Consumers' perceptions and tradeoffs between the safety and quality of artisan cheese

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Abstract

This paper combines hedonic analysis of retail prices of artisan cheese with analysis of experimental auction data to answer two key research questions: how do artisan cheese consumers perceive tradeoffs between safety and quality? To what extent do they perceive pasteurization and aging to be food safety attributes? Experimental auctions using a Becker-DeGroot-Marschak (BDM) auction mechanism were conducted on computer tablets with consumers at farmers markets in Michigan, New York, and Vermont. Along with the auctions, participants were asked to evaluate the sensory characteristics of multiple varieties of cheese and respond to pre-auction questions about demographics and post-auction questions about risk preferences and food safety attitudes. Retail data was also used to examine the marginal value of pasteurization and age as it is currently distinguished in the marketplace. We find that pasteurization is a food safety attribute to only a small portion of consumers and age is not a safety attribute. There does appear to be a tradeoff between safety and quality and this tradeoff is driven largely by ideological differences among consumers. There is also evidence that artisan cheese consumers appear to engage in selective exposure to information about pasteurization.

Key words

Artisan cheese, food safety, consumer demand, hedonic price analysis, experimental auctions.

Introduction

There is little consensus on the safety or risk of various food products and production processes and how to achieve a safer food system through government action or inaction. One reason for the lack of consensus is that scientists often disagree about the safety and risk involved (Millstone, 2009), illustrated by recent studies illuminating the differences of opinion on the safety of conventional versus organic food (Brandt, 2011; Smith-Spangler, 2013). Another reason is that factors such as the underreporting of illness, difficulty in traceability of outbreaks, and the changing nature of pathogens complicate the measurement of foodborne illness (Mead et al. 1999). It is also increasingly understood that decisions about the acceptability of risk in the food system involve perceptions, opinions and values as well as science (Nestle, 2003; Paxson, 2008). The lack of scientific consensus about food safety and risk, the lack of documentation on food safety outbreaks, and the range of opinions and values towards food safety make designing food safety policy particularly challenging.

The debate over whether or not the milk used in cheese making should be pasteurized is contentious. Federal regulation currently requires that cheesemakers using unpasteurized milk (also called raw milk) age the cheese for a minimum of 60 days before sale (Cheese from Unpasteurized Milk, 2011). This is not the case in Europe where there is no aging requirement for unpasteurized cheese and some of the most expensive cheeses are made from unpasteurized milk and not intended to be aged. The US Food and Drug Administration (FDA) is considering tightening restrictions on raw milk cheese by lengthening the required aging period or banning unpasteurized milk cheese altogether (Neuman, 2011; Layton, 2010; Huffstutter, 2011). This regulation would further limit artisan cheesemakers' ability to produce certain types of cheeses without pasteurizing the milk first. Pasteurization requires expensive equipment and eradicates the beneficial bacterial cultures that many artisan cheesemakers rely on for the flavor development that allows them to garner a premium in the marketplace.

The debate over the use of unpasteurized milk in cheese production has recently revived as artisan cheese consumption rises and the number of artisan cheesemakers in the US has doubled since 2000 to more than 400, seventy-five percent of whom use unpasteurized milk for at least some of their products (Roberts, 2007). The debate is part of a growing fissure between the burgeoning local food movement and the more traditional industrial food system that became apparent during the passing of the Food Safety Modernization Act of 2010 (H.R. 2751). Central to the discussion about the safety of products or processes is the role of risk assessment and the assumptions or 'framing' that is required in making assessments of risk (Millstone, 2009). Many assumptions in risk assessments reflect societal or personal values and preferences, not empirical evidence, and place weight on different dimensions of the assessment that can predetermine the outcome (Vaughan and Seifert, 1992). This is the main critique made by the artisan cheese trade group, the American Cheese Society (ACS, 2013), about a recent risk assessment of soft ripened cheese conducted by the FDA (FDA, 2012).

Given that values and preferences are so critical in defining risk and safety it is unfortunate that a rigorous treatment of them is often excluded from the policymaking process. The paper addresses two key research questions regarding the debate over the safety of cheese made from unpasteurized milk: how do artisan cheese consumers perceive tradeoffs between safety and quality? To what extent do they perceive pasteurization and aging to be food safety attributes? We explore these questions using experimental and non-experimental data. Non-experimental data such as retail prices are valuable because they reflect actual market

transactions but they are of limited utility because it is impossible to infer anything from them about the consumers and the behavior underlying the transactions. Experimental data on the other hand allow us to both create context and isolate causality. We can elicit values for real goods in a field setting to understand how much consumers would pay as well as who the consumers are and what motivates them. By combining an experimental auction with sensory experiments and a survey measuring consumer attitudes about food safety and demographics we gain a lot more insight into why the transactions occurred than we do by just looking at retail prices. The combination of both retail and experimental auction data enhances both the depth of information received and the validity of the results.

