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Who Does the Public Trust? The Case of Genetically Modified Food in the United States

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Trust is important for the perception of many types of risk, including those relating to genetically modified (GM) food. Who the public trusts in any given circumstance, however, is not well understood. In this study of public trust regarding GM food, an exploratory factor analysis with Promax rotation reveals public classification of three common institutional types—evaluators, watchdogs, and merchants. The structure of relationships among these stakeholders can act to enable or constrain public support for this new technology. Evaluators—scientists, universities, and medical professionals—are the most trusted. Watchdogs—consumer advocacy organizations, environmental organizations, and media sources—are moderately trusted. Merchants—grocers and grocery stores, industry, and farmers—are least trusted. While the federal government is seen as closest to being an evaluator, it is not highly correlated with any of the factors. The lack of trust in the organizations with the greatest resources and responsibilities for ensuring the safety of GM food should be seen as an important obstacle to the adoption of the technology.

KEY WORDS: Genetically modified food; institutions; public understanding of science; trust; uncertainty

1. INTRODUCTION

Genetic modification involves methods that make it possible for scientists to create new plants and animals by taking parts of the genes of one plant or animal and inserting them into the cells of another plant or animal. Though the absence of federal tracking makes it impossible to establish exact figures, most estimates suggest that between 60% and 70% of processed foods on American shelves now include at least a fragment of a genetically modified (GM) crop.(1) Because food processors often mix GM varieties of corn, soybeans, and canola with ordinary varieties, the incorporation of at least small amounts of GM ingredients in many processed foods is virtually inevitable. For example, many processed sweetened foods like sodas and baked goods often contain high-fructose corn syrup obtained from a silo-storage system that neither tracks nor treats GM corn differently than non-GM varieties. Despite its omnipresence, Americans report that they have heard or read very little about GM food, they know little about it, they are not talking about it with each other, they do not know it is for sale in supermarkets, and they do not even know they are already eating it.(2–4)

If, or when, the average American discovers that he (or she) is eating GM food, he will not have the scientific knowledge or other resources to decide for himself whether this constitutes a risk. He is then faced with having to rely on the competence, transparency, public interest, and honesty of the various organizations that play a role in the food supply chain to assess the risk of eating GM foods.

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Barely aware that the technology even exists, the public is forced to substitute trust for knowledge.[5] Furthermore, the public faces ongoing uncertainty and skepticism about GM food, involving basic issues of human safety and the potential for ecological contamination.[6] Trust—in abstract systems, authoritative experts, and institutions—is therefore an essential component of public acceptance of this technology. Whether the public exhibits trust toward the institutions that appear to control technology is an important question for scholars and policymakers interested in understanding public reactions to GM foods.

This rich example of a current technological controversy helps highlight the social and organizational foundations of trust. Granovetter[7] has stressed that social relations are mainly responsible for the production of trust in economic life. He believes that trust is generated when agreements are embedded within a larger structure of personal relations and social networks. Social structure is important not only for the formation of social capital,[8,9] but also for the generation of trust itself. People do not assess trust in a vacuum; rather, they make judgments and evaluations in particular social contexts that are often characterized by contested interests and symbolic battles over claims of expertise.[10]

To explore people's trust judgments, we build on three general propositions. We understand that trust in institutions is an important factor in perception and acceptance of risks.[10–14] We would also expect a variety of institutions—including key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products—to have some importance for consumers.[15] As such, a broad range of institutions and experts, rather than simply scientists or regulatory agencies, contribute to the production of trust. Finally, we would expect that a range of trust-related concepts influences the perception of risk-managing institutions.[16]

This article begins with an overview of the controversy surrounding GM food, followed by an explanation of the relevant organizational field, organizations, and experts involved in GM food. Next, we describe a newly developed survey instrument in which we explore a variety of trust-related factors and elicit people's perceptions of trustworthiness regarding genetic modification. Using this data, we undertake a number of discrete objectives. We test whether the perceived trustworthiness of an institution (with regards to GM food specifically) can be described by a limited number of underlying dimensions. In doing so, we explore several of the scholarly semantic and theoretical distinctions from the trust literature. In addition, we investigate the level of trust that people grant to a wide range of stakeholders—experts, social, and institutional actors—that comprise the organizational field of agricultural biotechnology. Finally, by applying findings from the previous steps, we examine whether people's perceptions of these institutions can be described by a limited number of underlying dimensions.

