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# Does safety information influence consumers' preferences for controversial food products?

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ABSTRACT

This paper uses experimental auctions to address two key research questions: are preferences for controversial food products a function of safety information, or personal attitudes and preferences? To what extent are consumers' preferences for a controversial food product influenced by positive and negative scientific information? Experimental auctions for pasteurized and unpasteurized artisan cheese were conducted on computer tablets with participants at farmers' markets in Michigan, New York and Vermont using a Becker-DeGroot-Marschak (BDM) auction mechanism. Along with the auctions, participants blindly evaluated the sensory characteristics of the cheeses and answered demographic questions and Likert scale questions about their attitudes towards food safety. We find that ideology, taste, and principle drive consumers' preferences for unpasteurized cheese, as opposed to misinformation or ignorance. There is also evidence that artisan cheese consumers exhibit confirmation bias when exposed to information about pasteurization.

## 1. Introduction

Consumers can be subjective in how they assess food safety risk. A consumer's assessment is a function of the information they have about the product or production technology as well as their attitude about food safety (Lobb, Mazzocchi, & Traill, 2007). Moreover, their attitude about food safety can influence how they respond to new information about a controversial food product or technology. From a policy perspective, the easiest way to ensure the safety of a food product and minimize risk to consumers is through government regulation of production practices. However, defining an optimal balance between food safety and consumer choice can be challenging for policymakers due to the heterogeneity in consumer attitudes about food safety and the heterogeneity in their preferences concerning the extent to which food safety should be pursued at the expense of other aspects of quality, such as taste.

There is an ongoing debate about the acceptability of risk in the food system (Nestle, 2010). The proliferation of small-scale "artisan" food producers has highlighted this debate and presents new concerns for policymakers. Artisan food products are often handmade, minimally processed, and highly diversified products in which the uniqueness of the product is of paramount importance to its demand. The uniqueness of these products however is the antithesis of standardization, which in the broader industrial scale food system has become the basis for ensuring the safety of food products. The emphasis on standardization to promote food safety presents challenges when it comes to regulating artisan products. In some cases, standardization of processes can improve food safety outcomes, although the standardization often comes at the expense of other aspects of quality including sensory characteristics, diversity of consumer choice, and health benefits. In many cases, there are divided opinions among both the public and scientists about the food safety outcomes of particular processes, such as the genetic modification of food (Funk & Rainie, 2015; European Network of Scientists for Social and Environmental Responsibility, 2014). The debate over the safety of unpasteurized or raw milk and more specifically the safety of cheese made from raw milk is another example where there are divisions among the public and the scientific community.

Previous consumer acceptance studies of controversial food technologies have tended to focus on mainstream products and markets (e.g. Nayga, Woodward, & Aiew, 2006; Rousu, Huffman, Shogren, & Tegene, 2002), thus omitting a unique subset of the changing food system. Artisan foods such as beer and cheese among many others are an increasingly important segment of the food market. Craft beer sales in the US capture 21% of the total beer market, 12% by volume, and expect to have a 50% market share in a decade (Shorto, 2016). Artisan cheese consumption is on the rise and the number of artisan cheesemakers in the US doubled between 2000 and 2007 to more than 400, with 75% of them using unpasteurized milk for at least

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some of their products (Roberts, 2007). Understanding the attitudes of artisan food consumers towards risk, their preferences, and their behavior is critical for designing policies that reflect consumers' demand for food safety. With artisan products becoming part of the broader food safety discussion they have placed policymakers in a challenging position with respect to the laws that govern food safety.

In this paper we examine how provision of information about the debate over pasteurization influences preferences for pasteurized and unpasteurized cheese. On one hand, pasteurization of milk has led to significant improvements in the safety of milk and milk products in the last century and is thus an obvious safety-enhancing procedure. On the other hand, pasteurization of milk used to produce cheese kills beneficial bacteria, which are the foundation of flavor development (Bachmann et al., 1998) and can improve safety by competing with harmful bacteria that may have been introduced post processing (Johnson et al., 1990). Pasteurization thus represents a tradeoff between safety and (sensory) quality for some consumers, particularly with artisan cheese, and this is what we explore in light of the positive and negative scientific information about pasteurization. By positive information we mean information in support of a particular practice, and by negative information we mean information in opposition to a given practice. We look at the effect of pro-pasteurization and pro-raw milk (unpasteurized milk) information on consumers' willingness to pay (WTP) for pasteurized cheese. We are particularly interested in whether consumers place greater weight on negative information as other researchers have found with other products (Fox, Hayes, & Shogren, 2002; Rousu, Huffman, Shogren, & Tegene, 2007).

## 2. Background

The practice of pasteurizing milk used in the production of cheese in the United States dates back to World War II when the United States Department of Agriculture (USDA) encouraged producers to pasteurize the milk used to produce the millions of pounds of cheese being supplied to US and allied troops abroad (Johnson et al., 1990). Following two outbreaks of typhoid fever in 1944, the Surgeon General declared that cheese must be made from pasteurized milk or be aged before sale to allow the beneficial bacteria time to proliferate. After some debate the Food and Drug Administration (FDA) passed 21 CFR 133 in 1949, requiring that cheese be made from pasteurized milk or aged no less than 60 days (at a temperature greater than 35 °F). D'Amico and Donnelly (2010) outline a series of early studies that may have laid the groundwork for the 60-day minimum aging period, namely a study by Gilman, Dahlberg, and Marquardt (1946), which found that undulant and typhoid fever epidemics had not been associated with cheese cured for more than 63 days.

This regulation has remained unchanged despite the changing nature of risk from dairy products and recent scientific findings that contradict the premise of the regulation. According to the Centers for Disease Control (CDC) database, safety of dairy products is now among the highest of all foods (CDC, 2014a). There have been no major outbreaks of milk or cheese-related illnesses in recent years as there have been with fruits and vegetables (such as spinach and cantaloupes). In addition to the decreased risk of dairy products, there is evidence that the 60-day aging period is arbitrary as recent research has demonstrated that pathogens can survive past 60 days (D'Amico, Druart, & Donnelly, 2008a), and that aging cheese supports the growth of the pathogen *Listeria monocytogenes,* regardless of pasteurization (D'Amico, Groves, & Donnelly, 2008b). Recent research has also found that in samples intended for cheese production, raw milk is not less safe than pasteurized milk (D'Amico & Donnelly, 2010).