In the second section we present some relevant literature on hedonic theory and its applications for goods similar to cheese, and briefly describe the experimental literature dealing with food safety. Then in section three we discuss the estimation strategy and present the two different methodological approaches to the research questions. In the fourth section we describe the methods used and our data and in the fifth section we discuss the results of the estimations. Section six concludes.

Literature

Hedonic price theory is often credited to Lancaster (1966), who developed a framework in which utility is generated by the characteristics of goods, and Rosen et al. (1974), who described how consumers and producers interact in a framework of prices for product characteristics. Rosen et al. (1974) suggested a two-stage estimation approach where the prices of goods are regressed on the goods' attributes in the first stage and then the marginal prices of each attribute in the "bundles" actually purchased by consumers are regressed onto the characteristics of the good along with consumer demographics and other demand variables in the second stage. In the first stage, differentiation of the hedonic price function with respect to a particular attribute yields the marginal implicit price of that attribute. The second stage allows for identification of willingness to pay (WTP) by relating the consumer demographic information back to the estimates of the marginal prices of the attributes. Follain and Jimenez (1985) and Witte et al. (1979) estimate the demand for housing characteristics from such multi-stage models.

Later research identified a simultaneity problem with the two-stage approach since consumers likely purchase goods that were higher in their preferred characteristic (Brown and Rosen, 1982). Numerous authors ignore the second stage since they are not interested in estimating consumer demand; they only estimate the marginal implicit prices of attributes from the first stage. Others have developed ways to avoid the simultaneity problem, such as Bajari et al. (2005) who take a semi-parametric approach to the second stage. Another alternative requires experimental data where purchases can be matched with actual consumers as per Melton et al. (1996). Melton used an experimental design to isolate the value of various attributes of a food product by varying the attributes present in each treatment across subjects. This approach does not require individually estimated price and quantity equations as in the two-stage approach but rather incorporates the demand shifters in the first stage estimation.

We take a traditional hedonic approach to estimate the marginal value of attributes that are related to the safety of artisan cheese (aging and pasteurization), as well as an experimental approach to estimating the WTP for these attributes. We estimate the first stage of a traditional hedonic price analysis using artisan cheese retail price data with a wide variety of attributes. Then we follow the example of Melton et al. (1996) in analyzing experimental auction bids in a hedonic framework in order to isolate the value of the cheese attributes (pasteurization and age)

as well as the underlying characteristics of the participants in the auctions that one typically gets from Rosen's second stage. We also explicitly look at consumers' choices of pasteurized and aged cheese and examine the relationship of these choices to their hedonic ratings (sensory scores of each cheese) and attitudes about risk to gainer a deeper understanding of the tradeoff between safety and quality.

Melton's work is situated within a broader literature that uses experimental auctions to estimate demand for food product attributes. Many of these studies use multiple methodological approaches for cross comparison of the value of the attribute estimated from experimental auction data. For example, there are studies that investigate the link between sensory evaluations and auction bids by comparing objective measurements of a product attribute with subjects' bids or evaluations and find that the bids and evaluations are increasing in that attribute (e.g. Lusk et al., 2001; Feuz et al., 2004; and Platter et al. 2005). Other studies compare auction bids with hedonic ratings for an attribute and find that subjects bid more for products they think have that attribute (e.g. Umberger and Feuz, 2004; Melton et al. 1996; Platter et al., 2005). Still other studies compare experimental auction bids with hedonic ratings for an attribute through post-auction surveys (Lusk, 2001; Lusk et al., 2006) or with risk tolerance by constructing an index based on answers to questions about risk (Brown et al., 2005).

In the next section we look at applications of hedonic price models and outline models for the retail price data and the experimental data.

Estimation Strategy

Applications of hedonic analysis can be relatively straightforward with durable goods characterized by highly differentiated and easily defined attributes such as homes or cars (Court, 1939; Grilliches, 1961). Application of hedonic theory to non-durable food goods such as wine or coffee is increasingly common although measures of quality are more subjective in food products (Combris et al., 2003; Benfratelloa et al., 2009, Teuber et al., 2012). Hedonic analysis has also been extended to explore less orthodox attributes of food products such as the value of origin denomination (Teuber et al., 2012) and the value of the physical characteristics of vineyards (Cross et al., 2012). We construct a hedonic price model of artisan cheese by looking at how wine, a product with similar characteristics, has been modeled in the literature.

