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# Morally Contentious Technology-Field Intersections: The Case of Biotechnology in the United States

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**Abstract** Technologies can be not only contentious—overthrowing existing ways of doing things—but also morally contentious—forcing deep reflection on personal values and societal norms. This article investigates that what may impede the acceptance of a technology and/or the development of the field that supports or exploits it, the lines between which often become blurred in the face of morally contentious content. Using a unique dataset with historically important timing—the United States Biotechnology Study fielded just 9 months after the public announcement of the successful cloning of the first mammal (i.e., Dolly the sheep)—we find that microlevel factors (i.e., conservative Christianity) predict unfavorable judgments of the technology-field intersection while macro-level representations [i.e., exposure to Science, Technology, Engineering, and Mathematics disciplines and media coverage] predict more favorable judgments.

**Keywords** Biotechnology · Individual level of analysis · Morally contentious fields · STEM disciplines · Survey methodology · Technology-field intersections

## Introduction

Despite numerous economic benefits (Abramovitz 1956; McArthur and Sachs 2001; Rosenberg 1982), technological advancements can be contentious. Technological advances overthrow existing conceptualizations of how activity is carried out (Charki et al. 2011; Powell 1999) and create a venue for reflection on practices used to date (Harshman et al. 2005; Zaleski 1997). Advances in phonography, broadcasting, travel, and communication deeply altered religions throughout the world (Davis 1976; Kinney 1995; Lee 1999), for example. These changes take place not merely because a technology is invented, but because an organizational field supporting the diffusion and trade of the technology emerges (Arora et al. 2002; Casper 2007; Florida and Kenney 1988; Powell 1999). "Fields are richly contextualized spaces where disparate organizations involve themselves with one another in an effort to develop collective understandings regarding matters that are consequential for organizational and field-level activities" (Wooten and Hoffman 2008, p. 138). For technologies to gain widespread support in society, a myriad collection of individuals (e.g., users, investors, consumers, critics, and political leaders) and organizations (e.g., firms, advocacy groups, and financial intermediaries) must become engaged in the construction and furtherance of the field (Dougherty and Dunne 2011; Lynn et al. 1996; Powell 1999). Sine and Lee (2009) have shown, for example, how renewable energy technology was able to garner widespread support as a result of educational programs and public relations efforts on the part of environmental social movement organizations. The role of venture capitalists in the support of firms attempting to commercialize nascent technology is extremely well documented (e.g., Baum and Silverman 2004; Florida and Kenney 1988; Mann and Sager 2007; von Burg and Kenney 2000). Without support coming from different directions, technology will not only fail to gain traction, but the field that would otherwise form around it may never fully develop.

Prior research suggests that some fields are contentious for moral or ethical reasons (Marshall 1999; Zelizer 1978).

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Morally contentious fields often deal with the potential for human or ecological harm, and the practices in these fields force individuals to reflect deeply on their personal values and societal norms. Technological advances have made it possible, for example, to graft human neural stem cells into primate brains, potentially altering not only the cognitive capabilities of the animals but also their moral status (Greene et al. 2005). Reflections on these advances help determine whether practices in the morally contentious field are viewed favorable or unfavorably and thus whether the field should develop further in support of those practices. As the technology surrounding organ transplants progressed, for example, members of society struggled with the moral dilemma of whether the sale of human organs should be allowed, and thus whether markets should be formed for that purpose (Titmuss 1971). Further advances in the technology will soon make possible the "printing" of functional human organs (Kluger 2010), which suggest manufacturing plants may someday provide human organs through mass production methods. As one can see, when morally contentious fields are seeded by technology, the line between the technology and the field that supports or exploits it becomes porous, creating a shared reputation between the two (Deeds et al. 2004; King et al. 2002). Given that economic progress could be slowed (Rosenberg 1982) and that social conflict may arise without consensus forming around a technology (Marshall 1999), there is value in determining what may impede the acceptance of a technology and/or the development of a supporting field when either component could be perceived as morally contentious.

A technology can have impact on multiple fields (Banerjee 2008; Banerjee and Cole 2010) and a field can be affected by many technologies (e.g., Kong 2001). In this article, we examine one slice, or intersection, of this technology-field set. We refer to this phenomenon as the technology-field intersection (TFI), which delineates a technology situated within a broader field that emerges to support or exploit the technology. By field, we mean any activity by any actor that is supportive (e.g., venture capital investment, material supply) or exploitative (e.g., genetically modified foods, vaccine manufacturing) of the focal technology. This activity could be commercial (e.g., the sale of products that directly exploit the technology, or the sale of machines that help researchers further the technology), regulatory (e.g., attempts to define the limits of activity), medicinal (e.g., the use of the technology in healing), or otherwise transactional in nature (e.g., the use of genetic markers to determine eligibility for credit cards). An intersection, by definition, is a set that contains elements shared by two or more given sets. Key to the TFI is that the constitutive components become difficult to separate, and thus become treated as one object of attention or concern. When either of the components is morally contentious, a cross-contamination of sorts can occur, holding back the development of both components, and even the TFI itself. Otherwise viable and acceptable technologies (e.g., water purification) can suddenly become the object of public concern when contentious organizational fields (e.g., nanotechnology) come into contact with the technology. Alternatively, otherwise acceptable organizational fields (e.g., IT) can be hampered when coming into contact with contentious technologies (e.g., artificial intelligence, AI). Managers should be concerned because either of these constitutive components, as well as the intersection between them, can directly affect growth of the firm—in terms of not only the ability to generate sales for their firms but also the ability to build knowledge that can be leveraged long-term for that purpose. Policy makers and academicians should care about management of the TFI because of this potential inflection point in the growth of science and engineering understanding.

As recognition that technologies may be "socially shaped" has gained ground, new questions emerge regarding "the character and influence of the shaping forces" (Williams and Edge 1996, p. 857). Some have gone further to argue that "technology is developed by humans and with a value system present" (Martin and Freeman 2004, p. 354). To this end, we build on prior work of how individuals make judgments in the face of moral concerns (Sonenshein 2007) and exploit a unique dataset with historically important timing—the United States Biotechnology Study, which was fielded just 9 months after the public announcement of the successful cloning of the first mammal (i.e., Dolly the sheep). For a new organizational field such as biotechnology to take hold successfully, it must garner broad support from numerous institutional actors, including sources of finance, human capital, and knowledge (Deeds et al. 2004; Sine and Lee 2009). Thus, positive judgments of the emerging TFI are vital for both the technology and the organizational field to expand and perpetuate, and negative judgments may hold both back. The emergence of the TFI of nuclear energy, for example, was plagued by concerns regarding the safety of the technology (Falk 1982), leading to numerous constraints on the organizational field, including government regulation. Given that the true potential of an organizational field such as biotechnology is completely unknown and that the possibilities are morally contentious, getting a sense of whether or not that potential is viewed in a favorable light (as opposed to an unfavorable light) could be important in the success of the technology and field long term.

Management scholars often have looked to particular snapshots in history to understand the emergence of modern organizational fields. Rao (1994) focused on the emergence of numerous competing technologies in the nascent automotive field to examine how the competitions for certifications led to the emergence of the modern auto industry. Likewise, Washington and Ventresca (2008) focused on the formative years of the NCAA to understand how collegiate basketball became institutionalized in the US. In the intersection between technology and adoption, Hargadon and Douglas (2001) focused on the sliver of time when Thomas Edison took actions—occasionally morally questionable—to establish his technology over his rivals'. Research that draws from historically important junctures has been called "needed" for the furtherance of organizational scholarship precisely because such examinations explain how today's world came to be (Kieser 1994). "Present forms have their particular nature *by virtue* of their past" (Manicas 1987, p. 274). Looking back from what we now know about how the organizational field of biotechnology has formed, we understand the period surrounding the Dolly the Sheep cloning incident to be particularly important, as it introduced a moral dimension (i.e., the cloning of animals for food and even the possibility of humans cloning themselves) to what had been merely a novel technology. A quantitative content analysis of biotechnology-related coverage appearing in the New York Times and Newsweek between 1970 and 1999 reveals that coverage of the TFI was characterized as "overwhelmingly positive, with heavy emphasis on the frames of scientific progress and economic prospect. A departure from this trend only occurs in correspondence to the late 1990s debate over cloning, as a greater media emphasis on ethics and controversy emerges" (Nisbet and Lewenstein 2002, p. 359). This makes the dataset a perfect vehicle for assessing what factors determine whether a morally contentious TFI garners support from individual members of society.