While it is important to stress that this is a *post hoc*, exploratory analysis, the results allow us to make a rough judgment about trust in key stakeholders involved in the production, evaluation, regulation, and communication efforts surrounding GM food in the United States. In sum, this article highlights the trustworthiness of key stakeholders involved in GM food using data from a large survey of American respondents.

2. A TECHNOLOGY THAT REMAINS LITTLE KNOWN

At the end of the 1980s, the first GM food products made it through the U.S. regulatory process to become a commercial reality. The first product approved by the U.S. Food and Drug Administration was chymosin (rennet), a GM enzyme used to make cheese.[17] Chymosin was followed by bovine somatotropin, a growth hormone given to cows to increase milk production. In the early 1990s, Calgene introduced the "Flavr Savr" tomato with the benefits of genetic modification marketed directly to consumers.[18] But Monsanto's introduction of commodity crops that could resist the toxic effects of specific herbicides made GM food widely available to consumers. After Monsanto's "RoundUp Ready" soybeans (that are resistant to powerful herbicides) received U.S. Department of Agriculture (USDA) approval and came to market in 1995, GM food availability increased dramatically.[19]

Although there is currently little diversity among available GM products—corn, soy, cottonseed oil, and canola account for the bulk of GM ingredients in the food supply—the USDA lists several products "in the pipeline" for future production. Among these are varieties of insect-resistant fruits and vegetables, naturally decaffeinated coffee beans, nicotine-free tobacco, and grains with radically enhanced nutritional properties and vitamin content.[20] As these GM products arrive on shelves with benefits marketed directly to consumers, Americans may become more aware of agricultural biotechnology. However,

surveys of American consumers suggest that when they do become aware of these products, they still will not have the scientific knowledge to evaluate risks on their own.[2–4] They will, therefore, be forced to continue trusting the judgments of the myriad experts and organizations that ensure the safety of their food.

2.1. Institutional Complexity

Though often overlooked by casual observers, there are multiple expert groups and organizations involved in the production and distribution of food within the United States.[21] In terms of regulations, GM foods are treated as equivalent to those produced through traditional means if the GM variety does not introduce allergens or substantially alter the nutritional value of the food.[22] As a result, GM foods in the United States are rarely handled differently than those produced through conventional means. In basic outline, the food production and distribution chain begins when agricultural biotechnology firms sell their genetically engineered seeds to farmers, who plant and grow them. Farmers, in turn, sell their crops to grain elevators or handlers (such as Archer Daniels Midland or Cargill), who sell the grain to food processors; food and grain processors (such as ConAgra Foods and Nabisco) transform grain into a range of products from bread to cooking oil to baby food.[54] Processors then sell these goods to food retailers, including grocery stores and restaurants. It is from these retail outlets that most people in the United States obtain their food. Consequently, the final consumers of GM foods are not the direct customers of the agricultural biotechnology firms.

In terms of regulation, the 1986 "Coordinated Framework for Regulation of Biotechnology" outlined the division of the responsibilities for GM organisms among the U.S. Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and the U.S. Environmental Protection Agency (EPA).[23] Depending on its characteristics, a product may be subject to review by one or more of these agencies; their responsibilities are usually complementary but in some cases are overlapping. Before humans or animals can consume a new GM crop variety, the FDA must evaluate its safety. The USDA monitors field trials and evaluates the potential impact of widespread environmental release of the plant. The EPA ensures that the pesticide levels in GM are safe. This jurisdiction extends to both human health and environmental impacts of the pesticide.

2.2. The Role of Science in Defining GM Food

Speaking at the National Press Club, then U.S. Secretary of Agriculture, Dan Glickman[24] said:

> With all that biotechnology has to offer, it is nothing if it's not accepted. This boils down to a matter of trust—trust in the science behind the process, but particularly trust in the regulatory process that ensures thorough review—including complete and open public involvement.

As Secretary Glickman suggests, scientific authority has great rhetorical power in our society. One of the ways that stakeholders try to maintain control over public opinion about biotechnology is by relying heavily on scientific data and scientists, which shifts the agenda to the more strictly scientific or safety aspects of the controversy. Experts and organizations shape public perceptions by using rhetoric—in this case, scientific rhetoric—to define a social reality.[10]

Of course, scientific facts, as well as the theories that explain them, are often in dispute. Yet, even when there is little scientific consensus, the mass media often present scientific evidence as "objective" fact.[25] In the case of GM food, although some argue that the basic scientific principles remain uncertain, and the potential consequences of technology remain disputed, reports in the United States have generally represented these products as natural, safe extensions of scientific progress.[25]

Yet, the potential for risk in using GM foods remains just that—potential. There has yet to be an event that would allow institutions and experts to move GM food from an uncertain risk to a quantifiable hazard. However, the complex connections in the food supply chain outlined in this section suggest that science alone will not determine public reactions to GM foods. Assessing the public perceptions of all the related institutions—farmers, grocers, industry, the government and media, consumer and environmental organizations, universities, and scientists—is fundamental. Because they can be said to play key roles in the public understanding and perception of this new technology, recent studies explore the trust in several of these groups.[6,34] These studies, however, have not given attention to the interaction between institutional structures or the nature of the relationships between institutions.

