs of NT do not appear to be as successful in proliferating their symbolic

packaging as proponents of NT. A key determinant of future media framing of NT may be the extent to which challengers have come to be considered "official" sources and are able to play a more central role in the social construction of risk and NT. Critics of scientific development are often defined and derided as "tree-huggers" and other forms of "fringe elements" outside of the dominant culture, effectively undermining the social legitimacy of alternative frames.

There is widespread belief that in a democracy, the media plays an important role in providing the public both with information and a forum for debate about new technologies. To the extent that the media influences public opinion, and public opinion affects policy, media framing of policy relevant issues is important to the engagement of the public in policy (Jargowsky and Jasanoff 1986; Short 1984; Hughes et al. 2006; Nisbet and Goidel 2007). The potential large-scale, invisible risks associated with nanotechnology are precisely the kind of risk identified by risk society theory. Because risk is, in part, socially constructed and because there are sparse scientific data on the human and environmental effects of NT, some in the nanotech production community suggest avoiding direct confrontation and public discussion, but instead, using "marketing practices that appeal to the emotions of the public" (Matsuura 2004). Similarly, at a recent conference on NT, participants were told to speak with a consistent voice in order to prevent confusion and distrust among the public who have already expressed concerns about control and equity issues associated with NT (*The Economist* 2004). These sentiments are consistent with the skepticism that risk society theorists suggest is characteristic of the public's attitude toward experts.

Beck (1992) for example, implies that the less the public is involved in the development of science (generated risks) the greater the risks that science will create. This public exclusion, in conjunction with the ability of producers and users of science and technology to affect "what is culturally defined as acceptable risk so that debates about hazards go on in an environment that is compatible with their interest" (Vaughan 1999, p. 293) creates the fundamental asymmetry in the framing process. This asymmetry may be one reason why social movement organizations, such as Greenpeace, have called for a "citizens' jury" to determine the scientific priorities of NT (Arnall 2003). Likewise, while Nisbet and Scheufele (2007) imply that "framing" is simply an efficiency-creating heuristic to simplify complex knowledge, and not manipulative spin, their argument eschews the difference in power between the "framers" and the recipients of knowledge.

Other empirical research on risk perception does support risk society theorists' claims that public resistance to technology often reflects a loss of trust in experts' ability to manage technology (Hampel et al. 2000, p. 241). Similarly, research on public response to bioengineering suggests that scientists' status and the public's perceptions of scientists' trustworthiness with respect to managing genetic risks are tainted by scientists' association with the creation of those genetic risks (Zwick 2000, p. 280). In efforts to resist such backlash, scholars such as Nisbet call on the scientific community to coordinate with the media to "frame" not "spin" information on new risky technologies to the public (Nisbet and Scheufele 2007). Because perceived risks on the part of the public are not the result of a scientific accumulation, according to some observers, public reactions are rooted not in rational assessment but values, imagination, experience, and religious belief (Schuler 2004, p. 6; Nisbet and Scheufele 2007). That basis for risk assessment may make individuals particularly vulnerable to media framing.

From Mary Shelley's *Frankenstein* to Michael Crichton's *Prey*, the Pandora's Box of scientific advance and technological development has long fueled public fears. The frightening possibilities (not to mention depictions of scientific hubris) offered in these stories have been potent cultural reflections of perceived, technologically created risk. Alternatively, contemporary society has been indelibly shaped by an Enlightenment philosophy that trumpets the epistemological and practical benefits of science and technology. This legacy, which is deeply reinforcing of a materialist Western culture built on innovation and marketing, suggests that potential risks from new transformative technologies may be unexamined, minimized, or ignored as long as these developments promise "new" and "better" knowledge and things—as is evident in our data on nanotechnology.