This research makes two main contributions. First, this article extends the literature on morally contested fields (Greene et al. 2005; Mathews et al. 2008; Zelizer 1978, 1979) not only to the technology around which organizational fields manifest but also to the TFI, which acknowledges the bidirectional relationships between the two component parts. Bringing together the literature on the social construction of technology with the literature on organizational fields, we describe how these two constitutive components exist interdependently in ways in which moral contestation in one of the components may cross-contaminate the other component via the TFI. Second, we document empirically how both microlevel factors and macrolevel processes affect the support the TFI receives from members of the public. In doing so, we extend prior work on individual judgments of one's own activity in the face of moral concerns (Sonenshein 2007) and show how this work can be applied to determining individual judgments of others' activity within the TFI. We specifically investigate how deeply held beliefs influence the favorable judgment that the TFI garners, and whether access to external representations has any sway over those judgments. Thus, we connect both micro- and macrofactors to support or lack of support for the technology or the organizational field that supports or exploits it. "[S]ince our values and institutions shape the progress and use of science and technology, the fundamental social response must come from change in these values and institutions" (Baram 1971, p. 535). The results suggest that microlevel factors (i.e., conservative Christianity) predict unfavorable judgments of the biotechnology TFI while macrolevel representations (i.e., prior experience in Science, Technology, Engineering, and Mathematics, so-called STEM disciplines, and media framings) predict more favorable assessments.

## Technology-Field Intersection

Technology has been defined as the application of science and engineering to solve practical problems (Arora et al. 2002). Technology is seeded by scientific knowledge, which is cumulative in nature and can be used repeatedly to tackle different problems without loss of that knowledge resource (Romer 1990). As more and more researchers seek to use the existing knowledge base and to create new knowledge, collectively these individual actors may come to self-identify as part of a scientific field (e.g., the scientific field of nanotechnology). Members of scientific fields hold conferences to share knowledge and findings among other interested parties (Garud 2008) and may form new journals as a way of categorizing advancements and enforcing norms of research in the scientific field (Swanson and Ramiller 1993). The objects of knowledge embodied within these research practices are transformed and given symbolic meaning through these socialized processes (Leydesdorff 2007; Luhmann 1990).

Still, the advancement and trajectory of technology is not sequestered from the outside world. When members of the scientific field define characteristics of their technology, they are forced to frame those definitions in terms of the world in which the technology will be evaluated and interpreted (Akrich 2000). Not only are scientists and technologists dependent on a number of supportive networks beyond their laboratories (Alcadipani and Hassard 2010, p. 420), they "assume that morality, technology, society, and the economy will evolve in particular ways. In a nutshell, they inscribe their vision, or prediction about the world, into the technical content of the new object" (Okunoye and Bertaux 2008, p. 14). In short, technologies are assembled and reassembled into being through contact with these varied networks (Latour 1999).

Firms are formed to commercialize technology and to further the technology for future market transactions, while financiers provide capital in support of these efforts. Intellectual property specialists seek to protect the efforts of these supporters or exploiters with respect to the technology, and the court system helps to demarcate the scope of that property (Carolan 2010). Believers in the promise of the technology seek to drum up interest and support, while skeptics of the technology seek to undermine or control it, often through regulatory means. This often happens via the mass media, which create narratives surrounding the technology, the scientific field, and the organizational field, often in incomplete or complex ways (Bauer 2002; Gamson and Modigliani 1989). Over time, this ecology of players garners an identity as a unique organization field (Dougherty and Dunne 2011; Wooten and Hoffman 2008), which collectively can be distinguished from other such organizational fields holding their own unique identities (Powell 1999).

These organizational fields naturally overlap with the scientific field that seeded the focal technology, which means that they often have the same name. We distinguish the two by the broadness of the participating players where scientific fields are those scientists and engineers who learn from the technology, whereas the organizational field is the broader tapestry of firms, investors, institutional entities, and complementary players who support and exploit that knowledge, often to commercialize and capitalize on that knowledge. The interesting aspect of technology, scientific fields, and organizational fields is that this intersection exists between them, creating an opportunity for the technology born within a scientific field to impact and be impacted by the larger ecosystem of firms, investors, institutional entities, and complementary industry players. We refer to this phenomenon as the TFI. (See Fig. 1 for a two-dimensional representation of a multi-dimensional space.)

Just because there is value in supporting and exploiting a technology, does not mean that everyone agrees with the decision to do so. It has been shown that social conflict may arise if consensus cannot be formed around a given technology (Marshall 1999). This is because technological

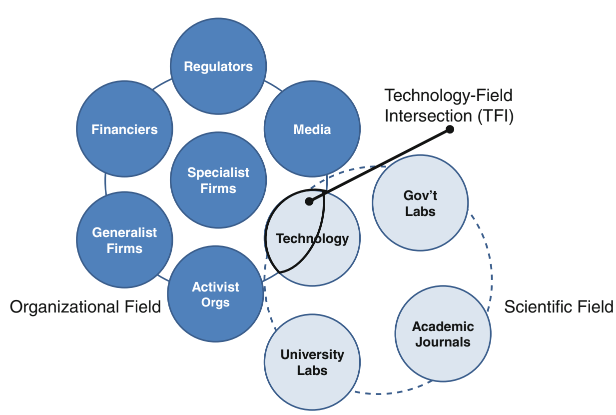


**Fig. 1** The TFI

advancements may overturn existing conceptualizations of how activity is carried out (Charki et al. 2011; Powell 1999). New technology may advance more quickly than our ability to provide evidence-based data before widespread application (Jones 2000, p. 676), which means that for many technologies it is our internal moral compass that determines whether we choose to support the technology or the organizational field that supports or exploits it. Technologists and ethicists long have struggled with the morally contested nature of technologies or the activities in the organizational fields the support or exploit the technology. When the commercialization of child surrogacy began to take root, for example, it was argued that "ethically, morally, and pragmatically, a ceiling has been reached regarding the social acceptability of some contentious technologies" (Baslington 1996, p. 675). Many times this moral contestation dimension leads to calls for regulation of the technology or limits on its usage or exploitation (Jones 1992).

"[T]he phrase 'social acceptability' suggests a normative judgment in a way that makes social acceptance come to involve inherently contentious characterizations of 'society's values'" (Thompson 2001, p. 252). Scholars and laymen alike have struggled with questions of the limits that should be placed on surveillance technologies (Marx 2005), which decisions should be considered off-limits for computers to handle (Moor 1979), and whether parents have the right to pre-select the gender of their offspring (Jones 1992). Questions of social acceptability may entail any number of factors, such as where the technology is used, economic parameters regarding the purchase of the technology or its usage, the comfort level of users and whether they are given transparent opportunities to accept or reject the technology (Thompson 2001).

As these examples suggest, this means that either the technology itself and/or the organizational field that supports and exploits the technology can be contentious in some form (See Table 1). This is particularly important in that the constitutive components of the TFI become difficult to separate in the eyes of observers, and thus become treated as one object of attention or concern. We know from the psychology literature that when something offensive comes into contact with something that is not already offensive, the offensiveness often "contaminates" the other object (e.g., juice becomes off-putting when a sterilized cockroach is dipped in it) (Rozin et al. 2009, pp. 1179–1180). We argue that a similar effect can occur in terms of moral contestation, wherein one component of the TFI can contaminate the other component of the TFI, with profound implications for all parties involved.

Let us consider the four different possibilities described in Table 1. The scientific field of meteorology emerged centuries ago, as sailors and farmers began noticing

**Table 1** Morally contentious TFIs

| | Technology | |
|---|---|---|
| | Morally non-contentious | Morally contentious |
| Org'l. Field | | |
| Morally non-contentious | Doppler weather systems in meteorology | AI in IT |
| Morally contentious | Water filtration and desalination technologies in nanotechnology | Cloning in biotechnology |

*Note* Organizational fields and scientific fields often have the same name. We distinguish the two by the broadness of the participating players where scientific fields are those scientists and engineers who learn from the technology, whereas the organizational field is the broader ecosystem of investors, firms, institutional players, and complementary industries who support and exploit (usually through commercialization) that knowledge

patterns in the weather they encountered. Loud rumblings and color changes in the sky would precede storms, which allowed individuals to seek shelter in advance of the rainfall. These observations were not necessarily helpful in longer term timelines, such as multi-day or multi-month boating expeditions. These observations were also not particularly helpful when devastating storms, such as hurricanes and tornados would destroy housing and crops. Modern meteorology reduces the socioeconomic vulnerabilities and impacts associated with weather, for example deaths and economic losses ($7 billion annually in the US) due to tornados, tropical storms, and flash floods (Riebsame et al. 1986). Various technologies have emerged as a result of these practical problems, ranging from thermometers and barometers to radar and scientific modeling, and the organizational field of meteorology entails numerous institutional actors (e.g., National Weather Service, Coast Guard, and universities), mass media entities that hire university graduates and rivals' weather announcers, firms who manufacture and market radar systems and other devices, and so on. Along both dimensions, the technology and the organizational field that supports and exploits the technology are both relatively uncontested.