3. TRUST

There are several scholars who speculate as to why people trust—offering theories of encapsulated

interest,[26] rational prediction,[27] or personality traits.[28] That some level of trust ideally exists between individuals and experts (or institutions and organizations acting as experts) is taken as given in this article. We see this in accounts of professional judgment in medicine,[29] studies of reactions to environmental disaster,[30,31] technological catastrophe,[32] and in the planning for reactions to disasters.[10] The primary value of concentrating on a single risk, like GM food, is to allow us to discuss trust not only as an abstract concept but as a practical problem. By placing the problem of trust within a specific context, we gain a realistic understanding of the important social factors and interests that shape the controversies and difficulties of researching this arena.

While most existing consumer studies of GM food have focused on broad issues such as public awareness and perceptions of the safety of this technology,[33] some scholars[34,35] have begun to explore the effects of trust as a prerequisite for risk communication about emerging technologies like GM food. Given the differing and sometimes scientifically complex opinions offered on GM food, relying on the information presented by trusted social actors provides the public an opportunity to resolve doubt. As such, trust may help the public decide which foods are safe to eat and which foods are to be avoided.

Trust helps individuals reduce uncertainty and therefore helps with the coordination of social expectations and interactions by allowing specific, rather than arbitrary, assumptions about future behavior. For some theorists,[36,37] trust is a uniquely modern phenomenon, fundamental to the emergence and prominence of organizations and institutions in daily life. As personal interactions decline in importance and practicality, it becomes necessary for people to develop trust in institutions that determine many of the conditions of modern life. Following this logic, scholars have examined the importance of trust for basic functions of society like good government[8] and economic prosperity.[9] For Zucker,[38] the more heterogeneous U.S. population produced by mobility and immigration patterns in the late 1800s displaced the interpersonal trust relationships characteristic of the 1700s and earlier. Theorists have argued that, over time, trust has moved from an unexamined and habitual confidence in science and technology to a bestowed trust that is earned by modern governments, organizations, and groups from autonomous, reflexive individuals.[36,39]

Luhmann[5] has suggested that, from a functionalist perspective, trust enables societies to tolerate increasing uncertainty due to progressive technological complexity. Barber[40] shares Luhmann's perspective on trust concerning its function—the reduction of complexity—and distinguishes between two types of expectation that comprise trust. In his framework, trust as a general concept has more than one dimension. The first is the expectation that actors or institutions will perform their role in a technically competent manner. The second is that actors or institutions will demonstrate "fiduciary responsibility," a special concern for other's interests above their own. Trustworthy experts—those who are competent and act with concern for others—help us navigate the uncertainties inherent in new technologies.

Following this work, researchers have conducted a number of factor-analytic studies to empirically test the dimensionality of trust. In a study of trust in sources of information about food risks, Frewer *et al.*[41] found two factors. The first factor combined the aspects of competence and caring, while the second was not clearly interpreted. In a study of trust in the U.S. Department of Energy, Metlay[42] also describes trust as two-dimensional, though his factors were composed of general trustworthiness and competence. Most recently, Poortinga and Pidgeon[34] found two factors common to the trustworthiness of the British government across five risk issues, including GM food. Their first factor combined elements of competence and caring, while the second included elements of credibility, reliability, and vested interest. Although the labels that these studies give to their two factors do not precisely correspond with one another, the presence of two factors is consistent. As such, we would also anticipate finding that a two-factor solution best fits the data.