There is some evidence that this imbalance may be slowly shifting. In 2004 a cross-agency nanotechnology working group was established by the U.S. Environmental Protection Agency to examine "potential applications and implications of nanotechnology" (U.S. Environmental Protection Agency 2007, p. viii). The EPA's 2007 *Nanotechnology White Paper* reports:

> **Some of the same properties that make nanomaterials useful are also properties that may cause some nanomaterials to pose hazards to humans and the environment, under specific conditions. Some nanomaterials that enter animal tissues may be able to pass through cell membranes or cross the blood-brain barrier. This may be a beneficial characteristic for such uses as targeted drug delivery and other disease**

> **treatments, but could result in unintended impacts in other uses or applications. Inhaled nanoparticles may become lodged in the lung or be translocated, and the high durability and reactivity of some nanomaterials raise issues of their fate in the environment. It may be that in most cases nanomaterials will not be of human health or ecological concern. *However, at this point not enough information exists to assess environmental exposure for most engineered nanomaterials*. . .. A challenge for environmental protection is to help fully realize the societal benefits of nanotechnology while identifying and minimizing any adverse impacts humans or ecosystems to nanomaterials. (p. 14, emphasis added)**

The peer-reviewed report reviews the research literature on NT and, as the above quote illustrates, acknowledges the lack of knowledge about the objective risks of most nanomaterials. Despite this lacunae "[o]nly a small part" of the $1.3 billion invested by the federal government in 2006, through the National Nanotechnology Initiative, "aims at researching the social and environmental implications of nanotechnology including its effects of human health, the environment, and society" (U.S. Environmental Protection Agency 2007, p. 15).

CONCLUSION

This article contributes to the literature on risk society theory and power. We examined the symbolic packaging of nanotechnology and our findings provide empirical support for risk theorists' claims about the role of the powerful to construct (or not) risks in new technologies. We provide analyses of specific framing processes and thus addressing concerns that risk society theory imposes reified categories rather than concrete analysis (Pidgeon et al. 2006). Likewise, our analyses support risk society theory's arguments about the ways in which obscuring the public's view of potential risks creates the conditions for future unmitigated risk. By presenting NT in a predominately positive light *across* and *between* media subfields, the public is precluded from serious discussion and informed debate about NT as a desired investment among a range of possible technologies.

Science and Technology scholars have argued that "real-time technology assessment" should incorporate a "range of stakeholders" in the R&D process (Guston and Sarewitz 2002). Moreover, they argue that successful science development and science policy rest on clear

and continuous communication of risk and technology assessment. Our research suggests that accomplishing this type of real-time assessment would need to include not only ongoing communication about technological innovation but an ongoing analysis of how that innovation is framed for all stakeholders to truly be incorporated.

While Beck consistently claims that media frames risk consciousness, he has not demonstrated how that happens. Our findings provide further empirical weight and nuance to risk society theory by showing that the framing process is an important mechanism that both reinforces long standing power asymmetry based on economic position as well as and the imperatives of an economic system based on growth and continual, uncritically examined, progress. Though the consequences of contemporary technologically created catastrophes may be global, their frames continue to privilege the interests of economically powerful stakeholders more than others (see also Cable et al. 2008).

Future research can build on the findings of this article in multiple ways. Scholars interested in media and framing can examine the rhetoric of NT more closely. Specifically, in addition to understanding the frequencies of certain topics and themes mentioned in different types of print media it is also important to examine *how* arguments are presented for and against NT. How are these topics drawn together within articles to form arguments or draw conclusions? Is there a relationship between the article's tone and its location within the publication? Does this change over time? Second, additional attention to the production of print media within institutional subfields might help specify precisely how symbolic boundaries are created and maintained. What role do editors, owners and advertisers play in shaping the final stories that are produced?

Likewise, our study also contributes to organizational analyses of "normal accidents" (Perrow 1984). Normal accident theory argues that risk and disaster are the inevitable by-product of tightly coupled, technologically complex organizational systems in which there is limited isolation of problems, limited substitution of supplies, unfamiliar or unintended feedback loops among other likely characteristics of NT producing organizations (Perrow 1984, p. 88). Thus, heightened risk of catastrophe is not an organizational anomaly but part of the "normal" workings of complex organizations' technological and cognitive practices (Vaughan 1999, p. 294). We demonstrate that the media is part of the social construction of those cognitive practices. Better understanding this link between the symbolic packaging, media framing and tightly coupled technological systems is a potentially fruitful area for future research. Likewise, future research might

investigate the coordination of organizational knowledge, expert knowledge and its framing. Organizations may, as part of "normal" function, contribute to technologically induced disaster as Perrow (1984) argues; certainly the scenarios for this to happen with NT are present. Yet media framing selects out these "normal" catastrophes as a likely outcome of this new technology by consistently focusing on the positive. This framing strategy arguably serves to protect the considerable investments in this innovation.