Benfratelloa et al. (2009) identify three categories of attributes that generally appear in the specification of hedonic functions of wine price. The first category includes *objective characteristics* such as the wine vintage, denomination, region, or grape variety, which usually appear on the label and are therefore easy for consumers to identify. The other two categories identified by Benfratelloa et al. (2009) involve quality, which is not easy to evaluate objectively with wine. *Sensorial quality* is measured through sensory evaluation such as the wine's aroma, finish and harmony of components, which experts say determine the wine's price. Wine buying guides sometimes publish sensory ratings but they do not represent a random sample of wines and are written and evaluated by a limited number of evaluators who may be biased in personal preferences (Castriota et al. 2012). Combris et al. (2003) compare predictions of quality ratings from a jury of evaluators and prices of wines from both sensory and objective characteristics and find that quality is mainly defined by the sensory characteristics of a wine whereas price is better predicted with objective characteristics. The other quality-related category identified by Benfratelloa et al. is the *reputation* of the wines, which conveys quality information to the consumer. Landon and Smith (1997) differentiate the individual reputation of a wine (specific

maker and vintage) from the collective reputation (membership in an appellation) and find that ignoring reputation can overstate the impact of quality on market price.

According to standard hedonic theory a basic model for artisan cheese prices would have the price of cheese P_c determined by the three categories of characteristics described by Benfratelloa et al. (2009):

$$(1) \qquad P_c = f(O_c, S_c, R_c)$$

where cheese attributes are classified as objective (O_c), sensory (S_c), or reputation (R_c). Objective characteristics are relatively straightforward to identify for artisan cheese since these attributes become a selling point for producers and are often readily available on labels. Basic objective characteristics of artisan cheese include the region or production location, milk type, style of cheese (including bacterial cultures and rind type), size of the cheese wheel, age of the cheese, and whether or not the cheese was pasteurized.

Sensory characteristics are more difficult to capture with cheese in the absence of a buying guide or a unique panel of expert jurist ratings as per Combris et al. (2003). The lack of this information on quality suggests that quality is not as well defined for cheese as it appears to be for wine. Defining cheese quality becomes a significant estimation challenge.

Public awards received at exhibitions or contests enhance reputation among artisan cheese producers. The most prominent awards for American cheese producers come from the American Cheese Society (ACS) in the US and the World Cheese Awards covering Europe and US. Another indicator of quality, limited to Europe, is participation in a protected designation of origin (PDO) such as AOC in France, DOC in Italy, which indicates not only the region it was produced in but also requires that a producer meets certain animal, production, and safety standards. This reputation information tends to be readily available to consumers who are interested, often on the label.

Given the nature of the market for cheese and the information available, two distinct approaches emerge to estimate the value consumers place on age and pasteurization, each with different data requirements. One approach is to estimate a hedonic model based on retail price data to predict cheese price as a function of a wide variety of objective attributes (including pasteurization and aging time) and reputation (as defined by individual and collective public awards received) across a wide variety of cheeses. This approach does not capture any measure of sensory quality but has high validity in that it uses objective characteristics from a large volume of actual market transactions. A second approach relies on data generated in an experimental setting where consumers bid on and submit sensory ratings for a small number of cheeses that differ only in the objective attributes we are interested in. With the latter approach we can estimate consumer WTP for cheese as a function of the marginal prices of a limited number of attributes of interest (pasteurization and age), the consumer perception of the quality of the cheese, and the underlying demographic characteristics of the consumers.

Hedonic analysis of retail price data

First we apply the basic Rosen (1974) hedonic model to describe the price of artisan cheese, a heterogeneous good with multiple differentiated characteristics. Theory has little to say about the functional form of the hedonic model and various authors have explored the goodness of model fit with mixed results. The following basic model, attributes, and attribute levels is used:

(2) $P_i = \alpha v_i + \beta w_i + \delta x_i + \varepsilon_i$

where: P_i is the price of cheese *i*; v_i is a vector of dichotomous objective characteristics of cheese including a pasteurization dummy variable, a vector of milk type (4 levels including cow, goat, sheep, mixed), the origin of the cheese (grouped either by state or region), the style of cheese (blue, bloomy, washed rind, etc.) and the texture of cheese (soft, semi-soft, soft-ripened, and semi-hard); w_i is a vector of continuous objective characteristics including the age of the cheese in days and the average weight of the wheel of cheese in pounds; x_i is a vector of dichotomous variables that indicate the reputation of the cheese; α, β, and δ are parameter vectors to be estimated; and ε_i is a random error term. With a quality-differentiated product, price is derived as the sum of the marginal utilities of its contributed attributes. We can obtain the marginal utility of each attribute by taking the partial derivative of equation (2) with respect to each attribute.