3.1. Empirical Measurement of Trust

Trust has many forms and meanings. It is, however, possible to find an overlapping set of characteristics of trust that most authors—often working with quite diverse theoretical assumptions—accept.[5,40,43] Despite different emphases on varying definitions of trust, all draw attention to the central role that risk plays in the meaning of trust; trust need not come into play where outcomes or intentions are fully known. Although trust does not necessarily eliminate a sense of risk, it is an important device in mitigating the risk of unpredictable and harmful consequences.[44]

Studies of trust in institutions primarily focus on identifying which factors influence trust judgments. We selected four trust factors—*competence*, *transparency, public interest,* and *honesty*—that are frequently discussed in previous work on

trust.[11,16,40–42,45] Although there is overlap in the factors and apparent equivalence to some degree, no two studies to date have used the same measures. As such, we designed four questions—one for each factor—that evaluate the intended trust factors. The proposed nomenclature is intended to organize theoretically hypothesized dimensions of trust into articulated response categories.

In the present study, respondents in the United States were asked to rate 10 institutions on four statements designed to evaluate *competence*, *transparency, public interest,* and *honesty*. "Competence" measures the respondent's judgment whether an institution has the knowledge and skill to evaluate information accurately and to take appropriate action. "Transparency" measures the perceived openness of communication from an institution. "Public interest" measures the degree to which respondents perceive an institution acts without bias when faced with conflicting social norms. "Honesty" measures the extent to which an institution is truthful about risk. Trust is undermined by perceived shortcomings in any of these four criteria.

Questions for this study were guided by these trust factors as well as the increasing volume of empirical work that connects attitudes about gene technology to trust in governments, regulatory agencies, and scientists.[46–50] This research finds evidence that trusting regulators, governments, and scientists is positively related to an individual's perception of the risks of GM food. Cross-national comparisons of focus groups in several European countries reveal similar results, finding that distrust of scientists and regulatory authorities is an important source of disquiet about GM food across Europe.[51]

4. SURVEY PROCEDURES AND SAMPLING

The data presented are from a mail survey that was the followup to a comprehensive, nationally representative study initially conducted by telephone.[3] Targeting the noninstitutionalized U.S. adult (18 years or older) population, a random proportional probability sample was drawn from more than 97 million telephone-equipped households in the contiguous 48 U.S. states. Using a computer-assisted telephone interview, 1,201 telephone surveys were completed, with a cooperation rate of 65%. In an effort to keep the telephone survey less than 30 minutes long, we conducted a follow-up mail survey to allow for a more thorough understanding of specific topics. The mail survey consisted of three parts: part one concerned economic choice modeling; part two consisted of questions related to consumer's willingness to consume GM food products; and part three covered trust questions with regard to institutions involved in genetic modification. By covering these topics in written form, respondents were able to give more detailed information than would have been possible—given time constraints or respondent fatigue—on the telephone. Only data from the third portion of the mail survey is presented in this article.

4.1. Description of the Survey Instrument

We took several steps to ensure the reliability of the survey instrument. A cover letter accompanied the written survey, explaining the survey purpose and instructions that included an example of a properly completed questionnaire. Between the choice sets, there were questions in the mail survey that would serve as breaks to stop potential response patterns or boredom. The survey layout was informally pretested twice, resulting in layout changes for readability and clarity.

In the mail survey, respondents were asked four questions—one each measuring competence, transparency, public interest, and honesty—to assess trust levels in 10 institutions in the specific setting of GM food. Although it may have been preferable to include more than one question for each element, a desire to minimize the respondent's time required to complete the questionnaire precluded that option. However, by including these four items, we intend to capture much of the theoretical meaning attributed to trust in the social science literature. Further, by using phrases that have slightly different interpretations, we avoid the potential of a biased response to unintentional associations or meanings particular to a respondent. Respondents were instructed to rate each of the 10 institutions on a 5-point scale, ranging from 1 = "strongly disagree" to 5 = "strongly agree."

1. Competence. The groups listed below have the expertise to make a competent judgment about GM foods.
2. Transparency. The groups listed below are a useful source of information about GM foods.
3. Public Interest. The groups listed below will do what is right for society regarding GM foods.
4. Honesty. The groups listed below will tell you the truth about GM foods.

Although the wording for each question in the survey remained constant, to minimize response-order effects, respondents were randomly assigned one of 12 versions of the questionnaire. In each version, the order of the questions was varied within each section,

as was the order of the institutions presented. To facilitate responding, a table followed each question listing the following 10 organizations that reflect important stakeholders in the organizational field: consumer advocacy organizations, environmental organizations, farmers, the federal government, grocers and grocery stores, industry, media sources, medical professionals, scientists, and universities. These stakeholders were selected both because of their importance in the organizational field, and because other surveys, such as the Eurobarometer, have also included many of them, permitting cross-cultural comparisons in future research.