REFERENCES

Adair, Stephen. 1996. "Overcoming a Collective Action Frame in the Remaking of an Antinuclear Opposition." *Sociological Forum* 11:347–375.

Adam, Barbara and Joost van Loon. 2000. *The Risk Society and Beyond: Critical Issues for Social Theory.* London: Sage.

Alexander, Jeffrey. 1996. "Critical Reflections on 'Reflexive Modernization.'" *Theory, Culture & Society* 13(4):133–138.

Altheide, David. 2006. *Terrorism and the Politics of Fear.* Lanham, MD: AltaMira.

Anderson, Alison, Stuart Allan, Alan Petersen, and Clare Wilkinson. 2005. "The Framing of Nanotechnologies in the British Newspaper Press." *Science Communication* 27(2):200–220.

Arnall, Alexander H. 2003. *Future Technologies, Today's Choices: Nanotechnology, Artificial Intelligences and Robotics; A Technical, Political, and Institutional Map of Emerging Technologies.* London: Report Commissioned by Greenpeace Environmental Trust.

Auyero, Javier and Deborah Swistun. 2008. "The Social Production of Toxic Uncertainty." *American Sociological Review* 73(3):357–379.

Babb, Sarah. 1996. "A True American System of Finance: Frame Resonance in the U.S. Labor Movement, 1866 to 1886." *American Sociological Review* 61: 1033–1052.

Beck, Ulrich. 1992. *Risk Society: Towards a New Modernity.* London: Sage.

———. 2006. "Living in the World Risk Society." *Economy and Society* 35(3): 329–345.

Bell, Daniel. 1999 [1973]. *The Coming of Post-Industrial Society: A Venture in Social Forecasting.* New York: Basic Books.

Bennett, W. Lance. 1996. "An Introduction to Journalism Norms and Representations of Politics." *Political Communication* 13(4):373–384.

Besley, John C., Victoria L. Kramer, and Susanna H. Priest. 2008. "Expert Opinion on Nanotechnology: Risks, Benefits and Regulation." *Journal of Nanoparticle Research* 10:549–558.

Bleeker, Ronald, Lois M. Troilo, and Dominic P. Ciminello. 2004. "Patenting Nanotechnology." *Materials Today* 7(2):44–48.

Brown, Phil, Stephen M. Zavestoski, Sabrina McCormick, Joshua Mandelbaum, and Theo Luebke. 2001. "Print Media Coverage of Environmental Causation of Breast Cancer." *Sociology of Health and Illness* 23(6):747–775.

Cable, Sherry, Thomas Shriver, and Tamara L. Mix. 2008. "Risk Society and Contested Illness: The Case of Nuclear Weapons Workers." *American Sociological Review* 73(3):380–401.

Castells, Manuel. 1996. *The Rise of the Network Society.* Malden, MA: Blackwell.

Clarke, Lee and James F. Short. 1993. "Social Organization and Risk: Some Current Controversies." *Annual Review of Sociology* 19:375–399.

Cobb, Michael D. 2005. "Framing Effects on Public Opinion about Nanotechnology." *Science Communication* 27(2):221–239.

Cobb, Michael D. and Jane Macoubrie. 2004. "Public Perceptions About Nanotechnology: Risks, Benefits and Trust." *Journal of Nanoparticle Research* 6:395–405.

Crichton, Michael. 2002. *Prey.* New York: HarperCollins.

Dietz, Thomas, Paul C. Stern, and Robert W. Rycroft. 1989. "Definitions of Conflict and the Legitimation of Resources: The Case of Environmental Risk." *Sociological Forum* 4:47–70.

DiMaggio, Paul J. and Walter W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." *American Sociological Review* 48:147–160.

Dunlap, Riley E. 1998. "Lay Perceptions of Global Risk: Public Views of Global Warnings in Cross-national Context." *International Sociology* 13:473–498.

Ebeling, Mary F. E. 2008. "Mediating Uncertainty: Communicating the Financial Risks of Nanotechnologies." *Science Communication* 29(3):335–361.