There are two potential problems in the above model specification. The first is that we are most interested in the marginal value of pasteurization and age but since it is currently illegal in the US to produce unpasteurized cheese that is less than 60 days old, we only observe pasteurized cheese in this category. We have included interaction terms to capture the effect of cheeses that fall into this category. A second problem is the strong correlation between independent variables in the model that are related to age. Typically aged or 'mature' cheese tends to be more expensive since flavors develop over time and the cheese maker accrues storage and maintenance costs while the cheese is aging (common with cheddar). However, there are several expensive young or fresh cheeses (less than 60 days old) that are considered artisan, in the sense that they have very small (about 4 ounces), unique forms and are aged and handled very carefully to promote vigorous bacterial growth in a short period of time. Other cheeses have very specific windows of aging and cannot withstand aging beyond about 60 days for white mold or 90 days for blue mold cheeses. The aging time is also correlated with the size of the cheese and the texture. A larger cheese takes longer to ripen and tends to be harder because it loses more moisture during the longer aging time. These interactions are discussed in more detail in the analysis section.

Hedonic price analysis of experimental auction data

A hedonic price model of experimental auction bids is set up as per Melton et al. (1996). The objective characteristics used in the experimental auction model are derived from specific comparisons of two characteristics isolated in the experiment: whether the milk was pasteurized and how long it was aged. Due to the small number of cheeses used we cannot determine the marginal value of the other objective attributes of the cheese as in the hedonic model of retail prices; instead we rely on consumers' sensory ratings and demographic characteristics to predict consumer WTP.

This model has two parts. First we want to predict whether or not a consumer would choose the cheese based on the attribute of interest versus a cheese that does not have that attribute. The probability of the participant choosing to bid on a cheese with a specific attribute (either pasteurized or aged) as opposed to taking the cheese they were endowed with that does not have that attribute is modeled using a logistic specification. Second, we model participants' willingness to pay for cheese as a function of the attributes of interest and the same factors used in the logistic model. Intuition led us to reject a model of WTP as conditional on the decision to

select the endowed cheese or bid (as in Cragg's (1971) double hurdle model). The logistic estimation of consumer choice follows the description of the hedonic model of WTP below.

The hedonic model of auction bids includes a vector of preferences for sensory characteristics continuously measured on a Likert scale ranging from 0 to 10. Unlike Combris et al. (2000; 2003), the sensory data come from consumers who participated in auctions and not from expert panels. Thus, the sensory data reflects personal preferences. Equation (3) is a hedonic price equation that explains the auction bids as follows:

$$(3) \qquad WTP_{ij} = \alpha v_{ij} + + \gamma z_{ij} + \beta w_{ij} + \partial x_{ij} + \varepsilon_i$$

where WTP_{ij} is the willingness to pay for cheese *i* by person *j*; v_i is a vector of objective attributes (including pasteurization and age); z_{ji} is a vector of sensory attributes (taste, visual, texture); and w_{ij} is a vector of socio-demographic characteristics; x is a vector of attitudinal characteristics (about risk and food safety); and α, β, and γ are parameter vectors to be estimated; and ε_i is a random error term.

We obtain three results from this portion of the analysis. First, we can examine the relationship of the two objective attributes of interest to individual bid prices. While the two models presented draw on different types of information we would still expect to see the same signs and relative importance assigned to the attributes of interest. Second, we can explore whether consumers' behavior in the auctions matches their sensory scores as per Noussair et al. (2004). Including sensory scores in the estimation allows us to explore the relative importance of sensory qualities in explaining artisan cheese prices. Third, we can examine the effects that characteristics of consumers and their households have on individual bid prices.

Methods

Data sources

As described above the analysis relies on two data sources. The data used in the hedonic analysis of retail prices comes from two online artisan cheese retailers. Along with the prices of cheeses we record the basic objective characteristics (pasteurization status, age, milk type, style, etc.) and whether the cheese or cheesemaker has won any awards. If we cannot ascertain the requisite information directly from the distributor's website we go to the retailer's website. All cheeses sold by the retailers are included in the sample with the exception of processed cheese products (such as spreadable cheeses, butter, etc.).

The hedonic model of experimental auction bids relies on sensory experiments, experimental auctions, and a short demographic survey with consumers at farmers' markets in multiple locations in Michigan, New York and Vermont. A description of the participants included in the sample and details of the experimental auction procedure follow.