Regulations such as mandating pasteurization of milk used in cheesemaking and setting a minimum aging period for cheese made from raw milk are designed to minimize the risk from consuming unpasteurized milk products. Given the heterogeneity in preferences for artisan food products and the contested science underlying this particular policy, it seems prudent to explore consumer behavior around this controversial food safety issue. We do this by looking at the role of safety information about pasteurization on consumer WTP for pasteurized and unpasteurized cheese in an experimental setting.

Much of the research testing the effect of information on controversial technology acceptance takes an experimental approach since it is possible to introduce information treatments and observe the change in consumers' responses to the new information. Studies have found that consumer preferences and acceptance of a specific food safety-enhancing process can be influenced by knowledge and information about the risks (Fox et al., 2002; Nayga, Woodward, and Aiew, 2006). Greater self-rated knowledge of a food technology is associated with positive attitudes about that technology, while increased knowledge of one technology leads to more negative attitudes towards other technologies (Teisl, Fein, & Levy, 2009). Lusk et al. (2004a) compared consumer acceptance of information about a controversial product and found that information on the product's benefits decreased the amount of compensation that subjects demanded to consume the food. Hayes, Shogren, Shin, and Kliebenstein (1995) investigated how subjects process information and found that they generally underestimated the probability of food-borne pathogens and placed more weight on their own prior perceptions of the odds of illness than on the new information presented to them during the study. Aschemann-Witzel and Grunert (2015) found that when US consumers were presented with contradictory information, they reduced their favorable attitude towards a risky product to a lesser extent in the presence of scientifically framed information than non-scientifically framed information. Rousu et al. (2007) developed a method for testing and calculating the economic value of the effects of objective information for a food product in a market with conflicting information.

This paper contributes to the literature by looking at a food product with a controversial safety-enhancing process where safety is intrinsically and inversely related to taste. We focus on consumers' attitudes towards food safety and their preferences for a controversial product or process in light of both positive and negative objective scientific information – information in support of or in opposition to that product or process, respectively.

## 3. Methods

### 3.1. Experimental auctions

The research reported here builds on the research presented in Waldman and Kerr (2015) regarding consumers' preferences between pasteurized and unpasteurized cheese and the associated tradeoff between food quality and safety. This paper relies on the same underlying experimental auction data in addition to a second round of observations following an information treatment. In this paper we examine the effect of providing consumers with information about the safety of pasteurization of milk used in artisan cheese production. We observe how this information changes consumers' WTP for the cheese and we explore the relationship between these changes and their underlying demographic characteristics, sensory preferences, and risk attitudes. We build on the method of valuing information outlined by Rousu et al. (2007) by sorting consumers into two endowment groups (pasteurized and unpasteurized cheese) in order to mitigate any signal of quality sent by the endowment and to better capture the heterogeneity of preferences. In addition, we conduct auctions and sensory experiments in a realistic field setting and we use an endow-and-upgrade approach to focus participants' attention on the marginal difference between the pasteurized and unpasteurized cheeses.

The auctions use the Becker-DeGroot-Marschak (BDM) auction mechanism (Becker, Degroot, & Marschak, 1964). In a BDM auction, a "market" price is randomly generated from a pre-specified distribution chosen by the experimenter and compared to the sealed bid the participant submits. If the individual's bid is greater than the market price,

the individual wins the good being auctioned and pays the market price. If the individual's bid is lower than the market price no transaction occurs. Lusk et al. (2004b) demonstrated that BDM auctions and English auctions generate statistically equivalent bids regardless of whether participants receive an endowment, offer bids to upgrade, or offer full bids. A BDM mechanism is advantageous in this context because it allows the researcher to conduct an auction in the field with a single participant, thus incorporating the participant's heuristics and the effect of the market experience (Lusk & Shogren, 2007).

Following the initial endowment and bidding round to upgrade, participants are provided with a pro-pasteurization information treatment, a pro-raw milk information treatment, or both information treatments together.

### 3.2. Auction procedure

A vending table was set up at each farmer's market location with two monitors conducting experiments simultaneously using computer tablets. At the beginning of the day or after a participant completed an auction a new participant was recruited. We randomized participation by inviting every passerby to participate if someone was not already participating at that station. The protocol for the auction consisted of the exact same nine steps with every participant. A schematic of the auction procedure can be found in Fig. 1.

In step 1, participants learned about the nature of the research and the benefits and risks to them and were asked if they consented to participate. They were informed that they would be engaged in the research for approximately 15–20 min and would be compensated $5 and half a pound of cheese for participating in the auction.

In step 2, participants answered a series of questions concerning their basic demographic data, cheese consumption habits, and frequency of purchasing cheese made from unpasteurized milk. The frequency categories were: "sometimes", "often", "never", and "I don't know".

Step 3 was a non-binding practice round to introduce participants to the BDM auction mechanism. In the practice round participants tasted two different samples of cheese (approximately 3/4″ cube) acquired from two different vendors at each market and labeled with random 3-digit numbers (eg. 324). They performed a practice round of sensory evaluation and a practice auction round at this stage. The details of the auction procedure are described below. The practice round was designed to familiarize participants with the bidding process and was not part of the analysis.

In step 4, each participant was given a sample of the three cheeses used in the auction (60-day unpasteurized, 60-day pasteurized, and 90-day unpasteurized). From here on we refer to the three cheeses as 60R, 60P, and 90R respectively. These cheeses were organic cheddar cheese made by the same Vermont cheesemaker and differed only in the date they were processed (aged for 60 or 90 days) and whether or not they were pasteurized. The cheeses were labeled with a random number and not labeled by age or pasteurization at this point. Participants were asked to provide a sensory evaluation of each of the three cheeses (on a scale from 1-10 where 1 is strong dislike). The use of sensory evaluation in this context was designed to look at how consumers make tradeoffs between cheese safety and quality attributes, not specifically to look at the differences in the sensory attributes between the cheeses.

In step 5, participants were presented with two of the cheese samples. In this step the two cheeses were both aged approximately 60 days and were identical except that one was pasteurized and one was not. The cheeses were labeled as aged for 60 days and pasteurized or unpasteurized, and the participant was "endowed" with the cheese that did not fit their stated preference during the pre-auction survey. In other words, participants who answered "never" or "I don't know" in response to whether they purchase cheese made from unpasteurized milk were endowed with unpasteurized cheese (step 5a), and participants who answered "sometimes" or "often" were endowed with pasteurized cheese (step 5b). Participants were then given the opportunity to bid on the cheese they were not endowed with.