In a similar vein, the production of clean water is not morally contentious either. Water filtration and desalination technologies afford the removal of the smallest contaminants from water supplies to increase the supply of scarce resources and diminish pollution for a cleaner environment (Roco and Bainbridge 2001). Still, if the technology of filtration and desalination is facilitated by the precise manipulation of materials at the molecular level, or on a scale as small as one-billionth of a meter, the technology becomes morally contested. This is because outside of the industry and academia, most people are first introduced to nanotechnology (which occurs on a scale of roughly 1–100 nm) through fictional works that, for example, posit scenarios that scientists largely reject as implausible, such as self-replicating nanobots running amok like pandemic viruses (Crichton 2002) and with members of the organizational field (e.g., firms and investors) using the knowledge gained by the technology for personal gain (Crichton 2002). In addition, if not with popular fiction, in the mainstream media, we are beginning to hear more reports about the risks that nanotechnology as an organizational field poses to the environment, health, and safety, and with conflicting reports from within the industry (Allhoff and Lin 2006).

Flipping the contentious nature of the field and the technology, one could consider information technology (IT) and the technology of AI. While IT as an organizational field has its beginnings in the national defense, as an organizational field it has been mostly seen as an extension of computing power (e.g., Christensen and Rosenbloom 1995). Where IT has seen trouble is with the technology of AI, or the simulation of intelligent behavior in computers. When computers start making decisions like humans, individuals begin to feel threatened, philosophizing whether there are certain decisions that computers should never be instructed to make, such as the choice to end life (Moor 1979).

> By its nature, computing technology is normative. We expect programs, when executed, to proceed toward some objective—for example, to correctly compute our income taxes or keep an airplane on course. Their intended purpose serves as a norm for evaluation—that is, we assess how well the computer program calculates the tax or guides the airplane. Viewing computers as technological agents is reasonable because they do jobs on our behalf. They're normative agents in the limited sense that we can assess their performance in terms of how well they do their assigned jobs (Moor 2006, p. 18).

Strong opponents of AI such as Searle (1980), however, suggest that our mental activity cannot be understood like that of a computer following a program.

Finally, there certainly exist situations in which both the technology and the organizational field that supports and exploits the technology are both morally contentious. Biotechnology, an organizational field that builds on the application of engineering to life sciences, has always had a questionable role in society, from the engineering and patenting of living organisms (with Diamond v. Chakraborty) to the replication of DNA (Kary Mullis). Likewise, the technology of cloning has been deeply questioned, beginning with the announcement of the first successful cloning of a mammal—Dolly the Sheep—and the successful patenting of the technology. The patents cover the so-called nuclear transfer technology itself and any cloned animals produced as a result. The cloning rights hold for 17 years and give the American owners of the company, Geron Bio-med, which was licensed by Dolly's creators to exploit the new science, sole rights to a technology that could help doctors grow living tissue for use in human transplants. The patents, numbered GB 2318578 and GB 2331751, are jointly owned by the Roslin Institute, the UK's Biotechnology and Biological Sciences Research Council (BBSRC) and the UK government through its Ministry of Agriculture, Fisheries and Food (MAFF). Critics have argued that these patents give one commercial organization too much control over something that promises to revolutionize medicine in the twenty-first century. Geron brought its expertise in stem cells, the master cells in the body that can become any type of tissue—bone, muscle, nerve, and so on. This expertise, combined with nuclear transfer, could allow scientists to "re-program" cells and grow tissue for transplants that would not be rejected by a patient's body. Now, because of the issuance of the patents, anyone who wants to attempt this type of work would be liable to pay a licensing fee to Geron. This is where the intersection of the technology with the organizational field (i.e., those who capitalize and commercialize knowledge gained by the technology field from the technology) makes for an interesting management question.

Cloning in biotechnology provides the ideal setting to investigate the TFI and implications for practitioners, academics, and policy makers. Compare the case of cloning with that of cancer screening [for example, the testing (such as through a PAP-smear) of whether an individual has abnormal cells that might lead to cancer in their body]—a technology that is morally acceptable (for the most part) but exists within the biotechnology field, which is morally contentious (for the most part). Cervical screening has been carried out in Western countries, such as the UK, since at least the 1960s (Howson 2001), and there is considerable consensus concerning its success as a preventive strategy and thus an effective health policy born out of scientific inquiry (Peto et al. 2004). Thus, it appears that biotechnology, when part of a TFI, can introduce moral concerns for observers.

## The TFI of Cloning and Biotechnology

Biotechnology is loosely defined as the application of technology to life sciences, including humans, animals, and plants. Based on Watson and Crick's discovery of the structure of DNA in the 1950s, emergence of the scientific field began in the 1980s when Kary Mullis of Cetus Corporation discovered polymerase chain reaction (PCR) as a "DNA amplification" technology—basically a Xerox machine for DNA (Rabinow 1996). In addition to PCR, other techniques and technologies were perfected at the turn of the century including the modification of genetic material (e.g., genetically modified seeds) and of biological material (e.g., cloning).

Technological advancement often is accompanied by a stigma, as the human and ecological risks associated with the use and furtherance of the technology manifests as public opposition to the technology (Gregory et al. 1995). The scientific field of biotechnology went through precisely this process in early 1997, when it was announced that the first mammal had been successfully cloned using the technology (i.e., Dolly the sheep). "Controversies are not…instances of badly conducted diffusions of technology. Instead they are…points of condensation in a shaping process where both technologies and public understanding of these technologies are continuously negotiated in a particular cultural and social setting" (Horst 2005, p. 187). The successful cloning of a mammal drew substantial interest worldwide, with Dolly held up as "the most famous sheep in the world" (Whitfield 2003). The TFI started to become formed as the potential implications of Dolly began to get public airing. Thoughts such as "Does this mean that someone will attempt to clone humans?" and "Does this mean that meats produced from cloned animals will be sold in stores?" created a deeply moral conversation on the advancement of the technology, either for knowledge reasons or for commercial reasons. This porous border meant that the advancement of the technology could not be separated from the support and exploitation of the technology, and the moral implications of both.

> Everyone favors therapy and health—just as everyone once favored "better living through chemistry" until we took the staggering measure of the chemical pollution of air, water and earth. Everyone favored cheap, limitless nuclear energy at one time, until the terrible danger of radiation and nuclear weapons became known. Is there not a compelling analogy here to what may happen as the result of irretrievable…mutation? (Nelson 1983, pp. 637–638).

The moral contention inherent in biotechnology is found within its basic science—biotechnology manipulates the building blocks of life (i.e., DNA) in its advancements.

> Genetic engineers can pull a desired gene from virtually any living organism and insert it into virtually any other organism. They can put a rat gene into lettuce to make a plant that produces vitamin C or splice genes from the cecropia moth into apple plants, offering protection from fire blight, a bacterial disease that damages apples and pears. The purpose is

the same: to insert a gene or genes from a donor organism carrying a desired trait into an organism that does not have the trait (Ackerman 2002, n.p.).

Figure 2 provides some evidence of the morally contentious nature of biotechnology, wherein respondents were asked the degree to which they agreed whether certain biotechnology advancements would be "morally acceptable for society." The chart shows summary data for respondents in the United States Biotechnology Study (1997–1998) data, part of which data was used to test empirically our hypotheses in Tables 3 and 4. The specific survey questions dealt with introducing plant genes into crop plants, using biotechnology to produce food and drinks, introducing human genes into bacteria to produce vaccines, introducing human genes into animals to produce transplant organs, and developing genetic tests for unborn children. The disparities in the perceived moral acceptability of these potential advancements among Americans surveyed capture some of the internal struggle inherent in the biotechnology TFI. One can see that a majority of respondents in the US-based survey tended to disagree that introducing human genes into animals to produce transplant organs was morally acceptable to society. Judgments of this potential advancement of biotechnology differed strongly than for other advancements.

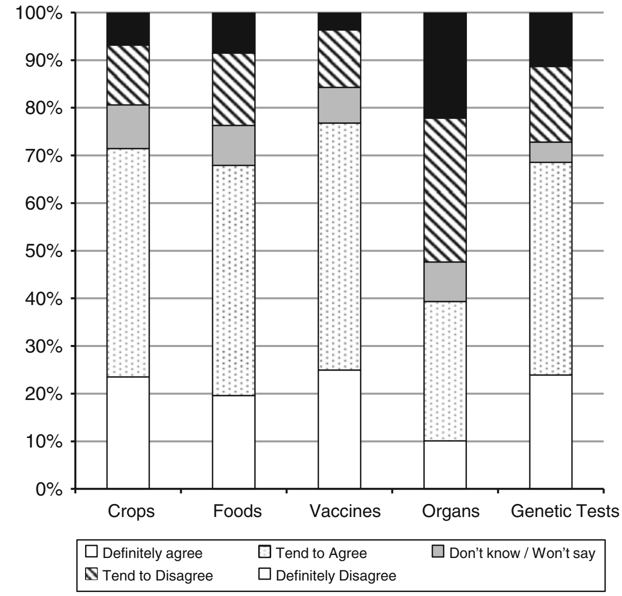


**Fig. 2** The morally contentious nature of biotechnology. *Source* United States Biotechnology Study (1997–1998), summary of respondent answers to the following questions: "Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 1. Using biotechnology to insert genes from one plant into a crop plant is morally acceptable for society. 2. The use of modern biotechnology in the production of food and drinks is morally acceptable for society. 3. Using biotechnology to introduce human genes into bacteria to produce medicines and vaccines is morally acceptable for society. 4. Using biotechnology to introduce human genes into animals to produce organs for human transplants is morally acceptable for society. 5. Using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease is morally acceptable for society"