4.2. Survey Respondents

More than half (55%) of the telephone survey respondents (1,201) agreed to complete the additional follow-up mail questionnaire in exchange for $5. Of the 661 who agreed, 409 (61.9%) returned a completed mail survey. The final sample size of 409 allowed a sampling error rate of ±5%. The mail survey sample was 40.3% male and 59.7% female. Respondent ages ranged from 18 to 88 years with a median age of 47 years. Using the standard U.S. Census racial categories, 85.3% of the respondents identified themselves as white, 6.1% as African American, 2.0% as Hispanic, 1.2% as Asian or Pacific Islander, 1.0% as Native American, and 1% as "other"; 4.2% of the sample identified themselves as ethnically Hispanic. Most respondents (94.1%) had completed high school. High school was the highest level of formal education for more than a quarter of the sample (28.9%). A quarter (25.4%) had some college education or an aassociates degree, 25.4% of the sample had completed a 4-year college degree, and 14.4% had earned postgraduate degrees. The remainder (5.6%) had less than a high school diploma. More than half of the respondents (54.0%) said they were employed full time, 15.9% were retired, and 7.8% said they were employed part time. The remaining respondents said they were homemakers (8.8%), students (4.9%), too disabled or ill to work (4.6%), unemployed (3.7%), or in the military (0.2%). A little more than half (52.1%) had household incomes at or above $50,000 and 46.0% had incomes below $50,000, while the remainder (2.0%) refused to answer.

5. OVERALL TRUST IN WATCHDOGS, MERCHANTS, AND EVALUATORS

Mean scores and standard deviations were computed for each of the four elements of trust measured (see Table I) for each organization rated. Although

Table I. Mean (and Standard Deviation) Trust Scores

	Overall Trust*	Honesty	Competence	Transparency	Public Interest	Standardized α
Scientists	3.95	3.84	4.32	4.06	3.58	0.83
	(0.81)	(1.04)	(0.91)	(0.95)	(1.11)	
Medical professionals	3.82	3.91	3.77	3.71	3.88	0.85
	(0.83)	(0.98)	(1.10)	(1.01)	(0.94)	
Universities	3.68	3.73	3.71	3.76	3.58	0.86
	(0.86)	(0.99)	(1.05)	(0.99)	(0.98)	
Consumer advocacy organizations	3.59	3.72	3.35	3.65	3.67	0.88
	(0.97)	(1.13)	(1.14)	(1.09)	(1.11)	
Environmental organizations	3.45	3.48	3.33	3.47	3.53	0.91
	(1.11)	(1.27)	(1.23)	(1.27)	(1.24)	
Farmers	3.37	3.43	3.26	3.44	3.35	0.83
	(0.84)	(1.02)	(1.08)	(1.04)	(1.05)	
Federal government	2.99	2.83	3.00	3.24	2.87	0.88
	(1.00)	(1.19)	(1.19)	(1.15)	(1.20)	
Media sources	2.77	2.92	2.32	3.20	2.63	0.81
	(0.87)	(1.13)	(1.03)	(1.16)	(1.09)	
Grocers & grocery stores	2.71	2.80	2.47	2.79	2.75	0.83
	(0.82)	(1.00)	(1.03)	(1.02)	(1.03)	
Industry	2.53	2.32	2.73	2.72	2.34	0.84
	(0.90)	(1.06)	(1.15)	(1.10)	(1.08)	
Averages	3.29	3.30	3.23	3.40	3.22	0.85

*Overall trust = the mean value of honesty + competence + transparency + public interest.

Note: Scales were coded 5 = highest; 1 = lowest; Entries in bold = above mean overall trust; Entries in italics = below mean overall trust.

different means were reported for the various elements of trust related to each organization, it is clear that regardless of the element of trust rated, the same general hierarchy of organizations emerges. As such, we computed a summary measure of trust using the overall mean score of each of the four hypothesized dimensions. By combining each of the four dimensions of trust into an overall measure, we can create a more robust measure of trust and more reliably determine how people discriminate among the organizations regarding GM food. In Table I, we show the mean trust scores for organizations, presented in descending mean order. Since summary scales are an assembly of interrelated items designed to measure underlying constructs, it is important to measure the internal reliability of the scales. To test the assumption of unidimensionality, we computed a Cronbach's α for each group, with standardized alpha scores ranging from 0.81 to 0.91.