Instructions on the tablet informed the participants that they were endowed with half a pound of one cheese but they could offer a bid to switch to the other cheese if they preferred. This is referred to as an "endow and upgrade approach" following Lusk et al. (2005), which focuses the participant's attention on the marginal difference between the two products for the attribute of interest.

Participants' bids were then compared with a random number between $0 and $5 generated by the computer tablet (participants were not informed of the distribution). The tablet then displayed a message informing participants that they won the auction if their bid to switch was higher than the random market price or lost if their bid was lower. Participants were informed that they would receive the cheese they bid on and be expected to pay the randomly generated price if they won, or keep the endowed cheese and pay nothing if they lost. The researcher then reiterated that the practice round was non-binding but there would be multiple rounds of bidding and a single randomly selected binding round at the end.

We split the participation fee into a cheese endowment and cash. The cheese endowment generates interest in the auction since the subject will leave with one kind of cheese or another either way (Lusk & Shogren, 2007).

In step 6, all participants were endowed with a 60-day unpasteurized cheese and given the opportunity to bid to switch to the unpasteurized version aged for 90 days.

In step 7, participants were provided with an information treatment and randomly assigned the bidding comparison from either step 5 or step 6. They received the same endowment they previously received in step 5 or 6 and followed the same procedure except they randomly received one of two information treatments. One information treatment was a collection of information from consumer advocacy groups and scientific research articles supporting the consumption of unpasteurized cheese. The other provides information from similar sources but opposing the consumption of unpasteurized cheese.

In step 8, participants repeated step 5 or 6, whichever one they were not randomly reassigned in step 7. Again they were given the same endowment as in step 5 or 6 and followed the same procedure except they received the information treatment that they did not receive in step 7. Note that some participants only received one information treatment. As a result, the sample contains participants who received both information treatments, only the pro-pasteurization information treatment, or only the pro-raw milk information treatment. This is described in more detail below.

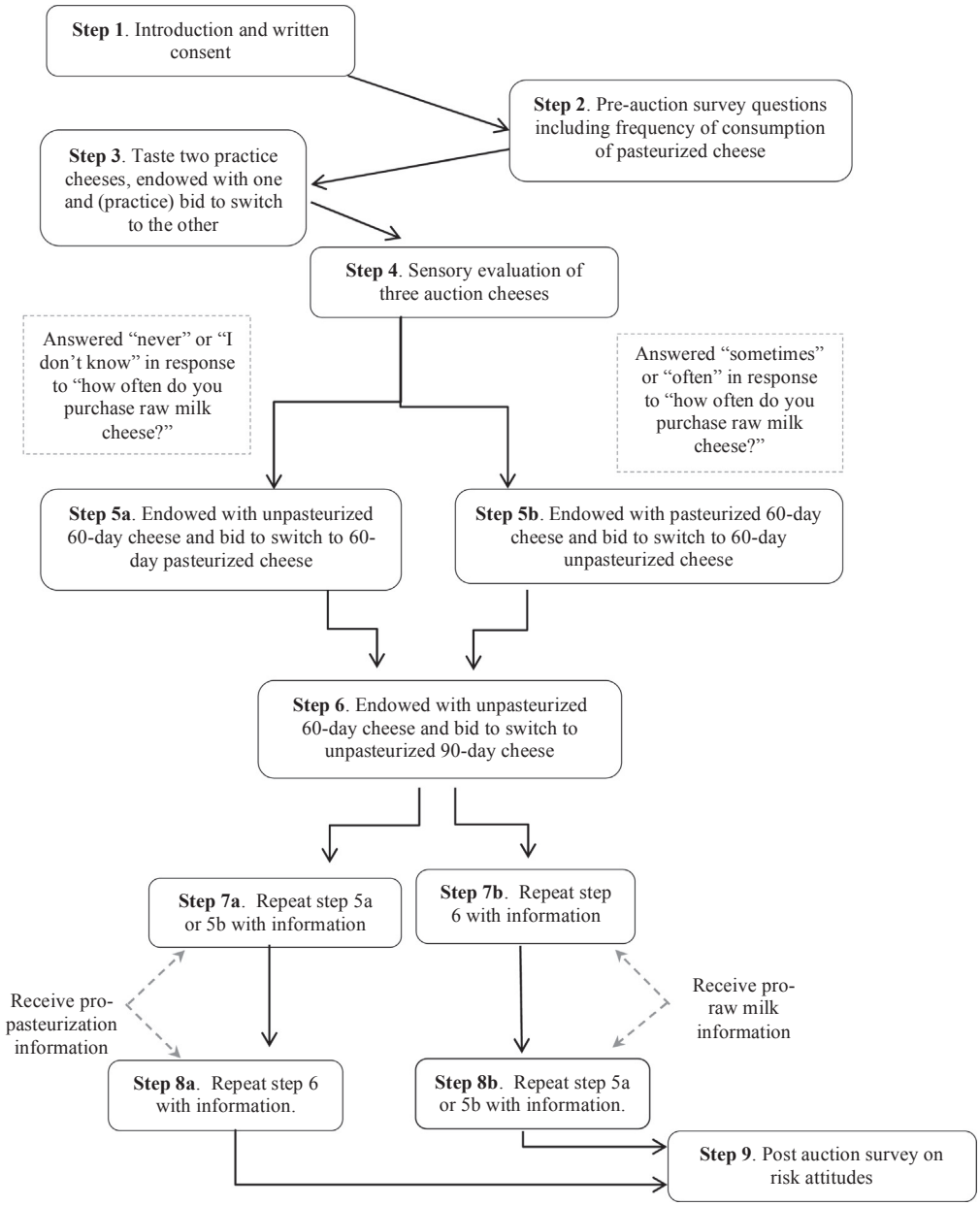
In step 9, participants completed a series of survey questions designed to characterize their attitudes towards risk and food safety.

In the final step, one of the rounds is selected at random as the binding round and the transaction occurs only for that round.

### 3.3. Description of information treatments

Table 1 illustrates the details of the six possible combinations of bidding comparisons and information treatments over two rounds, labeled A-F. Participants were asked to make two product comparisons—between a pasteurized and unpasteurized cheese of the same age (60R/60P) and between two unpasteurized cheeses, one of which was aged for 60 days and the other 90 days (60R/90R). The cheeses were identified as such and participants evaluated these comparisons and bid on products first without receiving any information about the debate, as described in Waldman and Kerr (2015), and then again after receiving an information treatment. Each participant was assigned one of the six two-round combinations displayed in Table 1, labeled A-F.