## Hypothesis Development

To understand how the issue of moral contestation may influence individuals' support (and subsequently managers' responses) for the TFI, it is important to consider how individuals broadly approach judgment when ethical components are present. While more traditional views of ethical judgment have focused on "rationalist" approaches that focus on deliberate moral reasoning, scholars have come to recognize that individuals may not even be aware of the moral dimensions of the issue at hand, such as the potential for people to be harmed (e.g., Taylor and Brown 1988). The uncertainty surrounding the issue of interest may make it difficult to discern the magnitude of the effect of decision making, for example, thus making rationalist approaches less appealing than more intuition- or affect-based perspectives. In 2007, Sonenshein articulated a powerful model that explains how individuals use intuitive judgments of ethical situations (e.g., "my gut tells me it is bad") before trying to rationalize those judgments to others (e.g., "I did not do it because it is against company policy") (Sonenshein 2007). While this sensemaking-intuition model was developed to explain how individuals face workplace situations that entail ethical or moral dimensions, the model can easily be extended beyond individuals' judgments of their own potential actions to individuals' judgments of others' potential actions. In our case, these actions refer to the activity within the TFI.

"As soon as an individual constructs an ethical issue, that individual instantaneously makes an intuitive judgment. Such intuitions come from an individual-level factor…and a collective-level factor" (Sonenshein 2007, pp. 1027–1028). Given that judgment in the face of moral concerns may follow a similar pattern when evaluating others' activity, it seems fruitful to begin at the more microlevel of the judgment process, then move out to macroconditions that may influence judgment when considering a TFI with morally contentious dimensions. Orienting our theory development around the dimensions that make biotechnology a morally contested TFI, at the microlevel, we begin by examining how religious beliefs may influence the support that individuals afford the TFI and then turn to the political leanings of the individual. We then turn to more macrofactors, including how individuals may use representations of the object of interest learned through exposure to Science, Technology, Engineering and Math (STEM) disciplines and through exposure to outside interpretations, either through framings of the TFI in the mass media or through interactions with other individuals. Because the survey focused on only US-based respondents, we focus on US-specific factors in the subsections to follow then discuss the generalizability and limitations of this approach in the conclusion.

## Microlevel Factors

### *Religious Beliefs*

Morally contentious TFIs are highly ambiguous settings for self-reflection. This means that microlevel characteristics that are tied to comfort or discomfort with ambiguity should inform judgments regarding the TFI. Given the moral implications of manipulating living *flora* and *fauna*, microlevel religious beliefs should be one of the most important influencers of judgments of the TFI. Individuals often cope with threats via stronger beliefs in the existence of a controlling God (Kay et al. 2008). According to recent surveys, in the United States, that controlling God is the Christian god—76 % of Americans surveyed self-identified as Christian in 2008 (Kosmin and Keysar 2009). While there is a long-held belief that religions such as Christianity are at odds with science (Draper 1881), this belief is a relatively new phenomenon (Russell 1985). Historically key figures in science often were motivated by their religious convictions (e.g., Isaac Newton) and many scientific discoveries were the result of arguments and discussions between people of faith (Pearcey and Thaxton 1994).

In present day America, Christians actually have begun adopting scientific framings of their faith. Christian activists engaged in proposing creationism as an alternative scientific theory to evolution, for example, cite "irreducible complexity" in biochemical systems as evidence of God's role in the creation of life. Irreducible complexity refers to a "single system composed of several well-matched, interacting parts that contribute to the basic function, where the removal of any one of the parts causes the system to effectively cease functioning" (Behe 1996, p. 39). Christians believe more strongly than the non-religious that important or improbable outcomes are "meant to happen," that is, predetermined and inevitable (Norenzayan and Lee 2010). It then follows that discoveries of relationships and structures in the field of biotechnology most probably will be viewed as revelations of the elegance of God's design (Pearcey and Thaxton 1994), which humankind is only now learning to understand. We thus hypothesize that Christians in America will more favorably view the TFI of biotechnology than non-Christians.

**Hypothesis 1** Individuals who are strongly Christian will be more likely to view the TFI favorably.

### *Political orientation*

Substantial research has shown that political orientation is a strong predictor of affect and is relatively stable across one's lifetime (Block and Block 2006). "Correlational analyses show that people's ratings on a simple left/right or liberal/conservative scale predict an extraordinary variety of other traits, behaviors, preference, and interactional styles…" (Haidt et al. 2009, p. 110). It is known, for example, that liberals and conservatives rely on fundamentally different sets of moral foundations when determining whether they support certain propositions or not (Graham et al. 2009). For a morally contentious TFI with high ambiguity about its full potential, such as biotechnology, conservatives (we argue) should hold the TFI in a less favorable light than liberals. This is because political conservatism has been linked with intolerance toward ambiguity and uncertainty (Jost et al. 2003), while political liberalism has been linked with responsiveness toward both ambiguity and novelty (Amodio et al. 2007). At the same time, seeing how biotechnology involves the manipulation of the building blocks of life, individuals who are characterized by an inflated anxiety toward death [i.e., political conservatives (Jost et al. 2003)] may feel anxious toward biotechnology and the field intended to support or exploit it. For these reasons, we anticipate that political conservatism will be a predictor of a certain degree of disfavor toward the morally contentious TFI of biotechnology, while political liberalism will be a predictor in the opposite direction.

**Hypothesis 2** Individuals who are politically conservative will be less likely to view the morally contentious TFI favorably.

**Hypothesis 3** Individuals who are politically liberal will be more likely to view the morally contentious TFI favorably.

Still, not all conservatives and not all Christians are alike. In the United States, the Religious Right is a particularly powerful political force, and thus deserves special attention. These individuals are strongly conservative, Christian voters who motivate around so-called social issues, particularly support for the rights of the unborn and opposition to the rights of homosexuals (Christian Coalition 2012). Given that it is anticipated that Christians will view biotechnology discoveries favorably as signs of God's hand and politically conservative individuals will view the field unfavorably due to anxiety of its potential, the interaction of these two characteristics is not exactly clear. The strong concerns for the lives of the unborn, however, may provide important insight. Members of the Religious Right do not believe that it is appropriate to interfere with natural reproduction, which they see as an act of God. This includes opposition to such activity as birth control and birth surrogacy; as religious leader Jerry Falwell famously said, "God's way is still the best way" (Greil 1989, p. 11). To see how far this thinking has evolved in the United States, several of the political candidates for the Republican nomination in the 2012 presidential election publicly came out against abortion even for victims of rape or incest (Goldberg 2011). Members of the Religious Right long have been concerned with people "playing God" (Augenstein 1967; Lammers 2002) and this stance has become more magnified over the years. At the same time, conservatives often reject activity that subverts the authority of established institutions, such as the church (Graham et al. 2009), and express concerns about physical and spiritual contamination (Haidt et al. 2009). Accordingly, we propose that apprehension with "playing God" via genetic manipulations of humans genes will tip the scale toward unfavorable assessments of the morally contentious TFI for this sub-population.

**Hypothesis 4** Individuals who are politically conservative and Christian will be less likely to view the morally contentious TFI favorably than other Christians or other political conservatives.

## Macrolevel Factors

### *Representation via Classroom Exposure*

Sonenshein suggests that at the collective level the concept of "representation" allows individuals to interpret ethical dilemma by having access to alternative mental models (Sonenshein 2007, p. 1031). These representations broaden the interpretations available to the individual, making it much more likely that the individual can create complex comprehensions.

One factor that might influence the ability of individuals to form complex comprehensions of a TFI as scientifically intricate as biotechnology is prior exposure to Science, Technology, Engineering, and Mathematics (so-called STEM disciplines). STEM skills are related to strategic research, or to the functional aspects of science and technology as they relate to human welfare, economic development, social progress, and the quality of life (Hurd 1998). Within an innovative organization, STEM skills would be considered part of the human capital of the organization, which is directly linked to the creation of innovation (Leiponen 2005; Mohnen and Röller 2005). Individually, however, STEM skills have been identified with science literacy (Hurd 1998), or an overall understanding of science and its applications. Studies using think aloud protocols show that readers of science articles often are concerned about the ability to understand the article (Steinke 1995). Higher levels of experience, knowledge, and ability are associated with better quality mental representations and increased learning of informational texts (Fox 2009), which strongly characterize technology articles.

Thus, we theorize that individuals who have experience with STEM disciplines will be more likely to view the morally contentious TFI favorably than those without such experience. This hypothesis moves beyond mere exposure to outside information on the TFI embodied in media representations or interpersonal communications, and instead suggests that prior exposure to specific disciplinary knowledge could help in comprehension of the TFI.