The overall computed mean for all items was 3.29, just slightly above a "neutral" rating of "neither agree nor disagree." Six groups have mean overall scores above the average overall computed mean, while four groups rate below. There is a relative lack of trust in the federal government, media sources, grocers and grocery stores, and industry regarding GM foods. Scientists, medical professionals, universities, consumer advocacy organizations, environmental organizations, and farmers were all relatively trusted regarding GM food. These ratings are roughly consistent with the results reported from quantitative surveys of the European public,[6,52] which indicate that the trusted sources in Europe are often the same as in the United States. It is worth noting that those who are generally considered as the main stakeholders in GM food—industry and the federal government—as well as those that are most likely to have public contact—grocery stores and the media—are less trusted than others in the field.

While the respondents are able to assign to each of the stakeholders distinct ratings on each element of trust, and a hierarchy is made evident, exactly how we might interpret or make use of these results is not immediately obvious. Respondents consistently rated scientists at or near the top of each dimension; conversely, they rated industry at or near the bottom of each dimension. Although the mean differences are statistically significant, that does not necessarily indicate a pattern of social significance. The ratings given to scientists might be seen as more indicative of social approval of science than of scientists themselves. It may be that the organizational location of an expert is more important than a professional title. For example, when respondents rate industry and consumer groups and universities, they may be considering the trustworthiness of scientists working for those institutions. A conservative interpretation would lead us to simply make a distinction between those groups that fall above and those groups that fall below the mean level of trust.

Given that the measures of overall trust for each of the groups were often significantly correlated (analysis not presented here), and given the likelihood that the four elements used do not account for all the variability possible in a measure of trust, we performed an exploratory factor analysis. This factor analysis, presented in Table II, further substantiates the use of a single concept to describe the four measures. The four components—competence, transparency, public interest, and honesty—all load onto a single factor,

Table II. Overall Trust as a Single Factor for Each of the 10 Organizations

Factor Analysis No.		Honesty	Competence	Transparency	Public Interest	Percent Variance
1	Scientists	0.80	0.74	0.74	0.67	65.6
2	Medical professionals	0.76	0.75	0.75	0.80	68.7
3	Universities	0.76	0.80	0.83	0.76	71.1
4	Consumer advocacy organizations	0.83	0.75	0.81	0.85	74.0
5	Environmental organizations	0.85	0.79	0.85	0.90	78.8
6	Farmers	0.67	0.77	0.74	0.76	65.8
7	Federal government	0.84	0.76	0.78	0.84	73.3
8	Media sources	0.76	0.71	0.65	0.75	63.6
9	Grocers & grocery stores	0.74	0.74	0.74	0.73	65.8
10	Industry	0.82	0.63	0.77	0.78	67.4

Note: Extraction method: Principal axis factoring. Each row represents an independent factor analysis. Only one factor was extracted in each of the 10 factor analyses.

suggesting that these four items measure a single concept, which we have labeled *overall trust*. This was contrary to our expectations of finding a two-factor solution. While this same exploratory factor analysis was repeated for each organization, our results were consistent. The variance explained by this overall trust factor ranges from a low of 63.6% for media sources to a high of 78.8% for environmental organizations. That the explained variance is substantial for each organization lends further support to the use of an overall trust measure.

The respondents rated 10 organizations that can be easily ranked in terms of overall trust. However, such rankings, while informative, do not present a clear picture of how these organizations may be appropriately grouped. To examine this, we performed an exploratory factor analysis using the total trust score. Using the principal axis method of extraction, a three-factor solution that explains 65% of the variance was retained based on eigenvalues greater than 1. This was followed by an oblique (Promax) rotation. Although an orthogonal rotation (such as Varimax) is more common, the assumption that factors are uncorrelated is not theoretically justified and could not be substantiated for our data. Although the interitem correlations were relatively low (analysis not shown), they were significant. If we were to, therefore, artificially assume orthogonality, we might provide an inaccurate and misinformative test of the factor structure. Furthermore, because we did not assume that the correlations between the underlying items were 0, oblique rotation might yield more parsimonious and interpretable factor patterns.

As Table III illustrates, we have labeled these factors as *watchdogs*, *merchants*, and *evaluators*. All three factors are distinct, with no one group loading (above 0.25) on more than one factor.

The first factor accounted for 37.3% of the original variance and comprised trust in consumer advocacy organizations, environmental organizations, and media sources. This factor can be interpreted as trust in *watchdogs*, i.e., independent organizations that keep a critical eye on developments in GM food and those who inform the public about its possible consequences. Grocers and grocery stores, industry, and farmers loaded highly on the second factor and accounted for 17.5% of the original variance. This suggests that respondents may see these three groups as being part of a wider system of GM food production and marketing that we have termed *merchants*. The third factor, which we termed *evaluators*, accounted for 11.0% of the original variance and was concerned with trust in scientists, universities, and medical professionals. The public often calls on these scientific experts to evaluate GM food.