There were two information treatments, pro-pasteurization and pro-raw milk. Each participant was assigned a given combination of cheese comparison and information treatment such that we end up with roughly the same number of bids recorded in each of three information-




Notes: In step 7, participants were provided with an information treatment and randomly assigned the bidding comparison from either step 5 or step 6. They received the same endowment they previously received in step 5 or 6 and followed the same procedure except they randomly received one of two information treatments. In step 8 they are faced with whichever comparison they did not receive in step 7.

**Fig. 1.** Schematic of auction procedure with information treatments. Notes: In step 7, participants were provided with an information treatment and randomly assigned the bidding comparison from either step 5 or step 6. They received the same endowment they previously received in step 5 or 6 and followed the same procedure except they randomly received one of two information treatments. In step 8 they are faced with whichever comparison they did not receive in step 7.

treatment categories: pro-pasteurization information, pro-raw milk information, and both information treatments. In the first information round, participants were all endowed with a 60R cheese and given the opportunity to bid to switch to either a 60P or a 90R cheese, and they were assigned one of the two information treatments. In the second information round, two-thirds of participants received the opposite information treatment as the previous information round, giving them both types of information (combinations A-D). Participants in treatments E and F received no information in the second round so these participants only had the information from the previous step (combinations E and F) and thus were bidding on comparisons 1 and 2 with the same information treatment. By only assigning one information treatment in combination E and F we are increasing the number of bids following each of the single information treatments to create a relatively balanced bid distribution. See table 2 for cumulative totals of each information treatment by comparison bid count.

The information treatment scripts can be found in Appendix A and B. These scripts are based on a collection of information from consumer advocacy groups, government and scientific research articles advocating either raw milk cheese or pasteurization of cheese. Since much of the science is disputed we characterized these perspectives with careful attention not to give any information that is scientifically inaccurate.

**Table 1**
Combinations of bidding comparisons and information treatments.

| | Information round 1 | | Information round 2 | | N = 347 |
|---|---|---|---|---|---|
| | Information Treatment 1 | Comparison 1 | Information Treatment 2 | Comparison 2 | |
| A | pro-pasteurized | 60R/60P[1] | pro-raw milk | 60R/90R | 69 |
| B | pro-raw milk | 60R/60P | pro-pasteurized | 60R/90R | 67 |
| C | pro-pasteurized | 60R/90R | pro-raw milk | 60R/60P | 65 |
| D | pro-raw milk | 60R/90R | pro-pasteurized | 60R/60P | 67 |
| E | pro-raw milk | 60R/60P | | 60R/90R | 41 |
| F | pro-pasteurized | 60R/60P | | 60R/90R | 38 |

[1] 60R = 60-day unpasteurized cheese, 60P = 60-day pasteurized cheese, and 90R = 90-day unpasteurized cheese.

**Table 2**
Total number of bids for each information treatment by cheese comparison (combining rounds 1 & 2).

| Information treatment | 60R/60P | 60R/90R |
|---|---|---|
| Pro-pasteurized | 69 + 38 = 107 | 65 + 38 = 103 |
| Pro-raw milk | 67 + 41 = 108 | 67 + 41 = 108 |
| Both pro past/pro raw | 65 + 67 = 132 | 69 + 67 = 136 |

### 3.4. Sample

The sample in this study is identical to that in Waldman and Kerr (2015). Since we are interested in how consumers are affected by the regulation of artisan cheese our target sample includes current artisan cheese consumers. We conducted the experiments "in the field" to reduce sample selection bias since participants are intercepted rather than self-selected (Harrison & List, 2004). The auctions took place in three states to capture different cultures of artisan cheese consumption and production in a nascent, intermediate and more developed artisan cheese market context (Michigan, New York, and Vermont respectively). Within each state we conducted experiments at farmers markets in multiple cities that ranged in size and median income. We chose to sample at farmers markets to capture the widest demographic of artisan cheese consumers and to have a consistent sample across and within states.

We identified three to four cities and towns of various sizes in each state where there was at least one farmers market. We then contacted the market managers, discussed the research and scheduled a day to conduct research at the market if the market manager was amenable. In Michigan, we conducted auctions at markets in Ann Arbor, Lansing, Grand Rapids and Bath. In New York we conducted auctions at markets in Ithaca, Albany and Schenectady. In Vermont we conducted auctions in Burlington, Brattleboro and Manchester. The markets varied in hours of operation ranging from three to six hours in length and in the density of pedestrian traffic. The total number of participants in the research across all locations was 347.

## 4. Results

We first describe the summary statistics of the sample and auction results prior to the information treatments and then auction outcomes following the information treatments. Table 3 displays the characteristics of the sample of artisan cheese consumers who participated in the experiments. The sample was mostly male and better educated but with similar income compared to the overall American population. A quarter of participants had children.

Participants consume about one pound of cheese per week. Almost all of the participants reported consuming artisan cheese but this only made up approximately 27% of all cheese consumed. The majority of participants consume cheese made from unpasteurized milk while 34 percent of participants answered "I don't know" and 9% had never purchased it.

**Table 3**
Descriptive statistics.

| Variable | Definition | Mean[1] | SD |
|---|---|---|---|
| Male | 1 if individual is male; 0 if individual is female | 36% | |
| Age | Age in years | 42.94 | 16.55 |
| Education | High school | 10% | |
| | College | 52% | |
| | Post graduate | 38% | |
| Income | < $30,000 | 26% | |
| | $30,000–80,000 | 34% | |
| | > $80,000 | 29% | |
| | Prefer not to answer | 11% | |
| Children | 1 if children under 16 are living at home; 0 otherwise | 25% | |
| Primary shopper | 1 if individual is primary shopper in household; 0 otherwise | 80% | |
| Pounds | Cheese consumption in pounds in the last 2 weeks | 1.96 | 1.72 |
| Artisan | 1 if individual consumes artisan cheese; 0 otherwise | 86% | |
| % Artisan | % of cheese consumption that is artisan | 26.86 | 25.63 |
| Unpasteurized cheese | Never purchase | 9% | |
| | Sometimes purchase | 43% | |
| | Often purchase | 14% | |
| | Don't know | 34% | |
| Food poisoning | 1 if individual has had food poisoning; 0 don't know or no | 57% | |

[1] A percentage in the mean column is used for all binary variables.