Sample

Since we are only interested in consumers affected by regulation of artisan cheese our target population included only artisan cheese consumers. We conducted the experiments "in the

field" to reduce sample selection bias since participants are intercepted rather than self-selected (Harrison and List, 2004). We chose three states that represent different cultures of cheese making in a nascent, intermediate and more developed 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 locations 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 in Ann Arbor (2 day markets and 2 evening markets), Lansing (2 day markets), Grand Rapids (1 day), and Bath (1 day). In New York we conducted auctions in Ithaca (1 day and 1 evening market), Troy (1 day and 1 evening), Albany (1 day), Schenectady (1 day). In Vermont we conducted auctions at Burlington (2 days), Brattleboro (2 days), and Manchester (1 day). The auctions varied in hours of operation from 3 to 6 hours in length and in the density of pedestrian traffic. The total number of participants in the research across all locations was 347.

Auction procedure

A table was set up at each location during market hours 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 ten steps with every participant and is illustrated in appendix 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 minutes and would be compensated $5 and a ½ lb of cheese (approximately a $7 value) for participating in the auction.

In step 2, participants answered a series of questions concerning their basic demographic data, cheese consumption habits, and the frequency of purchasing cheese made from unpasteurized milk.

Step 3 was a non-binding practice round to introduce participants to the Becker-DeGroot-Marschak (BDM) auction mechanism (Becker et al., 1964). In the 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. (2004) 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 us to conduct the auction in the field with a single participant thus incorporating the participant's heuristics and the effect of the market experience (Lusk and Shogren, 2007).

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). Instructions on the tablet informed the participants that they were endowed

with ½ 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 Shogren et al. (1994) and Lusk et al. (2005). If a participant accepted the endowed cheese, we refer to them as having chosen that cheese, and if they bid on the alternative cheese then that is the one they chose. 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.

The endow-and-upgrade approach is advantageous in this context for multiple reasons despite an ongoing debate about the presence of an endowment effect, i.e. that people become attached to a good if they perceive that they own it (Hanemann et al., 1991; Shogren et al., 1999; Corrigan and Rousu, 2006; Plott and Zeiler, 2011). Upgrading directs participant attention away from field substitutes (in this case a field substitute would be a similar cheese available by a vendor at the market) and focuses attention on the marginal difference between the attributes of interest. Endowing participants also minimizes uncertainty and information effects such as the option value problem, where people expect to gather more information in the future about the value of the goods (Corrigan, 2005). We split the participation fee into cash and a cheese endowment; the cheese endowment generates interest in the auction since the subject will leave with the good either way (Lusk and Shogren, 2007) and the relatively small amount of cash allows us to avoid a house money effect, i.e. that people bid more because they are not using their own money (List and Rondeau, 2003).

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 all organic Vermont cheddar cheese made by the same cheesemaker and only differed in the date they were processed (60 or 90 days old) and whether or not they were pasteurized. Participants were asked to blindly evaluate the sensory attributes of the three cheeses using a marked scale. They were instructed to rate the visual, olfactory, and taste attributes of each cheese on a 0-10 scale.

In step 5, participants were presented with two cheese samples aged approximately 60 days and identical except that one was pasteurized and one was not. The cheeses were identified 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. 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 that answered "sometimes" or "often" were endowed with pasteurized cheese (step 5b). Participants were then given the opportunity to "upgrade" to the cheese they were not endowed with.

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.

Results and Discussion

Hedonic analysis of retail price data

The mean retail price of 227 cheeses sold by two of the largest online retailers is $24.29/lb (table 1, column 1). The mean price of the unpasteurized cheese is approximately $2 more per pound than pasteurized cheese and the difference is statistically significant. For comparison we also present the same estimation after removing cheeses that are aged less than 60 days since most of these are expensive specialty cheeses that in the US can only be produced with pasteurized cheese according to the current federal law. When we compare all cheeses that are aged more than 60 days we are left with a similar number of cheeses in each group and the premium for unpasteurized cheese widens to almost $6 per pound (table 1, column 2).

Table 1. Descriptive statistics of retail prices (per pound) by pasteurization status.