**Hypothesis 5** Individuals who have had access to alternative representations via exposure to the STEM disciplines will be more likely to view the morally contentious TFI favorably.

### *Representation via Media Exposure*

The controversy surrounding morally contentious TFIs certainly will draw individuals into the broader, social conversation regarding the set. These conversations can come from one of two sources: the mass media and interpersonal communications. The mass media historically is a one-way transfer of information from a specialist organization to the captive audience. The media is a boundary-spanning field that blocks, filters, or otherwise influences the development of public concern (Howlett 1998). While the average consumer of the media may believe that there exists some objective reality, which is then filtered for consumption by media entities, substantial research indicates a more constructionist approach. "[M]edia discourse is part of the process by which individuals construct meaning, and public opinion is part of the process by which journalists and other cultural entrepreneurs develop and crystallize meaning in public discourse" (Gamson and Modigliani 1989, p. 2). Media framings, which organize the world for both journalists and the public who consumes the framing, play a vital role in the formation of public opinion (Gitlin 1980). The media can play an important role in enhancing the level of public knowledge about science and health (Wade and Schramm 1969), and exposure to science in the press has been shown to positively predict science beliefs (Hwang and Southwell 2009) and more general attitudes toward science (Dudo et al. 2010).

The media do not necessarily tell us what to think, but they do tell us what to think about (Marks et al. 2007, p. 184). Through the fact that the media provide coverage, the object of description actually becomes newsworthy (Lester 1980), making it part of the societal discourse of what it is and normatively what it could be. Descriptions of emergent technology in the media often use conditionals (e.g., "could") to play up the possibilities inherent within the technology (Anderson et al. 2007). Historically, the media framed the morally contentious TFI of nuclear power as both "a source of energy independence" as well as a "Devil's bargain" (Gamson and Modigliani 1989). For biotechnology, the visions of biotechnology available to the public ranged from the "elixer of life" to "images of doom" (Bauer 2002, p. 95). In this way, the media are part of a larger storytelling and sensemaking operation in society (Dahlgren 1988; O'Connell and Mills 2003), helping spur understanding and normative activity within an emerging TFI.

Technologies are not "self-contained entities that impact on the 'social' but are 'socialized'—'as property and infrastructure, as the objects of attention for workers and consumers, as tools for economic and regional development" (Crang et al. 1999, p. 2; Kong 2001, p. 404). Research shows that judgments of risk for a threatening technology are most acute when technological development is high but the prevalence of the technology is still low (Lima et al. 2005). As exposure to alternative representations increase, however, the ability to recognize what could be achieved via the technology also increases. It is known that specialists in the field perceive lower risk of scientific advances than the less informed public (Berube et al. 2011). This suggests that as members of the general public become exposed to alternative representations about technological and scientific advances that their judgments of risk should decrease.

Judgments about science and technology are also informed by interpersonal discussions, generally in response to coverage of the issue in the media (Dunwoody and Neuwirth 1991). Exposure to media programs regarding science and technology leads individuals to self-report a greater understanding of the issue, which in turn spurs further interpersonal discussions (Southwell and Torres 2006). These conversations increase understanding of the issues surrounding the technology, and may create a situation ripe for social anchoring, wherein the individual tests his or her own interpretation of the object of interest against those of others (Sonenshein 2007, p. 1030). Such social anchoring represents an important part of the sensemaking process for individuals maneuvering within larger collectives of people. For this reason, exposure to alternative representations about the TFI—whether from media sources or interpersonal communications—should increase an understanding of the topic. We hypothesize that as these alternative representations become available, consideration of the TFI should become broadly more favorable.

**Hypothesis 6** Individuals who have had access to alternative representations from media sources or interpersonal communications will be more likely to view the morally contentious TFI favorably.

## Methodology

### Data

The dataset that we use for this study is historically important in the evolution of the TFI of biotechnology. Technological invention (Balachandra and Friar 1997) and technological adoption (Powell 1999; Rao 1994) are both highly contextualized phenomenon. "Historical analyses can prepare us to better identify and to make better use of choice opportunities" (Kieser 1994, p. 611). In our case, it is those choices that we are interested in examining. The emergence of biotechnology as a viable field soon ran affront with ethical considerations, a situation catalyzed by the Dolly the Sheep announcement of successful cloning technology. At that particular point in time, it was unclear to the average person precisely how biotechnology would evolve, making it a choice period to evaluate how individuals form judgments when morally contested dimensions are present in the TFI. Moreover, only now, after a decade and a half of progress in the TFI can we look back and recognize that point in time as a highly contentious one that could have made or broken the technology and/or organizational field. Using this period in time over a decade later also allows us to bring in a media analysis of content that further enriches the theory.

Fielded Nov 11, 1997, through Feb 14, 1998, the United States Biotechnology Study collected data "from United States citizens aged 18 and older regarding their interest in and attentiveness to selected current news issues, knowledge of and attitudes toward biotechnology, various forms of political participation, and knowledge of scientific concepts" (Miller 2000, p. vii). Conducted by telephone not long after the 1996 Eurobarometer Survey (1996), the study posed some questions similar to those asked of European respondents. The data was made publicly available in November 2000 and is available to institutions affiliated with the Inter-university Consortium for Political and Social Research at the University of Michigan (James 2006). All together, the dataset contained 1,067 cases, of which 915 were asked questions regarding the variables of interest (see Appendix B). The data were probability weighted by race (Miller 2000), using self-identified categories: African American, Hispanic American, White/Caucasian, Asian or Pacific Islander, or American Indian or Alaskan Native. All observations were clustered by respondent.

### *Dependent Variable*

Our dependent variable is a five-point scaled variable that captures the specific feelings the respondent expressed about biotechnology or genetic engineering. The precise wording of the survey question was, "…[W]hat comes to mind when you think about modern biotechnology in a broad sense, that is including genetic engineering." The variable is coded as follows: 2 = "strongly positive," 1 = "positive," 0 = "neutral/mixed," −1 = "negative," or −2 = "strongly negative," so that higher numbers capture increasingly positive judgments and lower numbers capture increasingly negative judgments. Because the terms "biotechnology" and "genetic engineering" are not precisely defined by the survey taker, their interpretation is open to the individual. For some, this question will evoke thoughts about the underlying science and technology of biotechnology (e.g., manipulation of DNA). For others, this question will evoke thoughts about the potential application of the technology, commercially, medicinally, or otherwise transactionally. This makes this measure an appropriate measure for capturing the inevitable overlap that exists between the technology and the organizational field that emerges to support or exploit the technology.

*Independent Variables*

For our microlevel factors, we created a dummy variable for individuals who "strongly agree" or "agree" with the statement "The Bible is the actual word of God and is to be taken literally" as our measure of strong Christian faith. To capture the political leanings of the survey respondents, we use a dichotomous variable for self-identified members of the Republican Party and Democratic Party, respectively. While it is not necessarily true that all self-identified conservatives will belong to the Republican Party (Cf. Libertarian Party), it is fair to say that those who self-identify as Republicans will consider themselves more "conservative" than "liberal." Thus, this measure represents a conservative test of Hypothesis 2. Similarly, while not all self-identified liberals will belong to the Democratic Party (Cf. Green Party), those that do should consider themselves more "liberal" than "conservative," again representing a conservative test of Hypothesis 3. In total, roughly 28 % of the sample respondents self-identify as Republican and roughly 28 % percent of the sample respondents self-identify as Democrat, leaving 43 % of the sample non-identified with either party. For the measure of the Religious Right, we use an interaction term between the Christian religiosity measure and the Republican Party measure. To reduce the possibility of collinearity concerns (Aiken and West 1991), we demeaned the two measures before creating the interaction term.

Turning to our macrolevel processes of representation, to test our hypothesis regarding the 'STEM' disciplines, we include six different variables. The first four are dichotomous variables designating whether the respondent acknowledges having taken Biology, Chemistry, Physics, or Pre-calculus/Calculus in high school. The fifth variable is a count of the total number of science classes that the respondent identifies as having taken in college or university. The sixth variable is a dichotomous variable indicating familiarity on the part of the respondent with the scientific method, wherein a designation of one indicates the respondent is familiar with the benefit of testing drugs on only half one's scientific sample versus testing the entire sample with the same drug (see Appendix B).