The sensory variables and the attitudinal variables were both recorded on a scale ranging from 0-10, where 0 represents a "strong dislike" and 10 represents a "strong like". The scales were presented as sliders on a computer tablet that could take on continuous values between 0 and 10 and were set at a default value of 5. The sensory variable mean values ranged from 6.08 to 7.07 points with standard deviation ranging from 1.75 to 2.22. The attitudinal variables ranged from 4.35 to 7.86 with standard deviation ranging from 2.08 to 3.00. The attitudinal variables had slightly more variation but both were constrained somewhat by the default position of the sliders.

### 4.1. Determinants of choosing pasteurized cheese and aged cheese

In this section we look at the determinants of a) the probability that a consumer chose the pasteurized cheese over the unpasteurized cheese, and b) the probability that a consumer chose the unpasteurized aged cheese over the unpasteurized unaged cheese. To analyze the dichotomous choices, separate logistic models were estimated based on a logistic probability function specified as follows:

$$P_i = F(WTP_i) = \frac{1}{1 + e^{(-X'\beta)}} \quad (1)$$

where $P_i$ is the probability that the $i$th consumer will choose a pasteurized cheese over an unpasteurized cheese or a 90-day aged cheese over a 60-day aged cheese, given the observed demographic characteristics, sensory variables, and food safety attitudes contained in $X_i$. If a participant accepted the endowed cheese (and effectively bid zero), we refer to them as having chosen that cheese, and if they bid on the alternative cheese then that is the one they chose. Recall that the cheeses were labeled as aged for 60 days and pasteurized or unpasteurized, and the participant was "endowed" with the cheese that did not fit their stated preference during the pre-auction survey. Logistic coefficients were converted to marginal effects at the means using the delta method so should be interpreted as probabilities not odds ratios (see Table 4).

The probability that a participant chooses pasteurized over

**Table 4**
Predicted probability of choosing a pasteurized or aged cheese (marginal effects at the mean calculated from logistic regressions using the delta method)[1].

| Variables | Pasteurized[2] | | Aged[3] | |
|---|---|---|---|---|
| | Coef. | SE | Coef. | SE |
| *Demographic variables* | | | | |
| Male (0/1 = yes) | 0.02 | 0.05 | 0.06 | −0.05 |
| Age (in years) | 0.00 | 0.00 | 0.00 | 0.00 |
| Income (> 80,000) | 0.06 | 0.07 | 0.07 | −0.06 |
| Income (30–80,000) | 0.00 | 0.07 | 0.05 | −0.06 |
| Income (not reported) | 0.14 | 0.09 | 0.04 | −0.08 |
| College graduate (0/1 = yes) | 0.11 | 0.08 | 0.16** | −0.07 |
| Post graduate (0/1 = yes) | 0.16* | 0.09 | 0.25*** | −0.08 |
| Children (0/1 = yes) | 0.01 | 0.03 | 0.02 | −0.03 |
| Primary shopper (0/1 = yes) | 0.05 | 0.07 | −0.06 | −0.06 |
| Cheese consumed (lbs) | 0.00 | 0.02 | 0.02 | −0.10 |
| Artisan (percent) | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sensory variables* | | | | |
| 60R_visual (0–1 0) | −0.01 | 0.02 | 0.00 | −0.02 |
| 60R_smell (0–1 0) | −0.05*** | 0.02 | −0.05*** | −0.02 |
| 60R_taste ((0–1 0) | −0.10*** | 0.02 | −0.11*** | −0.01 |
| 60P_visual (0–1 0) | 0.01 | 0.02 | – | – |
| 60P_smell (0–1 0) | 0.03 | 0.02 | – | – |
| 60P_taste ((0–1 0) | 0.11*** | 0.02 | – | – |
| 90R_visual (0–1 0) | – | – | −0.02 | −0.02 |
| 90R_smell (0–1 0) | – | – | 0.04*** | −0.02 |
| 90R_taste (0–1 0) | – | – | 0.15*** | −0.01 |
| *Attitudinal variables*[4] | | | | |
| Worry (0–1 0) | 0.00 | 0.01 | 0.02** | −0.01 |
| Trust government (0–1 0) | −0.01 | 0.01 | 0.01 | −0.01 |
| Stronger standards (0–1 0) | 0.03*** | 0.01 | 0.00 | −0.01 |
| Pay more (0–1 0) | −0.01 | 0.01 | −0.01 | −0.01 |
| Expiry date (0–1 0) | 0.03*** | 0.01 | −0.01 | −0.01 |
| Floor (0–1 0) | −0.01 | 0.01 | 0.00 | 0.00 |
| Raw milk (0–1 0) | −0.02** | 0.01 | 0.00 | −0.01 |
| Natural (0–1 0) | −0.02 | 0.01 | 0.01 | −0.01 |
| *Control variables* | | | | |
| Food poisoning (0/1 = yes) | 0.08 | 0.05 | 0.04 | −0.04 |
| Endowment (0/1 = yes) | 0.16*** | 0.05 | 0.05 | −0.05 |
| Vermont (0/1 = yes) | 0.13** | 0.06 | −0.01 | −0.05 |
| New York (0/1 = yes) | 0.13** | 0.06 | −0.02 | −0.05 |
| Pseudo R-squared | 0.25 | | 0.38 | |

[1] Statistical significance is denoted as follows: *** < 1% level, **1–5%, and *5–10%.
[2] Pasteurized is the choice between U60 (unpasteurized aged for 60 days) and P60 (pasteurized aged for 60 days).
[3] Aged is the choice between U60 and U90 (unpasteurized aged for 90 days).
[4] Table 3 is based on data generated from steps 5 and 6 of the auction procedure.

unpasteurized cheese before receiving an information treatment is based on their education level but also the sensory ratings of the cheese and their attitudes about food safety. A person with a post-graduate degree is 16% more likely to choose the pasteurized cheese than a respondent with an average education level (eg. a college educated respondent). The coefficient on the sensory and attitudinal scales represents the probability that someone who rated a cheese one point higher is more likely to choose that cheese. For each 1 point higher on a 10 point Likert scale participants rated the taste of the pasteurized cheese they were 11% more likely to choose the pasteurized cheese. The mean taste scores of the pasteurized cheese was 6.18, with a standard deviation of 2.22, so the difference between a score that is one standard deviation below the mean and a score one standard deviation above the mean could translate into 44% probability of choosing the pasteurized cheese. Participants who rated the taste and smell lower were also 5% and 10% less likely to choose the pasteurized cheese.