Economist. 2004. "Much Ado About Almost Nothing." *The Economist.* Retrieved March 22, 2004 from http://www.economist.com/printedition/printerfriendly.cfm?story_ID=2521232

Faber, Brenton. 2006. "Popularizing Nanoscience: The Public Rhetoric of Nanotechnology, 1986–1999." *Technical Communication Quarterly* 15(2): 141–169.

Fitzgerald, Scott T. 2009. "Cooperative Collective Action: Faith-Based Community Development and the State." *Mobilization: The International Quarterly Review of Social Movement Research* 14(2):405–422.

Fligstein, Neil. 2001. *The Architecture of Markets: An Economic Sociology of Twenty-First-Century Capitalist Societies.* Princeton, NJ: Princeton University Press.

Freudenburg, William R., Cynthia-Lou Coleman, James Gonzales, and Catherine Helgeland. 1996. "Media Coverage of Hazard Events: Analyzing the Assumptions." *Risk Analysis* 16(1):31–42.

Gamson, William A., David Croteau, William Hoynes, and Theodore Sasson. 1992. "Media Images and the Social Construction of Reality." *Annual Review of Sociology* 18:373–393.

Gamson, William A. and Andre Modigliani. 1989. "Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach." *American Journal of Sociology* 95(1):1–37.

Gamson, William A. and David Stuart. 1992. "Media Discourse As a Symbolic Contest: The Bomb in Political Cartoons." *Sociological Forum* 7(1):55–86.

Giddens, Anthony. 1990. *The Consequences of Modernity.* Stanford, CA: Stanford University Press.

———. 1998. *The Third Way: The Renewal of Social Democracy.* Cambridge, UK: Polity.

Goffman, Erving. 1974. *Frame Analysis: An Essay on the Organization of Experience.* Cambridge, MA: Harvard University.

Guston, David H. and Daniel Sarewitz. 2002. "Real-Time Technology Assessment." *Technology and Society* 24:93–109.

Hampel, Jurgen, Uwe Pfenning, and Hans Peter Peters. 2000. "Attitudes Towards Genetic Engineering." *New Genetics and Society* 19:233–249.

Heimer, Carol A. 1988. "Social Structure, Psychology, and the Estimation of Risk." *Annual Review of Sociology* 14:491–517.

Hughes, Emma, Jenny Kitzinger, and Graham Murdock. 2006. "The Media and Risk." Pp. 250–270 in *Risk in Social Science*, edited by Peter Taylor-Gooby and Jens O. Zinn. Oxford, UK: Oxford University.

Jargowsky, Paul and Sheila Jasanoff. 1986. *Risk Management and Political Culture.* New York: Russell Sage.

Johnson-Cartee, Karen S. 2005. *News Narratives and News Framing: Constructing Political Reality.* New York: Rowman & Littlefield.

Joy, Bill. 2000. "Why the Future Doesn't Need Us." *WIRED* 8.04. Retrieved March 23, 2004 from http://www.wired.com/wired/archive/8.04/joy_pr.html

Krogman, Naomi T. 1996. "Frame Disputes in Environmental Controversies: The Case of Wetland Regulations in Louisiana." *Sociological Spectrum* 16:371–400.

Kulve, Haico Te. 2006. "Evolving Repertoires: Nanotechnology in Daily Newspapers in the Netherlands." *Science as Culture* 15(4):367–382.

Lukes, Stephen. 2005 [1974]. *Power: A Radical View.* New York: Palgrave Macmillan.

Lupton, Deborah. 1999. *Risk*. London: Routledge.

Marx, Karl and Freidrich Engels. 1967 [1888]. *The Communist Manifesto.* London: Penguin.

Matsuura, J. H. 2004. "Anticipating the Public Backlash: Public Relations Lessons for Nanotechnology from the Biotechnology Experience." *Technical Proceedings of the 2004 NSTI Nanotechnology Conference and Trade Show* 3:491–493.

Misra, Joy, Stephanie Moller, and Marina Karides. 2003. "Envisioning Dependency: Changing Media Depictions of Welfare in the 20th Century." *Social Problems* 50(4):482–504.