Table III. Trusting Watchdogs, Merchants, and Evaluators

	Factor		
	Watchdogs	Merchants	Evaluators
Consumer advocacy organizations	**0.96**	−0.10	0.00
Environmental organizations	**0.79**	−0.02	0.00
Media sources	**0.44**	0.24	0.08
Grocers and grocery stores	0.12	**0.84**	−0.12
Industry	−0.15	**0.77**	0.07
Farmers	−0.03	**0.56**	0.09
Scientists	−0.12	−0.06	**0.96**
Universities	0.16	−0.04	**0.64**
Medical professionals	0.12	0.16	**0.45**
Federal government	0.02	0.23	**0.37**
Eigenvalue	3.73	1.75	1.10
Mean overall trust	3.27	2.87	3.82
Cronbach's α (standardized)	0.78	0.77	0.75

Note: Extraction method: Principal axis factoring; Rotation method: Promax with Kaiser normalization. Rotation converged in five iterations. The scales were coded to range from 1 = "totally disagree" to 5 = "totally agree."

Though often studied as the most important organization, the federal government did not highly load on any of the factors. The government loaded moderately (0.37) on the *evaluators* factor and did not load on any other factor. Forcing a fourth factor does not make the pattern of results any clearer. This may be, in part, because respondents may not recognize the various roles that government plays, ranging from regulatory and scientific evaluation to the resolution of trade and policy disputes regarding GM food.

Table III shows that (the average) trust in *evaluators* was the highest (3.82 on a 5-point scale, represented here as ranging from 1: "totally disagree" to 5: "totally agree," with 3: "neither agree nor disagree" as the scale's midpoint). *Merchants* were trusted the least to tell the truth about GM food (2.87). Although *watchdogs* seem to be moderately trusted (3.27), a closer examination of the factors reveals that consumer advocacy organizations (3.59) and environmental organizations (3.45) are more trusted than media sources. The relatively low trust in media sources (2.77) depresses the average trust for the watchdogs factor.

Because we performed an oblique rotation, we can describe the correlations between factors.

Table IV. Factor Correlation Matrix

Factor	Watchdogs	Merchants	Evaluators
Watchdogs	1.00		
Merchants	0.22	1.00	
Evaluators	0.39	0.51	1.00

Note: Extraction method: Principal axis factoring; Rotation method: Promax with Kaiser normalization.

Table IV shows that a low correlation exists between watchdogs and merchants. There is a low-to-moderate correlation between watchdogs and evaluators. A moderate correlation exists between merchants and evaluators. Though we cannot know for certain, it is possible that these correlations partly indicate that the respondents consider all of these groups part of a "system" that is trustworthy. In other words, absent real knowledge of these groups, it is possible that respondents simply trust that some general social system is managing the potential risks of this technology. Yet, the relatively low magnitudes of the intercorrelations between the factors indicate that the choice of oblique rotation was not strictly called for and no second-order factor analysis was pursued. Further exploratory factor analysis (not shown) with a Varimax rotation results in the same three-factor structure. We have, however, retained the oblique rotation for our results because it was initially justified.

6. DISCUSSION

We met with mixed success in our objectives. We had believed that our results would indicate that trust was best described as a concept with two distinct dimensions. Instead, we found an overall trust dimension that best characterized the data. At least two plausible reasons may explain this difference, each providing rich areas for further research. In part, some of the inconsistency may exist because of cross-cultural variations. How trust operates across various cultures certainly deserves increased scholarly work, as transnational relations are now the norm across a range of endeavors. In addition, some dissimilarity in results may exist because of methodological differences. These methodological complications highlight an important truism about the state of trust research. Although it is an increasingly studied topic and researchers are growing more sophisticated in their analyses, there is not yet an agreed upon definition of trust and, therefore, researchers continue to invent new measures. This leads to difficulties in comparison across research projects.

Further difficulties in comparison arise when comparing institutions. As previously noted, researchers have often concentrated their efforts on general measures of trust in scientists and regulators. But, as Poortinga and Pidgeon[34] have discussed, the more specific and differentiated the subject institution is, the more likely we are to come to a nuanced understanding of the social relationships. This increased understanding of the social relationships among and between institutions as well as the relationship of the institutions to individuals is perhaps most interesting and theoretically relevant.