Responses to the questions about participants' attitudes about food safety were also predictors of choosing the pasteurized cheese. Participants who agreed more with the statement "I want stronger food safety standards imposed in the US" were 3% more likely to choose a pasteurized cheese (for every 1 point on the Likert scale). The average attitudinal score was 6.22 on a scale of 10 with a standard deviation of 2.75 so the interpretation of the attitudinal coefficients is comparable to the sensory coefficients. Those who were more agreeable with the statement "I check expiration dates before purchasing food" were 3% (for every 1-point) more likely to choose the pasteurized cheese. As expected, participants who agree more with the statement "I think it is safe to consume raw milk if I know the source" were 2% (for every 1-point) more likely to choose the pasteurized cheese, indicating discomfort with raw milk in any form.

A respondent who is endowed with pasteurized cheese is 16% more likely to choose the pasteurized cheese, supporting the notion that many consumers took the endowed cheese because it was free. Very few participants appear to have chosen pasteurized cheese simply because it was identified as pasteurized. Finally, participants from Vermont and New York were 13% more likely to choose the pasteurized cheese than respondents from Michigan.

The probability of choosing a cheese that is aged 30 days longer, on the other hand, is largely a function of education and taste preferences. Participants with college and post graduate degrees were 16% and 25% more likely to choose the aged cheese than the average respondent. Participants who gave the aged cheese a 1-point higher taste score and smell score were 15% and 4% more likely to choose the aged. Conversely the lower they rated the pasteurized cheese, the less likely they were to choose the aged cheese. Finally, there is some evidence that participants chose the aged cheese because of a safety concern. Participants who were more agreeable (1-point on a 10 point Likert scale) with the statement "I worry about the safety of the food I buy" were 2% more likely to choose the aged cheese.

The logistic regression results are summarized by a sequential analysis of model fit (Table 5). The likelihood ratio of each category of variables is isolated by sequentially removing each of the other categories of variables and observing the difference in the likelihood ratio statistic between the full model and the reduced model. For the pasteurized choice, sensory variables are the most important determinant, twice as important as attitudes, followed by the control variables and the demographic variables. For the choice of the aged cheese the overwhelming determinant is sensory scores, although demographics are more important than for pasteurized cheese and attitudes and controls are much smaller determinants.

### 4.2. The effects of sensory preferences and pasteurization status on cheese choice

In this section, we compare participants' choices with their taste preferences to see if they are consistent. We look at whether participants' notions of quality conveyed through their sensory ratings of the pasteurized and unpasteurized cheeses are consistent with their choices for the cheeses in the auctions.

First we examine the tradeoffs between sensory preferences and the cheese that was chosen in the auction considering which cheese the participant was endowed with. Of the 347 participants in the research, 186 chose the unpasteurized cheese (60R) and 161 chose the

**Table 5**
Summary of the statistical importance of each variable category.[1]

| | Pasteurized | | Aged | |
|---|---|---|---|---|
| | df[2] | LR[3] | df | LR |
| Demographics | 11 | 12.12 | 11 | 23.12 |
| Sensory | 6 | 74.59 | 6 | 144.42 |
| Attitudes | 8 | 34.41 | 8 | 9.97 |
| Controls | 4 | 17.73 | 4 | 2.01 |
| Full model: | 29 | 121.12 | 29 | 177.51 |

*Notes:* [1]Variable categories are defined in Table 4. [2]df = degrees of freedom in each category. [3]LR = Likelihood ratio statistic for each category of variables.

**Table 6**
Consistency between auction participants' choice and sensory ratings.[1]

| Total sample | Choice[2] | Endowment | Taste preference[3] | Bid | n for each choice × endowment × taste preference combination | Consistency of choice & taste preference[4] |
|---|---|---|---|---|---|---|
| N = 347 | 60R | 60P | R > P | > 0 | 47 | Consistent |
| | (n = 186) | (n = 99) | R = P | > 0 | 30 | Inconsistent |
| | | | R < P | > 0 | 22 | |
| | | 60R | R > P | > 0 | 40 | Consistent |
| | | (n = 87) | R = P | 0 | 31 | Indifferent |
| | | | R < P | 0 | 16 | |
| | 60P | 60P | R > P | 0 | 16 | |
| | (n = 161) | (n = 99) | R = P | 0 | 27 | |
| | | | R < P | > 0 | 56 | Consistent |
| | | 60R | R > P | > 0 | 5 | Inconsistent |
| | | (n = 62) | R = P | > 0 | 13 | |
| | | | R < P | > 0 | 44 | Consistent |

[1] Table relies on data generated from step 4 ("Taste preference") and step 5 ("Choice" and "Endowment" columns) of the auction procedure.
[2] The participant's choice is either the endowed cheese (if they did not bid) or the alternative cheese (if they bid).
[3] R > P indicates the participant has a sensory preference for raw (unpasteurized) over pasteurized cheese, R < P indicates a sensory preference for pasteurized cheese, and R = P indicates indifference between the two.
[4] "Consistent" represents consumers whose choice was consistent with their taste preferences, "indifferent" represents that they rated the two cheeses equal or took the endowed free cheese, "inconsistent" indicates that their choice was inconsistent with their taste preference (including participants who rated them equal but did not take the free cheese).

pasteurized cheese (60P) in the first round, regardless of the endowment (see Table 6).

Fifty-four percent of participants' choices in the first round of the auction were consistent with their taste preferences, with slightly more of these participants choosing pasteurized over unpasteurized cheese. Presumably these participants have a preference for either pasteurized or unpasteurized cheese on principle and prefer the taste of this cheese. Approximately 26% of the sample was indifferent between the two cheeses or had preferences that were not strong enough to justify bidding so they took the endowed cheese, presumably because it was free. The majority of these consumers rated the tastes equally and would have been happy with either cheese so it makes sense that they took the free one. The preferences of the remaining participants in this group were not strong enough to warrant paying more. Approximately 20% of the sample either made a choice that was inconsistent with their taste preferences or they rated the taste of the two cheeses equally but still chose to bid to switch rather than take the free cheese.