Mnyusiwalla, Anisa, Abdallah S. Daar, and Peter A. Singer. 2003. " 'Mind the Gap': Science and Ethics in Nanotechnology." *Nanotechnology* 14:R9–R13.

Montpetit, E. and C. Rouillard. 2008. "Culture and the Democratization of Risk Management: The Widening Biotechnology Gap Between Canada and France." *Administration and Society* 39:907–930.

New York Times. 2000. "A Clinton Initiative in a Science of Smallness." January 21.

———. 2001. "Scientists Debate What to Do When Findings Aid an Enemy." September 25.

———. 2002a. "Nanotechnology has arrived; a serious opposition is forming." August 8.

———. 2002b. "They've Seen the Future and Intend to Live It." July 16.

———. 2003a. "As Uses Grow, Tiny Materials' Safety Is Hard to Pin Down." November 3.
———. 2003b. "Frontier of Military Technology Is the Size of a Molecule." April 8.
———. 2004. "Today's Visions of the Science of Tomorrow." January 4.
———. 2005. "Cosmetics Break the Skin Barrier." January 8.
Nisbet, M. C. and K. Goidel. 2007. "Understanding Citizen Perceptions of Science Controversy: Bridging the Ethnographic-survey Research Divide." *Public Understanding of Science* 16:421–440.
Nisbet, Matthew C. and Dietram A. Scheufele. 2007. "The Future of Public Engagement." *The Scientist* 21:16–44.
Perrow, Charles. 1984. *Normal Accidents: Living with High Risk Technologies*. New York: Basic Books.
Pidgeon, Nick, Peter Simmons, and Karen Henwood. 2006. "Risk, Environment, and Technology." Pp. 94–116 in *Risk in Social Science*, edited by Peter Taylor-Gooby and Jens O. Zinn. Oxford, UK: Oxford University Press.
Radin, Joanna and Bruce V. Lewenstein. 2003. "Nanotechnology in the Media: A Preliminary Analysis." Pp. 1–5. in *Report prepared for NSF Workshop on Societal Implications of Nanoscience and Nanotechnology, 3–5 December 2003*, Arlington, VA.
Rotman, David. 1999. "The Hope and the Hype: Will the Real Nanotechnology Please Stand Up?" *Technology Review* 102(2):47–53.
Scheufele, Deitram A. and Bruce V. Lewenstein. 2005. "The Public and Nanotechnology: How Citizens Make Sense of Emerging Technologies." *Journal of Nanoparticle Research* 7:659–671.
Schuler, Emmanuelle. 2004. "Perception of Risks and Nanotechnology." *Emmanuelle Schuler: Perception of Ricks and Nanotechnology* Pp. 1–7. Retrieved March 24, 2004 from http://www.ifs.tu-darmstadt.de/phil/Schuler.pdf
Scientific American. 2001. "Machine-Phase Nanotechnology." September 16.
———. 2002. *Understanding Nanotechnology*. New York: Warner.
Scott, Richard W. 2003. *Organizations: Rational, Natural and Open Systems*, 5th edition. Upper Saddle River, NJ: Prentice Hall.
Short, James. 1984. "The Social Fabric at Risk: Toward the Social Transformation of Risk Analysis." *American Sociological Review* 49:711–725.
Siegrist, Michael, Carmen Keller, Hans Kastenholz, Silvia Frey, and Arnim Wiek. 2007. "Laypeople's and Experts' Perception of Nanotechnology Hazards." *Risk Analysis* 27(1):5969.
Singer, E. and P. M. Endreny. 1993. *Reporting on Risk: How the Mass Media Portray Accidents, Disease, Disasters, and Other Hazards*. New York: Russell Sage.
Snow, David and Robert Benford. 1992. "Master Frames and Cycles of Protest." Pp. 133–155 in *Frontiers in Social Movement Theory*, edited by Aldon Morris and Carol M. Mueller. New Haven, CT: Yale University Press.
———. 2006. "Clarifying the Relationship Between Framing and Ideology." Pp. 205–212 in *Frames of Protest: Social Movements and the Framing Perspective*, edited by Hank Johnston and John A. Noakes. Lanham, MD: Rowman & Littlefield.

Snow, David E. Jr., S. W. Rochford, and Robert D. Benford. 1986. "Frame Alignment Processes: Micromobilization and Movement Participation." *American Sociological Review* 51:464–481.