	All observations			**Aged > 60 days only**		
	Mean	**St.dev**	**N**	**Mean**	**St.dev**	**N**
Unpasteurized	$25.54	6.43	82	$25.54	6.43	82
Pasteurized	$23.59	10.95	145	$19.45	7.43	86
Total	**$24.29**	**9.60**	**227**	**$22.42**	**7.58**	**168**
Mann-Whitney[†]	*Prob > |z| = 0.0141*			*Prob > |z| = 0.0000*		

[†]Note: P-value for a two-sample Wilcoxon rank-sum (Mann-Whitney) test of equivalency between the price of pasteurized and unpasteurized cheese

Next we turn to hedonic price estimation to look at the marginal values of all the attributes simultaneously. When we control for the objective characteristics described above using hedonic price analysis we are able to disaggregate the values more clearly. We identified the main attributes of the cheeses and included them as predictors of price using ordinary least squares (OLS) regression.

In a linear hedonic regression, the coefficients represent the marginal value (in dollars) estimated for each attribute. The attributes include: texture (fresh, soft, semi-soft, semi-hard, hard), milk type (cow, sheep, goat, mixed milk), rind type (bloomy rind, washed rind, washed rind, natural rind, waxed, and clothbound) processing style (cheddar), bacterial cultures (blue), added flavoring (herbs or smoked), and rennet type (animal or microbial). Other independent variables include the length of time the cheese was aged (in months), weight (in pounds), and whether it was pasteurized (dummy variable). A dummy variable is used to indicate whether the cheese ever received an award from the American Cheese Society (ACS) annual competition. Experimental variables include the source of the online data and a random effects component to account for multiple cheeses from a single manufacturer.

When we include each attribute in the regression individually, the cheese style variables are marginally significant with relatively large coefficients. Using a correlation matrix of all the individual attributes and intuition about which attributes tend to occur together we created interaction terms in order to reduce the number of insignificant variables in the regression, reduce collinearity between texture and style, and better characterize the price of artisan cheese. For example, a bloomy rind cheese is generally a soft cheese that is aged for less than 60 days and is required by law to be pasteurized so we interacted bloomy, soft, and pasteurized. Blue cheese wheels are typically semisoft cheeses so an interaction between blue and semisoft is included. Cheddar is almost always considered a semi-hard cheese and clothbound cheeses are always cheddar. Washed rind cheeses can be any texture. The results of this estimation are presented in Table 2.

Table 2. Marginal values of cheese attributes from hedonic estimate of retail prices

variable	Coef.	Std.	t
Past/bloomy/soft	6.07***	(1.70)	3.56
Blue/semi-soft	4.93***	(2.04)	2.42
Cheddar/semi-hard	-0.02	(1.81)	-0.01
Cloth/cheddar	7.52	(4.57)	1.65
Washed rind	4.38***	(1.86)	2.35
Natural rind	3.33**	(1.75)	1.90
Waxed rind	-0.36	(2.26)	-0.16
Flavors added	3.43***	(1.49)	2.31
Goat milk	8.71	(1.50)	5.80
Mixed milk	-2.25	(2.64)	-0.85
Sheep milk	9.86***	(2.19)	4.51
Pasteurized	-4.19***	(1.40)	-2.98
Age (in months)	0.15***	(0.05)	2.98
Microbial rennet	2.14	(1.39)	1.53
Weight (in pounds)	-0.14***	(0.06)	-2.23
Awards (dummy)	0.67	(1.25)	0.54
Murrays	6.75***	(1.67)	4.03
Constant	18.67***	(2.01)	9.29
R-squared	0.45		
Observations	215		

Notes: The same model with a random effects component for the cheese maker (89 cheese makers in the sample) yields almost identical results (not shown). ** indicates significance at the 5% level, and *** indicates significance at the 1% level. The dependent variable is price per pound. Estimates using OLS with interaction effects.

Most of the interactions are significant compared to cheeses that do not have these attributes. In other words, we have attempted to capture as much of the heterogeneity of the cheeses as possible but attributes that were not easily characterized fall into the constant. Pasteurized bloomy rind soft cheeses and clothbound cheddars are two of the most lucrative combinations at about $6 and $7/pound more than a cheese without these attributes. Blue cheese (which is usually semi-soft) and washed rind cheese both sell for about $4 more than an average cheese. Cheese flavored with herbs or smoked sells for about $3 more than a similar non-flavored counterpart. Milk type variables are significant and large with goat and sheep milk cheeses selling for more than cow milk by about $4/lb. This result is reasonably expected because the milk from the smaller ruminants tends to be higher in fat and is more expensive per gallon. After controlling for other variables, pasteurized cheese sells for $4.19/pound less than unpasteurized cheese on average. The age of cheese (in months) is positive and equal to about $0.15/pound/month or about $1.80/pound/per year. Cheese weight is negative implying that smaller cheeses tend to be more expensive on a per pound basis. The retailer dummy is significant and large since one retailer tends to sell cheeses at approximately $6/pound more than the other.