We also needed a measure of whether the respondent had come into contact with external representations about the biotechnology TFI. Accordingly, we include a dichotomous variable for whether the respondent replied affirmatively to the question "Over the last 3 months, have you heard or read anything about issues involving modern biotechnology?" Naturally, any such contact may occur due to a broader interest in biotechnology or simply access to general information sources—both create the conditions for a selection effect in hearing or reading about biotechnology. To ameliorate these potential selection effects, we decided to employ a two-staged Heckman model (1979). The instruments that we employed in the first stage were whether the respondent self-reported having access to a computer at work, whether the respondent self-reported having access to a computer at home, and whether the individual answered "no trust" to the question, "Would you have a lot of trust, some trust, or no trust in a statement made by reporters on a television news show like '60 Minutes' about biotechnology?" We theorized having access to a computer at work or at home could provide an opportunity for the respondent to access news and information online, which might increase the probability of encountering information about biotechnology. We also theorized that the propensity to seek information would be tempered by the trust in reporters who are framing and relaying the information. Following Heckman (1979), we ran a probit model of the probability of hearing or reading anything about biotechnology in the last 3 months on these three proxies (see Table 3). The resulting estimation was used to generate an Inverse Mills' Ratio, which is included in the full model in the second stage (see Table 4).

In addition, it is important to control for the content of the media coverage that the respondent may encounter. To control for this, we elected to do a content analysis of the magazines that the respondents identified when asked, "Are there any magazines that you read regularly, that is, most of the time? What magazine would that be?" For each identified magazine, we searched for the terms "biotech" or "biotechnology" or "genetic engineering" for the 3-month period preceding the survey start month (i.e., November 1997). This time period (i.e., August 1997–October 1997) aligns with the 3-month period the respondents were asked to consider in terms of whether they had heard or read anything about modern biotechnology. While respondents may interpret the length of "3 months" differently when asked about their activity retrospectively, the window does provide a concrete time period that was immediately salient to the survey's solicitation. The searches were performed across LexisNexis, Proquest, Academic Search Complete, Business Source Complete, and American Search Complete as available to the authors via their university site licenses (See Appendix A for details). The content of these articles was then was analyzed using the Internal Pennebaker Dictionary in LIWC version 2007 to generate a content measure of "positive emotion" for each magazine aggregately for all articles from that particular magazine.

*Other Controls*

Other controls include whether the respondent was female ("female" = 1, otherwise = 0), the respondent's age (18–85), whether the respondent was married ("married" = 1, otherwise = 0), and whether the individual had not heard anything about the "Dolly the Sheep" experiment itself, which was critical in catalyzing the moral contestation conversation of biotechnology ("not heard" = 1, otherwise = 0).

### Statistical Methods

Because the dependent variable is an ordered scale and the respondent was not recontacted across time to form a time-series, a simple ordered logit model can best capture not only the difference in strength of the answers, but the order as well. We clustered on the individual respondent for both the first stage and second stage equations. The results can be seen in Tables 3 and 4; summary statistics and correlation coefficients can be seen in Table 2.

## Results

Table 2 shows the summary statistics and correlation coefficients for all variables, which did not show signs of problematic collinearity within our sample. Table 3 shows the first stage model predicting the probability of hearing or reading information about biotechnology, controlling for access and willingness as described above. Table 4 shows the nested model for each of the hypotheses (Models 2–5), culminating in the final fully nested model (Model 5).

The ordered logit model does not have a constant; instead, it has cutpoints (or thresholds) which distinguish adjacent levels of the dependent variable. When the independent variables are held at zero, below Cut 1 refers to the value that distinguishes low levels of the judgment variable (i.e., "strongly negative") from higher (more positive) levels; below Cut 2 distinguishes the next highest level (i.e., "negative") from its higher levels; and so on. Above Cut 4 represents the highest level (i.e., "strongly positive") from all lower levels that preceded it. The coefficients on the independent variables indicate that for a one unit increase, the dependent variable level is expected to change by its regression coefficient in the ordered log-odds scale, holding all other factors constant. Exponentiating the coefficients will yield the proportional odds ratio, which may be more intuitive for some readers. For the control variable "Not heard of Dolly experiment," this means that a one unit increase in the variable (i.e., those who have not heard of the Dolly experiment), the odds of "strongly positive" are 1.59 times greater versus the combined "positive" through "strongly negative" perceptions, holding all other variables constant [$\exp(0.462) = 1.59$]. Likewise, the odds of the combined categories "strongly positive" and "positive" are 1.59 times greater versus the combined "neutral/mixed," "negative," and "strongly negative" perceptions, holding all other variables constant, and so on. This means that individuals who were less exposed to the morally contentious content of the Dolly experiment are more likely to view the biotechnology TFI positively when compared to those who had heard of the Dolly experiment.

While we had hypothesized in Hypothesis 1 that the dimensions of Christian religiosity and in Hypotheses 2 and 3 that political disposition would independently have an effect, as the full model shows (Table 4, Model 5), only those who shared Christian identification and Republican identification (i.e., members of the Religious Right) express strong emotions regarding biotechnology and/or genetic engineering ($p < 0.01$). The exponentiated negative coefficient shows that for members of the Religious Right in the US, the odds of "strongly positive" perceptions of biotechnology versus the combined "positive" through "strongly negative" perceptions are 0.39 times lower than for non-Religious Right respondents, given the other variables are held constant [$\exp(-0.939) = 0.39$]. Likewise, the odds of the combined categories of "strongly positive" and "positive" versus less positive perceptions are 0.39 times lower for Religious Right respondents compared to others, ceteris paribus. The negative coefficient on the Religious Right variable (Table 4, Model 5) provides support for arguments that the Religious Right is unique among peer groups in the United States. The result provides support for H4, which states that individuals who are politically conservative and Christian will be less likely to view the morally contentious TFI favorably than other Christians or other political conservatives. We do not find support for H1–3 (n.s.), which hypothesize favorable views of the morally contentious TFI on the part of Christians,

**Table 2** Summary statistics and correlation coefficients

| | Variables | Mean | SD | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Read or heard in last 3 months | 0.62 | 0.49 | 0 | 1 | 1.00 | | | | | | | |
| 2 | Access to computer at work | 0.54 | 0.50 | 0 | 1 | 0.17 | 1.00 | | | | | | |
| 3 | Access to computer at home | 0.59 | 0.49 | 0 | 1 | 0.23 | 0.27 | 1.00 | | | | | |
| 4 | No trust of reporters | 0.08 | 0.27 | 0 | 1 | −0.09 | −0.02 | −0.06 | 1.00 | | | | |
| 5 | Favorability | 0.02 | 0.63 | −2 | 2 | 0.04 | | | | 1.00 | | | |
| 6 | Female | 0.50 | 0.50 | 0 | 1 | −0.07 | | | | −0.07 | 0.09 | | |
| 7 | Married | 0.55 | 0.50 | 0 | 1 | 0.05 | | | | −0.05 | −0.04 | 0.01 | |
| 8 | Age | 42.89 | 15.12 | 18 | 85 | 0.01 | | | | −0.02 | −0.01 | 0.19 | 1.00 |
| 9 | Not heard of Dolly experiment | 0.08 | 0.27 | 0 | 1 | −0.19 | | | | 0.07 | 0.03 | −0.11 | −0.15 |
| 10 | Bible is word of God[a] | −0.02 | 0.50 | −0.54 | 0.46 | −0.22 | | | | −0.08 | 0.07 | 0.06 | 0.03 |
| 11 | Self-identified Republican[a] | 0.00 | 0.45 | −0.27 | 0.73 | −0.01 | | | | 0.03 | −0.08 | 0.12 | 0.02 |
| 12 | Self-identified Democrat | 0.29 | 0.46 | 0 | 1 | −0.05 | | | | 0.00 | 0.11 | −0.08 | −0.01 |
| 13 | Religious right[a] | 0.03 | 0.22 | −0.39 | 0.34 | 0.04 | | | | −0.09 | −0.00 | −0.00 | −0.01 |
| 14 | High school biology | 0.83 | 0.37 | 0 | 1 | 0.17 | | | | 0.04 | 0.02 | −0.03 | −0.17 |
| 15 | High school chemistry | 0.57 | 0.50 | 0 | 1 | 0.19 | | | | 0.09 | −0.12 | −0.05 | −0.12 |
| 16 | High school physics | 0.38 | 0.49 | 0 | 1 | 0.13 | | | | 0.14 | −0.21 | −0.02 | 0.03 |
| 17 | High school calculus/precalc | 0.19 | 0.39 | 0 | 1 | 0.12 | | | | 0.07 | −0.10 | −0.07 | −0.26 |
| 18 | College science classes | 3.62 | 7.51 | 0 | 90 | 0.19 | | | | 0.11 | −0.09 | −0.01 | −0.05 |
| 19 | Scientific method | 0.78 | 0.41 | 0 | 1 | 0.11 | | | | 0.02 | −0.03 | 0.01 | −0.09 |
| 20 | Inverse Mills ratio | 0.67 | 0.19 | 0.47 | 1.12 | −0.26 | | | | −0.07 | 0.09 | −0.13 | 0.18 |
| 21 | Media—Positive Emotion | 0.52 | 1.01 | 0 | 3.26 | 0.13 | | | | 0.05 | −0.09 | −0.03 | 0.08 |

| | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 1.00 | | | | | | | | | | | | |
| 10 | 0.09 | 1.00 | | | | | | | | | | | |
| 11 | −0.06 | 0.11 | 1.00 | | | | | | | | | | |
| 12 | 0.09 | −0.01 | −0.40 | 1.00 | | | | | | | | | |
| 13 | 0.05 | −0.01 | 0.08 | −0.05 | 1.00 | | | | | | | | |
| 14 | −0.03 | −0.08 | 0.02 | 0.01 | 0.02 | 1.00 | | | | | | | |
| 15 | −0.06 | −0.19 | 0.02 | −0.02 | −0.01 | 0.27 | 1.00 | | | | | | |
| 16 | 0.01 | −0.16 | 0.00 | −0.01 | 0.01 | 0.11 | 0.38 | 1.00 | | | | | |
| 17 | −0.05 | −0.22 | 0.02 | −0.06 | −0.02 | 0.12 | 0.31 | 0.31 | 1.00 | | | | |
| 18 | −0.09 | −0.21 | 0.01 | −0.06 | 0.03 | 0.10 | 0.24 | 0.24 | 0.22 | 1.00 | | | |
| 19 | −0.07 | −0.08 | 0.05 | −0.08 | 0.02 | 0.08 | 0.09 | 0.06 | 0.08 | 0.07 | 1.00 | | |
| 20 | 0.13 | 0.14 | −0.11 | 0.08 | −0.05 | −0.13 | −0.22 | −0.07 | −0.20 | −0.17 | −0.07 | 1.00 | |
| 21 | −0.08 | −0.10 | 0.02 | −0.01 | 0.02 | 0.07 | 0.13 | 0.13 | 0.07 | 0.08 | −0.00 | −0.16 | 1.00 |

[a] Variables demeaned to create interaction term

unfavorable views on the part of political conservatives and favorable views on the part of political liberals, respectively. While the politically conservative variable did show signs of significance prior to the interaction with religiosity (Table 4, Model 4), the combination of the two overwhelmed the individual components in the final model (Table 4, Model 5). The non-effect on political liberals was surprising, given their supposed comfort with ambiguity, a characteristic of moral contestation. Perhaps the result arises from positive support among some members of the group due to their openness being canceled out by negative support for the commercialization aspect of the organizational field. In addition, liberals often make judgments based on potential harm to others (Graham et al. 2009), which also may counteract any degree of openness expressed by other liberals in the sample. Only future research in other contexts can unpack the drivers of liberalism on judgments of morally contested TFIs.

**Table 3** Model predicting read or heard about biotechnology (last 3 months)

| Variable | Model 1 |
|---|---|
| Access to computer at work | 0.239* (0.105) |
| Access to computer at home | 0.510*** (0.106) |
| No trust of reporters | −0.295 (0.191) |
| Constant | −0.170* (0.086) |
| Observations | 953 |
| Degrees of freedom | 3 |
| Wald $\chi^2$ | 41.12 |
| Log psuedolikelihood | −620.506 |

Robust standard errors in parentheses, clustered by case id

* $p < .05$; ** $p < .01$; *** $p < .001$

Turning now to the macrolevel processes that might influence individual-level judgment of morally contentious TFI, as hypothesized, we find that exposure to representations via the STEM disciplines earlier in life strongly predicts positive perceptions of the TFI. Results of our model show that survey respondents with a background that included high school physics are statistically significantly more favorable in their assessment of the biotechnology TFI (H5: $p < 0.05$). The exponentiated coefficient shows that the odds of "strongly positive" perceptions of biotechnology versus the combined "positive" through "strongly negative" perceptions are 1.62 times higher for individuals who self-identify as having taken physics in high school compared to others, ceteris paribus [exp(0.481) = 1.62]. Likewise, the odds of the combined categories of "strongly positive" and "positive" versus less positive perceptions are 1.62 times higher for the physics students compared to others, and so on. We interpret these results as indication that macrolevel processes can affect judgments of morally contentious TFIs above and beyond microlevel factors.

We see that individuals may be influenced by other macrolevel processes, as well. Positive coverage of biotechnology in the magazines that the individuals read regularly creates alternative representations above and beyond microlevel perceptions. Our content analysis of the

**Table 4** Model predicting favorable view of technology-field set

| Variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Female | −0.187 (0.167) | −0.157 (0.172) | −0.143 (0.177) | −0.049 (0.179) | −0.033 (0.179) |
| Married | −0.149 (0.169) | −0.124 (0.167) | −0.147 (0.170) | −0.115 (0.173) | −0.116 (0.179) |
| Age | 0.001 (0.005) | 0.002 (0.005) | 0.001 (0.005) | 0.002 (0.006) | 0.002 (0.006) |
| Not heard of Dolly experiment | 0.308 (0.203) | 0.341 (0.209) | 0.349† (0.212) | 0.420† (0.222) | 0.462* (0.225) |
| Bible is word of God | | −0.234 (0.170) | −0.272 (0.171) | −0.154 (0.183) | −0.133 (0.189) |
| Self-identified Republican | | | 0.356† (0.207) | 0.331† (0.206) | 0.323 (0.206) |
| Self-identified Democrat | | | 0.100 (0.198) | 0.074 (0.201) | 0.062 (0.203) |
| Religious right | | | −0.871* (0.361) | −0.914* (0.362) | −0.939** (0.359) |
| High school biology | | | | 0.122 (0.228) | 0.106 (0.229) |
| High school chemistry | | | | 0.198 (0.199) | 0.182 (0.203) |
| High school physics | | | | 0.489* (0.193) | 0.481* (0.195) |
| High school calculus/pre-calculus | | | | −0.221 (0.242) | −0.254 (0.242) |
| College science classes | | | | 0.023† (0.013) | 0.021 (0.013) |
| Scientific method | | | | 0.093 (.204) | 0.086 (0.204) |
| Inverse Mills ratio | | | | | −0.321 (0.562) |
| Read or heard in last 3 months | | | | | −0.021 (0.197) |
| Media—Positive Emotion | | | | | 0.158† (0.088) |
| Cut 1 | −3.670 (0.318) | −3.634 (0.320) | −3.647 (0.324) | −3.156 (0.389) | −3.156 (0.389) |
| Cut 2 | −1.765 (0.258) | −1.728 (0.261) | −1.735 (0.267) | −1.231 (0.376) | −1.231 (0.376) |
| Cut 3 | 1.573 (0.255) | 1.620 (0.260) | 1.645 (0.268) | 2.221 (0.381) | 2.221 (0.381) |
| Cut 4 | 5.319 (0.657) | 5.367 (0.662) | 5.402 (0.675) | 5.998 (0.719) | 5.998 (0.719) |
| Observations | 915 | 915 | 915 | 915 | 915 |
| Wald $\chi^2$ (*df*) | 5.20 (4) | 7.03 (5) | 17.03 (8) | 39.55 (14) | 48.90 (17) |
| Log psuedolikelihood | −858.951 | −857.631 | −852.531 | −841.670 | −839.199 |

Robust standard errors in parentheses, clustered by case id

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

magazine content indentified by the survey respondents shows indications that the odds of “strongly positive” perceptions of biotechnology versus the combined “positive” through “strongly negative” perceptions are 1.17 times higher for each unit increase in the positiveness of articles that mention biotechnology or genetic engineering compared to other coverage, ceteris paribus [exp(0.158) = 1.17]. Our results thus provide some support for the idea that individuals who have had access to macrolevel representations will be more likely to view the morally contentious TFI of biotechnology favorably (H6: $p < 0.10$), controlling for selection into exposure to the information in the first place.

## Conclusions

Building on the literature of the social construction of technology and organization fields, we describe how technologies and the organizational fields that grow up to support and exploit them come to be viewed as one object of interest or concern. We argue that this phenomenon can be particularly challenging when one of the two constitutive components is considered morally contested, creating an environment where the technology or the field can cross-contaminate the other component, and thus the entire TFI. Building on prior work on individual judgments of one’s own activity in the face of moral concerns (Sonenshein 2007), we then demonstrate empirically how microlevel characteristics and macrolevel processes ultimately affect how such TFI are judged favorably or unfavorably by individuals.

Using data from the United States Biotechnology Study (1997–1998), we find that microlevel characteristics, specifically religious/political persuasion, and the macrolevel process of representation [absorbed through classwork in Science, Technology, Engineering and Math (STEM) disciplines, and through media coverage of the TFI] play an important role in the perceptions of the morally contested TFI. We find evidence that members of the Religious Right have strongly unfavorable perceptions of the biotechnology TFI, while those with exposure to physics in high school have highly favorable perceptions. Work in technology fields shows that cross-pollination facilitates the mobility of concepts among science, technology, and commercialization (Grodal and Thoma, forthcoming). It is well known that the ability to generate and integrate knowledge determines the economic value of that knowledge in the market for ideas (Elliasson 1996). Our results suggest that the ability to integrate knowledge also determines the perceptions afforded morally contested TFIs.