Stallings, Robert A. 1990. "Media Discourse and the Social Construction of Risk." *Social Problems* 37(1):80–95.

Steensland, Brian. 2008. "Why do Policy Frames Change? Actor-Idea Coevolution in Debates over Welfare Reform." *Social Forces* 86(3):1027–1054.

Stephens, Lowndes F. 2005. "News Narratives about Nano S&T in Major U.S. and Non-U.S. Newspapers." *Science Communication* 27(2):175–199.

Stephens, Lowndes F. and J. R. McKissick. 2004. *News Narratives About Nano: How Journalists and the News Media Are Framing Nanoscience and Nanotechnology Initiatives and Issues*. Presented at Imaging and Imagining Nanoscience & Engineering Conference, March.

Stryker, Robin, Martha Scarpellino, and Melissa Holtzman. 1999. "Political Culture Wars 1990s Style: The Drum Beat of Quotas in Media Framing of the Civil Rights Act of 1991." *Research in Social Stratification and Mobility* 17:33–106.

Taylor-Gooby, Peter and Jens O. Zinn. 2006. *Risk in Social Science*. Oxford, UK: Oxford University Press.

Technology Review. 2002. "Nanotechnology." June.

———. 2004. "Cooking Tumors." November.

Throne-Holst, Harald and Eivind Stø. 2008. "Who should be precautionary? Governance of Nanotechnology in the Risk of Society." *Technology Analysis and Strategic Management* 20(1):99–112.

Tulloch, John and Deborah Lupton. 2003. *Risk and Everyday Life*. London: Sage.

Ungar, Sheldon. 1998. "Bringing the Issue Back in: Comparing the Marketability of the Ozone Hole and Global Warming." *Social Problems* 45(4):510–527.

U.S. Environmental Protection Agency. 2007. *Nanotechnology White Paper*. EPA 100/B-07/001. Washington, DC: Social Policy Council.

van Loon, Joost. 2002. *Risk and Technological Culture Towards a Sociology of Virulence*. London: Routledge.

Vaughan, Diane. 1999. "The Dark Side of Organizations: Mistakes, Misconduct and Disaster." *Annual Review of Sociology* 25:271–305.

Wagner, Wolfgang, Nicole Kronberger, and Frank Seifert. 2002. "Collective Symbolic Coping with New Technology: Knowledge, Images, and Public Discourse." *British Journal of Social Psychology* 41:323–343.

Wall Street Journal. 1999. "The Wall Street Journal Millennium (A Special Report): Industry & Economics." December 31.

———. 2001. "Ready-to-Wear Watchdogs—'Smart' Garments Keep Track of Vital Signs, Hide Odor." August 10.

Warheit, David B. 2004. "Nanoparticles: Health Impacts?" *Materialstoday* 7:32–35.

Washington Post. 2004a. "EPA Backs Nanotechnology Safety Research." November 12.

———. 2004b. "For Science, Nanotech Poses Big Unknowns." February 1.

Whitesides, George M. and J. Christopher Love. 2002. "The Art of Building Small." Pp. 36–53 in *Understanding Nanotechnology*, edited by *Scientific American*. New York: Warner.

Wilkinson, Clare, Stuart Allan, Alison Anderson, and Alan Peterson. 2007. "From Uncertainty to Risk?: Scientific and News Media Portrayals of Nanoparticle Safety." *Health, Risk & Society* 9(2):145–157.

Woodrow Wilson Center Project on Emerging Nanotechnologies, Inventory of Consumer Products. 2008. Retrieved November 9, 2008 from http://www.nanotechproject.org/inventories/consumer

Zachary, G. Pascal. 2003. "Essays, Arguments, and Opinions from Around the World." *Nanotechnology* 14:108.

Zinn, Jens O. and Peter Taylor-Gooby. 2006. "Risk as an Interdisciplinary Research Area." Pp. 20–53 in *Risk in Social Science*, edited by Peter Taylor-Gooby and Jens. O. Zinn. Oxford, UK: Oxford University Press.

Zwick, Michael M. 2000. "Genetic Engineering: Risks and Hazards as Perceived by the German Public." *New Genetics and Society* 19:270–281.