The hedonic analysis of artisan cheese retail prices shows that in the current market there is no evidence that consumers pay more for pasteurization as a food safety attribute. On the

contrary the marginal value is negative and significant for pasteurized cheese (about $4- 5 less per pound), suggesting that consumers place a higher value on unpasteurized cheese. Either consumers do not believe pasteurization is safer, are unaware that the FDA considers pasteurization to be safer, or believe it may be safer but value another attribute (such as the taste) more than pasteurization. Consumers do pay more for aged cheese, but since age is a signal of quality in terms of both taste and safety, from retail prices we cannot determine whether consumers who pay more for aged cheese do so because it is safer or because it tastes better. We explore this question in the experimental portion of the research.

Hedonic analysis of experimental auction bids

Descriptive statistics of participants

Table 3 summarizes the descriptive statistics for selected demographic variables. One hundred fifty-three, 98, and 96 consumers from farmers markets in Michigan, New York, and Vermont, respectively participated in experimental auctions for a total of n=347 participants. The sample was approximately 36% female with an average age of 43. The highest level of education attained by 10% of the sample was high school, the highest level of education attained by 52% of the sample was a college degree, and 38% attained postgraduate education. This sample was more educated than the average American where high school was the highest level of education for 47.07% of the population and 30.9% attained a college degree or higher (United States Census Bureau, 2012a). The distribution of reported household income in our sample was relatively similar to the overall US population albeit with fewer participants from the highest income households. Across the US approximately 32% of households have income less than $30,000, 40% have income between $30,000 and $80,000 and 28% have income more than $80,000 (United States Census Bureau, 2012b). There were two slight differences between New York and Vermont which balanced each other out overall: in New York fewer participants than average were in the $30,000 to $80,000/year category and in Vermont slightly more than average fell into the less than $30,000/year category. Approximately 25% of the sample had children and 80% of participants considered themselves the primary shopper in the household.

Participants reported consuming an average of about two pounds of cheese in their household in the last two weeks and 86% of consumers reported consuming artisan cheese in the last two weeks overall. Approximately 27% of all the cheese reportedly consumed by participants in the last week was artisan cheese. The majority of participants consume cheese made from unpasteurized milk: 43% “sometimes” purchase it and 14% “often” purchase it. Thirty-four percent of participants answered “I don’t know” and 9% never purchase it.

Table 3. Descriptive statistics and definitions of demographic variables

Variable	Definition	All	MI	NY	VT
Gender	1 if individual is male; 0 if	0.36	0.37	0.37	0.34

	individual is female	(0.48)	(0.48)	(0.48)	(0.48)
Age	Age in years	42.94	43.77	43.56	41.01
		(16.55)	(17.89)	(15.1)	(15.78)
Education	High school	10%	11%	9%	10%
	College	52%	53%	54%	47%
	Post graduate	38%	35%	37%	43%
Income	<$30,000	26%	27%	14%	33%
	$30,000 to 80,000	34%	33%	43%	23%
	>$80,000	29%	25%	31%	28%
	Prefer not to answer	11%	15%	7%	9%
Children	1 if children under 16 are living at home; 0 otherwise	0.25	0.26	0.26	0.23
		(0.43)	(0.44)	(0.44)	(0.42)
Primary shopper	1 if individual is primary shopper in household; 0 otherwise	0.8	0.83	0.75	0.8
		(0.4)	(0.4)	(0.44)	(0.41)
Pounds	Cheese consumption in pounds in the last 2 weeks	1.96	1.92	2.12	1.85
		(1.72)	(1.47)	(2.45)	(1.02)
Artisan	1 if individual consumes artisan cheese; 0 otherwise	0.86	0.84	0.97	0.78
		(0.35)	(0.37)	(0.17)	(0.42)
% Artisan	% of cheese consumption that is artisan	26.86	26.22	28.78	25.92
		(25.63)	(26.63)	(22.37)	(27.28)
Unpasteurized cheese	Never purchase	9%	9%	9%	10%
	Sometimes purchase	43%	39%	43%	50%
	Often purchase	14%	13%	13%	17%
	Don't know	34%	40%	35%	23%
Food poisoning	1 if individual has had food poisoning; 0 don't know or no	0.57	0.63	0.52	0.54
		(0.50)	(0.49)	(0.50)	(0.50)
Observations		347	153	98	96

Notes: Mean value is reported except when there is a percentage. Standard deviations are in parentheses.