Table 7 reports the mean attitudinal scores of respondents by each of the consistency groups described above along with Analysis of Variance (ANOVA) tests of the difference in means. The average attitudinal responses of subjects who bid on unpasteurized cheese (labeled raw) compared to pasteurized cheese were not statistically different within the consistent group. This result is expected since this group likely voted based on their taste preferences. An attitudinal divide however emerges with the inconsistent group. Within this group, participants who chose the pasteurized cheese over the raw cheese were on average more agreeable with the statements "I trust that government regulations protect them adequately" and "I would like to see stronger food safety standards imposed in the US". They also prefer to take food safety into their own hands and were on average more agreeable with the statement "I checking the expiry date before purchasing". They were less likely to entrust their safety to someone else, indicating more

**Table 7**
Mean attitudinal responses by consistency group.[1]

| Description (1 = disagree; 10 = agree) | Consistent[2] | | p-value[3] | Inconsistent[4] | | p-value | Indifferent[5] | | p-value[3] |
|---|---|---|---|---|---|---|---|---|---|
| | Raw | Past | | Raw | Past | | Raw | Past | |
| I worry about the safety of the food I buy | 7.05 (2.91) | 6.28 (2.99) | 0.08 | 6.77 (3.03) | 7.61 (2.28) | 0.29 | 6.66 (3.34) | 7.28 (3.01) | 0.36 |
| I trust that government food safety regulations protect me adequately. | 4.69 (3.10) | 3.95 (2.99) | 0.08 | 3.92 (2.74) | 5.61 (2.52) | 0.02 | 5.04 (2.62) | 3.86 (2.78) | 0.04 |
| I would like to see stronger food safety standards imposed in the US. | 6.62 (2.67) | 6.28 (2.70) | 0.40 | 5.35 (2.95) | 6.89 (2.05) | 0.04 | 5.94 (2.93) | 6.40 (2.77) | 0.45 |
| I would pay more for a product with a higher than average level of food safety. | 6.81 (2.41) | 6.38 (2.39) | 0.23 | 6.17 (2.65) | 6.61 (2.48) | 0.55 | 6.62 (2.95) | 7.19 (2.28) | 0.31 |
| I check the expiry or "best before" date on food before purchasing it. | 7.98 (2.56) | 7.99 (2.46) | 0.97 | 7.21 (2.98) | 9.06 (1.30) | 0.01 | 8.74 (2.01) | 8.74 (2.11) | 1.00 |
| I throw out any food that falls on the floor while being prepared. | 4.81 (3.32) | 5.00 (3.23) | 0.70 | 4.12 (3.32) | 5.17 (2.98) | 0.24 | 5.47 (3.44) | 3.70 (3.12) | 0.01 |
| I think it is safe to drink unpasteurized milk if I know the source. | 6.83 (2.60) | 6.30 (2.94) | 0.20 | 7.81 (2.48) | 5.44 (3.15) | 0.00 | 6.72 (2.70) | 6.60 (2.90) | 0.84 |
| I usually aim to eat natural foods. | 7.80 (2.27) | 7.69 (1.95) | 0.71 | 8.69 (1.83) | 7.11 (2.49) | 0.01 | 7.53 (2.24) | 8.09 (1.64) | 0.18 |
| Number of observations | 86 | 99 | | 52 | 18 | | 47 | 43 | |

[1] Attitudinal variables are on a 10-point hedonic scale with 0 is disagreement and 10 is agreement so responses greater than 5 represent more agreement on average and less than 5 represent more disagreement on average.
[2] Consistent represents consumers whose choice was consistent with their taste preferences.
[3] P-values report ANOVA test of difference between ratings (0–10).
[4] Indifferent represents that they rated the two cheeses equal or took the endowed free cheese.
[5] Inconsistent" indicates that their choice was inconsistent with their taste preference (including participants who rated them equal but did not take the free cheese).

**Table 8**
Changes in willingness to pay (WTP) resulting from the information treatments.

| Preferred cheese:[1] | Information treatment | Bids | Change in WTP | Std. dev | Min | Max | % zero | Prob > \|z\|[2] |
|---|---|---|---|---|---|---|---|---|
| Pasteurized | Pro-pasteurization | 50 | $0.51 | 1.05 | 0 | 5 | 70% | 0.04** |
| (Bids = 149) | Pro-raw milk | 45 | $−0.25 | 0.88 | −3.5 | 2 | 71% | 0.29 |
| | Both | 54 | $0.24 | 1.09 | −2.9 | 4 | 72% | 0.60 |
| Unpasteurized | Pro-pasteurization | 57 | $0.00 | 1.01 | −2.5 | 5 | 77% | 0.70 |
| (Bids = 198) | Pro-raw milk | 63 | $0.30 | 1.26 | −5 | 4 | 60% | 0.18 |
| | Both | 78 | $0.49 | 1.43 | −3.5 | 5 | 63% | 0.05** |
| Aged | Pro-pasteurization | 103 | $−0.02 | 1.11 | −4 | 5 | 82% | 0.92 |
| (Bids = 347) | Pro-raw milk | 108 | $0.03 | 0.91 | −2 | 5 | 68% | 0.25 |
| | Both | 136 | $−0.03 | 0.93 | −4 | 3 | 78% | 0.99 |

[1] In the information treatments round, participants are endowed with the cheese they did not prefer and then given the opportunity to bid to upgrade to their preferred cheese. This table indicates how their willingness to pay for that cheese changed in response to different information treatments.
[2] Prob > |z| is the probability of the null hypothesis of no significant difference in WTP from the information treatment using a Wilcoxon rank sum test.
** Indicates significant differences at the 5% level.

agreement with the statement "I think it is safe to drink unpasteurized milk if I know the source". The participants who chose the pasteurized cheese were also less likely to agree with the statement "I usually aim to eat natural foods" suggesting a general preference towards food processing and enhanced safety.

Participants in the indifferent group who bid on either raw or pasteurized cheese were statistically similar to each other except that respondents who chose the pasteurized cheese were less likely to agree with the statement "I trust that government food safety regulations protect me adequately" and less likely to agree with the statement "I throw out any food that falls on the floor while being prepared". This suggests that participants in the indifferent group who chose pasteurized cheese were generally less concerned about food safety and bacteria than those who chose unpasteurized cheese.

### 4.3. Effect of information treatments on WTP

Table 8 reports the change in WTP for each cheese type following the information treatment in steps 7 and 8. Of the 149 participants who were endowed with the unpasteurized cheese and were invited to bid to switch to a pasteurized cheese (their preferred cheese), 50 received pro-pasteurization information, 45 received pro-raw milk information and 54 received both information treatments sequentially. As a reminder, these participants were endowed with their non-preferred cheese and were bidding to switch to their preferred cheese. The pro-pasteurization information treatment increased participant WTP for pasteurized cheese by an average of $0.51 and the pro-raw milk information decreased WTP for pasteurized cheese by $0.25. The effect of receiving both pro-pasteurization and pro-raw milk information treatments sequentially was an increase in WTP for pasteurized cheese of $0.24.