The results for the second aim of our study, assessing the level of trust afforded to particular institutions in the organizational field of agricultural biotechnology, although not definitive, direct our attention to the importance of trust in relevant social institutions. Respondents distinguish between competency and honesty, between public interest and transparency; for each institution there are variations in the ratings of the four elements. However, while minor distinctions are present, each of these elements is highly related to the others and, therefore, these elements can be combined to create a more robust measure of trust. Using this combined measure of trust, it is possible to rank organizations in terms of respondents' overall trust. In this ranking, we find that respondents do not trust many of the organizations that have the greatest resources and responsibilities for ensuring the safety of GM food.

Without trust in these organization, people may misperceive the risks and uncertainties and be swayed by the exaggerated claims of those opposing the technology.[53] Given that the public remains somewhat fearful of GM food, the dictum that risk communication messages should be given by trusted experts to alleviate public skepticism may prove difficult in this setting. The public perception of risk surrounding GM food, coupled with distrust of the risk managers, may increase or continue to amplify public concerns about this technology and fuel further controversies.[12,13] That certain stakeholders are trusted and others are viewed skeptically, at least in Europe, was already understood.[6,34,52] While these findings have obvious consequences for policy and applied work, by not only rank ordering and categorizing stakeholders into the trusted and distrusted groups, we might find broader applicability for the research.

The third aim of our study was to determine whether the stakeholders themselves can be categorized and described in more general terms. If there are strata of social actors, then we can make assumptions about organizational characteristics that make one group more or less likely to be trusted in disputes over new technologies. Through the creation of abstract categories, we can more intelligently organize our hypotheses for novel technologies and risks. This new approach also begins to direct attention to the organizational features and characteristics that may be important for promoting trust in new technologies. By situating experts—and the institutions that act as experts for a given technology—in these categories, we can begin to focus on the organizational features that allow for trust. The relationship between watchdogs, merchants, and evaluators is complex. The respondents grant each group distinct trust judgments; however, those judgments are related. In other words, these groups are not always seen as distinct and opposing social actors, but as part of a larger social system.

As such, trust must be treated as a social mechanism that is embodied in structures of social relations. To measure trust, therefore, we need to place our analytic focus on the institutional and organizational contexts in which individuals derive their meanings. If we are to concentrate on institutional legitimacy and trust, we must further pursue a research agenda that emphasizes the decision processes in powerful organizations and experts. Those processes, organizations, and experts—not the general public—allocate resources toward and away from technologies. As such, the increasing complexity in agricultural systems represented by GM food increases public reliance on trustworthy experts and institutions. Furthermore, the structure of relationships among these stakeholders can act to enable or constrain public support for new technology.[54]

The grouping of organizations resulting from the factor analysis suggests a novel and useful set of relationships for us to explore. For example, trust in media, consumer, and environmental advocacy organizations are seen similarly. Rather than viewing the media as weighted toward the point of view of large institutions, the respondents perceive the media as more akin to a watchdog of the public interest. Regarding the U.S. government, critics have often asserted that the various regulatory agencies act in the interests of corporate policies above the interests of individual citizens, blurring the distinction between corporations and the government.[55] However, the respondents in this study evidently do not consider industry and the federal government to be intertwined in that fashion. Rather, consumers view industry and the federal government as worthy of distinct trust judgments.

Ultimately, members of the public will place their trust in specific institutions, while myriad expert groups will attempt to influence these choices. Given the complex organizational field of this technology, this means that exercising public influence over policy and practice is more difficult because it has to be aimed in several directions at once. The complex nexus of connections among the institutions involved with GM food may further contribute to consumer confusion. However, the classification of watchdogs, merchants, and evaluators might give important clues as to how organizations and experts not evaluated in this study might be seen by consumers.

It is apparent that successful dialogue between all the interested parties will require a high degree of trust in the organizations presenting the technology. The expansion of these dialogues invites an analysis of trust relationship between individuals and institutions. Public trust in responsible institutions involves a consideration of a broader notion of relevant information as well as the significance of the relational dimensions of trust. These results indicate that public perceptions of trust involve some element of judgment—of the quality of the relevant organization, the competence of the organization to answer the challenges of the new technology, and the organization's relationship to the individual and society. As such, thinking through the uncertainties surrounding GM food calls for an examination of not only the scientific, environmental, and moral issues, but also an examination of the trust inherent in the social and organizational underpinnings of the technology.

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