At the same time, we see indications that positive tenor of coverage about the TFI increases the probability of favorable perceptions of the TFI. If the general perceptions of a TFI can be viewed as a subset of the literature on reputation (Lange et al. 2011; Pfarrer et al. 2010) or reputational commons (King et al. 2002), this article makes a direct tie between individual-level observation and macrolevel reputation, something that generally has been ignored in macroportrayals of reputation formation (cf. Brooks et al. 2003). “The development and testing of such alternate models is important because scholars have argued that the creation of reputation is causally ambiguous” (Rindova et al. 2005, p. 1034). Prior work on reputation at the individual level generally has used experimental situations regarding affect toward potential employers (e.g., Brooks et al. 2003; Turban et al. 2001). While helpful in determining feelings toward organizations, these prior methods have held the potential to conflate career concerns and perceived organizational fit with broader reputational perceptions, in addition to drawing attention to specific firms rather than to the organizational field at large or the technology that the field has grown to support or exploit. Our findings suggest that broad brushstrokes by macroscholars on the formation of favorable reputations (Lange et al. 2011; Pfarrer et al. 2010) or shared reputation commons (Deeds et al. 2004; King et al. 2002) may need some adjustments at the microlevel when examining morally contested technologies and/or organizational fields. While it is challenging to cross the boundaries between micro- and macrolevels of analysis (Boyd et al. 2010) and it is difficult to know how precisely these individual-level perspectives aggregate to shared (i.e., collective) reputational perspectives (Mathieu and Chen 2011), the insights gained from the process suggest that there are benefits to examining constructs at various levels of analyses, including intersections of technologies and organizational fields.

Despite these insights, these findings are not without shortcomings. First, we are not able to include data on race directly into the model. This data was not made available by the study’s original principal investigator, and instead were used only to create the probability weightings for the data. While the weighting did inform the model, we were unable to assess whether individual-level racial profiles actually informed the judgments of the TFI under study. According to the US Commission on Civil Rights, while black and Hispanic students have the same interest in science careers as white peers in the first year of college, they were less likely to pursue a doctorate or a major in science career fields (Richards 2011). Perhaps future research could examine how race at the individual-level informs morally contested TFIs. Second, because the data come from a preexisting, publicly available dataset, we were constrained in our variable selection and in the size of the sample. Third, because the purpose of the survey was to collect data from US citizens regarding their interest in selected current news issues, knowledge of and attitudes toward biotechnology, various forms of political participation, and knowledge of scientific concepts (Miller 2000), its generalizability outside the US context is unknown. The data represent a rare snapshot of a cross-section of the United States during an important time in the evolution of the biotechnology TFI, and our findings show that certain microlevel characteristics and macrolevel processes do, in fact, predict favorable judgments regarding the TFI. We did supplement the data with external sources, providing some degree of external validity, but the respondents were still limited to only US citizens on topics oriented around biotechnology. Thus, it is not clear the degree to which similar results would manifest in other countries, in other technologies or in other organizational fields with some degree of moral contestation (e.g., nanotechnology). These shortcomings have not inhibited other scholars from using the data to, for example, uncover important insights into the drivers of public trust toward the field of biotechnology (James 2006); we feel similarly that the potential insights outweigh the shortcomings of the dataset.

Firms and policy makers often engage in educational efforts to build support for their technologies or organizational fields. Our results suggest that initiatives to educate the public on a particular technology have lower impact on the support the technology and field receives than broader initiatives to increase STEM knowledge in the populous. While our paper focuses on morally contentious technologies, the findings of this paper are more broadly generalizable. As Tenner (1997) finds, even the best intended innovations can have negative consequences, at which point they can become morally contentious. Managers of firms, innovators, entrepreneurs, and policy makers should keep in mind that technology use is a socially driven process and managing the moral contentiousness will improve the likelihood of acceptance and adoption.

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## Appendix A

Magazine Coverage Content Analysis

*Search terms* “Biotechnology” or “Biotech” or “Genetic Engineering.”

*Search Window* 8/1/1997–10/31/1997.

| Magazine title | Database searched | Article count |
|---|---|---|
| Newsweek | LexisNexis | 1 |
| Time | ProQuest | 1 |
| US News & World | Academic Search Complete | 3 |
| National Review | ProQuest | 2 |
| Harpers | Academic Search Complete | 1 |
| New Yorker | LexisNexis | 0 |
| Saturday Evening Post | ProQuest | 1 |
| Smithsonian | Academic Search Complete | 1 |
| Cosmopolitan/Vogue | ProQuest | 0 |
| Redbook | LexisNexis | 0 |
| Good Housekeeping | LexisNexis | 0 |
| Glamor/Mademoiselle | LexisNexis | 0 |
| MS Self | ProQuest | 0 |
| People | ProQuest | 0 |
| Rolling Stone | ProQuest | 1 |
| US | ProQuest | 0 |
| Ebony Jet | LexisNexis | 0 |
| Life | Academic Search Complete | 1 |
| Science | ProQuest | 0 |
| Scientific American | American Search Complete | 3 |
| Popular Science | ProQuest | 2 |
| Omni | ProQuest | 0 |
| Discover | ProQuest | 4 |
| National Geographic | ProQuest | 0 |
| Science News | ProQuest | 9 |
| Esquire | LexisNexis | 0 |
| Gentleman’s Quarterly (GQ) | LexisNexis | 0 |
| Fortune | Business Source Complete | 9 |
| Barron’s | ProQuest | 18 |
| Forbes | ProQuest | 11 |
| Business Week | Business Source Complete | 16 |
| Money | Academic Search Complete | 2 |
| Sports Illustrated | ProQuest | 0 |

*Source* United States Biotechnology Study (1997–1998). Magazines identified as regularly read in response to the following question: “Are there any magazines that you read regularly, that is, most of the time? What magazine would that be? ENTER MAGAZINE NAME. IF THE RESPONDENT ASKS IF IT COUNTS IF THEY READ A MAGAZINE ON THE WEB, SAY ‘YES.’” Magazines identified as regularly read yet unavailable for content search: Family Circle, Ladies Home Journal, McCalls, Woman’s Day, Readers Digest, Hunting & Fishing, Playboy/Penthouse/Hustler, Science Digest/Smithsonian Air & Space, TV Guide, National Enquirer, and The Star

## Appendix B

United States Biotechnology Study (1997–1998)
Survey Wording

*Selection Model Variables*

Do you use a computer in your work?
1. Yes
2. No

Do you presently have a home computer in your household?
1. Yes
2. No

Reporters on a television news show like 60 min. Would you have a lot of trust, some trust, or no trust in a statement made by reporters on a television news show like 60 min about biotechnology?
1. Lot of trust
2. Some trust
3. No trust

*Predicted Model Variables*

Now, let me ask you again what comes to mind when you think about modern biotechnology in a broad sense that is including genetic engineering. INTERVIEWER: PROMPT "ANYTHING ELSE?" AFTER EACH PHRASE; WRITE VERBATIMS IN FULL IF NOT RECORDING.

The variable is coded as follows: 2 = "strongly positive," 1 = "positive," 0 = "neutral/mixed," −1 = "negative," or −2 = "strongly negative,"

Respondent's gender ("female" = 1, otherwise = 0), respondent's age (18–85), and respondent's marital status ("married" = 1, otherwise = 0)

Have you heard or read about the cloning of a sheep named Dolly in Scotland?
1. Yes
2. No

The Bible is the actual word of God and is to be taken literally. Do you strongly agree, agree, disagree, or strongly disagree?
1. Strongly agree
2. Agree
3. Disagree
4. Strongly disagree

Politically speaking, would you call yourself a Democrat, a Republican, or an independent?
1. Democrat
2. Independent
3. Republican

Did you take a high school biology course?
1. Yes
2. No

Did you take a high school chemistry course?
1. Yes
2. No

Did you take a high school physics course?
1. Yes
2. No

Now, let me ask you to think about the courses you took in high school. What was the highest level of math that you completed in high school? DO NOT READ OPTIONS!

1. No math in HS; did not go to HS
2. General math, business, or vocational math
3. Pre-algebra
4. 1 Year of algebra
5. 2 Years of algebra—Algebra 2
6. Geometry (plane or solid or both)
7. Trigonometry/linear programming/analysis
8. Pre-calculus
9. Calculus
10. Statistics/probability
11. Other

IF A RESPONDENT SAYS "SENIOR MATH" "MATH 2," "MATH 100," OR SOME OTHER GENERAL COURSE PLEASE ASK THEM: Would that be algebra, algebra two, geometry, trigonometry, pre-calculus, calculus, or general math?

Have you ever taken any college-level science courses? IF YES: How many? ENTER NUMBER OF COURSES OR ZERO FOR NONE.

Now, please think about this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?
1. All 1,000 get the drug
2. 500 get the drug; 500 do not

NOTE: IF THE RESPONDENT ASKS WHETHER OR NOT A PLACEBO WAS GIVEN, SAY "IN THIS CASE, NO PLACEBO WAS GIVEN."

Over the last 3 months, have you heard or read anything about issues involving modern biotechnology?
1. Yes
2. No

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