Of the 198 participants endowed with pasteurized cheese (and invited to bid to switch to unpasteurized cheese), 57 received the pro-pasteurization information treatment, 63 received pro-raw milk information and 78 received both information treatments sequentially. The pro-pasteurization information had no effect on participant WTP for unpasteurized cheese, and the pro-raw milk information increased WTP for unpasteurized cheese by $0.30, although this was not significant. However, receiving both information treatments increased WTP for unpasteurized cheese by $0.49.

Participants also received either or both information treatments before bidding on the aged cheese. 103 participants received pro-pasteurization information, 108 received pro-raw milk information, and 136 received both information treatments before bidding. There was no significant effect of any of the information treatments on WTP for aged cheese.

The minimum and maximum change in WTP ranged from negative to positive in all of the bidding scenarios except that there were no negative WTP values for participants bidding on pasteurized cheese who received pro-pasteurization information. There was a relatively high percentage of zero bids across the pasteurized, unpasteurized and aged bidding scenarios ranging from 60% to 82%, indicating that many consumers were unaffected by the information treatments. Based on Wilcoxon rank sum tests the only two scenarios where the information treatments had a significant effect on WTP were the pro-pasteurization information on WTP for pasteurized cheese and the combination of both types of information on WTP for unpasteurized cheese. Pro-pasteurization information appears to have bolstered the conviction of participants who bid on the pasteurized cheese, while receiving both types of information caused participants who were bidding on the unpasteurized cheese to bid higher. There were no categories for which an information treatment reduced consumers' WTP for their preferred cheese. These results suggest that participants exhibit a confirmation bias, i.e. they seek or interpret evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand (Nickerson, 1998).

We conducted a two-sample *t*-test of the effect of the order of the information treatment on the change in WTP in the second round of bidding. We found there was no statistical difference between the bids of participants who received the pro-pasteurization information first and those who received the pro-raw milk information first. The mean difference was $0.06 with a t-value of 0.45 indicating that the order participants received the information did not influence their WTP.

## 5. Discussion

Our findings differ from those of Colonna, Durham, and Meunier-Goddik (2011), who conducted sensory tests with pasteurized and unpasteurized pairs of numerous cheeses and found that on average more people preferred cheese made from unpasteurized milk (in blind taste tests and particularly when they were labeled). In contrast to Colonna et al. (2011), the experimental design employed here used only one type of cheese and the goal was not to isolate the differences in consumers' sensory preferences between pasteurized and unpasteurized cheese. Other studies have also found that while consumers may not detect taste differences between different processing technologies they may have distinct preferences between the technologies (Lee, Lusk, Mirosa, & Oey, 2016). Our results are consistent with Frewer, Howard, Hedderley, and Shepherd (1997), who studied consumer attitudes towards different food-processing technologies used in cheese production and found that on average participants made decisions based on process considerations rather than tangible benefits (such as animal welfare).

Consumer preference for cheese made from unpasteurized milk is not due to a lack of information or ignorance about a controversial production technology. More than half of consumers in the study made decisions based on their taste preferences, one quarter took "free" cheese, and only one fifth of consumers appear to base their decision on

whether or not the cheese was pasteurized—and most of those participants chose the unpasteurized cheese. The sensory scores were the most important determinant of choosing either a pasteurized or aged cheese. Participants were generally indifferent between the pasteurized and unpasteurized cheeses or were not willing to pay more once they received an information treatment. Consumers who indicated that they are more likely to purchase pasteurized cheese were already informed about the benefits and risks of pasteurization and consumers who indicated that they were more likely to purchase unpasteurized cheese were informed about the benefits and risks of not pasteurizing. In general, participants preferred aged cheese but they were not responsive to information about the safety aspects of aging cheese, nor did knowing that the aged cheese was unpasteurized deter them from buying it.

Consumers' attitudes about food safety are an important determinant of their decision to choose either a pasteurized or unpasteurized cheese and this difference is seemingly ideological. In our study, consumers who chose pasteurized cheese on principle (e.g. they chose the pasteurized cheese even though they rated the taste of the unpasteurized cheese higher) were more likely to trust government regulation of food safety and more interested in seeing stronger regulations. On the other hand, consumers who chose the unpasteurized cheese on principle were more likely to trust a product that was sold directly by the producer and was not regulated by the government.

In contrast to previous studies, we did not find that negative information about a controversial product decreases WTP (Fox et al., 2002). We found that consumers weigh positive information more when it supports their choice and discount negative information when it runs contrary to their choice. In other words, they are more responsive to information that provides support to the product they chose, and less responsive to information that is in opposition to the product they chose. More specifically, someone who is likely to choose pasteurized cheese is also likely to increase their WTP for pasteurized cheese after hearing of its benefits. Additionally, consumers who are likely to choose unpasteurized cheese because they feel it is of higher quality despite the potential increased risk are more interested to have both information about pasteurization and raw milk together. This suggests that these consumers were aware of the tradeoff but still chose the "riskier" product. Research that has found consumers to discount prices of controversial products or technologies after receiving negative information about it may simply be observing part of a confirmation bias related to previously held beliefs.

Consumers select information that confirms their preconceptions on the safety of pasteurization of milk used in cheesemaking, and are thus not likely to be swayed by new scientific information or a consumer education campaign. Numerous authors have framed research in terms of the acceptance of a controversial technology following new information, for example with the use of irradiation to increase the safety of meat products (DeRuiter & Dwyer, 2002; Fox, Bruhn, & Sapp, 2001; Nayga, 2003). This approach assumes that consumer demand is driven by ignorance and that education about the controversial safety procedure will lead to increased demand. In contrast, we provide evidence that decisions about food safety are based more on attitudes and ideologies related to consumers' perspectives on the food system and how it should be governed, particularly when it comes to artisan, local, and natural foods. Our findings are consistent with research in the psychology and sociology literature that find consumer risk assessment is a complex, context-specific expression of personal values (Finucane & Holup, 2005; Hansen, Holm, Frewer, Robinson, & Sandøe, 2003; Korthals, 2001; Sapp, Harrod, & Zhao, 1995).

## 6. Conclusions

Evidence suggests that the debate about the safety of unpasteurized milk products and how to regulate the safety of small scale artisan food products more broadly is not about consumer ignorance but rather about the acceptability of risk in the food system. Consumers' preferences are driven by preconceived notions or attitudes about food safety as well as taste preferences so perspectives about the debate over a food safety issue such as the safety of unpasteurized cheese are seemingly ideological. When consumers are provided with scientific information on the topic they exhibit confirmation bias, supporting the notion that preferences are ideological.

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## Appendix A. Supplementary data

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