We also calculated the percentage of participants in each state who were local residents based on the zip codes provided. In Michigan, 97% of those surveyed were Michigan residents, in New York 82% of participants were New York residents, and in Vermont only 65% of participants were Vermont residents. The demographics in Vermont appear to be influenced by a transient tourist or student population while the participants at farmers markets in Michigan were almost all local residents. The average participant in Vermont was younger, more educated, had lower income, consumed less cheese and less artisan cheese in particular but was more likely to consume cheese made from unpasteurized milk. In the analysis that follows we control for any differences in demographics but in general find that they have little influence on WTP.

Sensory evaluations

Participants were instructed to rate the sensory characteristics: visual, olfactory, and taste,

on a scale from 0 (labeled dislike) to 10 (labeled like). The default on each scale was set to 5, which was labeled as neutral to participants.

First we look at means comparisons between the three states (Michigan, New York, and Vermont) and then within the three cheeses (60R, 60P, 90R). One-way ANOVA comparison of multiple means determined that there was no statistical difference in the visual or olfactory ratings across the states. With respect to taste there was a difference in ratings between consumers in Michigan and the other two states. Between Michigan and New York there was a difference of -0.39 at the 3% confidence level and between Michigan and Vermont there was a difference of -0.50 at less than 1% confidence. There was no statistical difference between New York and Vermont however.

Table 4. Summary of sensory ratings

All States	**Visual**	**Olfactory**	**Taste**
Unpasteurized 60-day	6.96	6.09[a]	6.18[a]
	(1.95)	(1.99)	(2.23)
Pasteurized 60-day	6.72	6.10[a]	6.41[a]
	(1.84)	(1.75)	(2.06)
Unpasteurized 90-day	6.94	6.54[b]	7.08[b]
	(1.93)	(1.85)	(1.94)
Michigan	**Visual**	**Olfactory**	**Taste**
Unpasteurized 60-day	7.01	6.09	6.58[a]
	(1.96)	(2.08)	(2.26)
Pasteurized 60-day	6.75	6.14	6.59[a]
	(1.85)	(1.82)	(2.21)
Unpasteurized 90-day	6.94	6.53	7.25[b]
	(1.96)	(1.89)	(2.05)
New York	**Visual**	**Olfactory**	**Taste**
Unpasteurized 60-day	6.89	6.06	5.95[a]
	(1.96)	(2.08)	(2.19)
Pasteurized 60-day	6.76	6.12	6.28
	(1.85)	(1.71)	(2.01)
Unpasteurized 90-day	6.78	6.54	7.02[b]
	(1.99)	(1.88)	(1.98)
Vermont	**Visual**	**Olfactory**	**Taste**
Unpasteurized 60-day	6.95	6.10	5.80[a]
	(1.95)	(1.74)	(2.13)
Pasteurized 60-day	6.65	6.03	6.26
	(1.82)	(1.71)	(1.84)
Unpasteurized 90-day	7.09	6.57	6.85[b]
	(1.82)	(1.80)	(1.70)

Note: Ratings are based on a scale of one to ten with ten being the highest and five neutral. Standard deviations are in parenthesis. If two mean ratings within a state for a given cheese treatment have the same letter they are not statistically different. If they have different letters then the Bonferroni-adjusted significance of the difference between the three cheese varieties is 5% or better in that state. If there are no letters there is no statistical difference.

The difference in the visual ratings between the three cheeses for participants in all states was not significant at a conventional level but the two unpasteurized cheeses had somewhat higher visual ratings, possibly because of the more natural knitted curd appearance that is lost

with pasteurization (via homogenization). There was no significant difference between the olfactory ratings of the unpasteurized 60-day cheese and the pasteurized 60-day cheese but there was between each of those two cheeses and the unpasteurized 90-day aged cheese (indicated by the superscripted letters in table 4). The higher ratings on the olfactory and taste characteristics of the aged cheese make sense since these qualities tend to improve as a cheese ages. In Michigan there were differences in the taste ratings between the two younger cheeses and the 90-day aged cheese as in the aggregated data. In New York and Vermont the only statistical difference was that the taste of the unpasteurized 60-day cheese was rated statistically lower than the unpasteurized 90-day cheese.

From these ratings we conclude that the average artisan cheese consumer cannot detect a taste difference between a pasteurized and an unpasteurized cheese but can detect a difference related to aging the cheese. These findings differ from Colonna et al. (2011) who conducted sensory tests with pasteurized and unpasteurized versions of numerous cheeses and found that more people preferred cheese made from unpasteurized milk cheese on average (in blind taste tests and particularly when they were labeled). The experiment used in this paper 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. A more appropriate experimental design for that research question would involve multiple varieties of cheese as per Colonna et al. (2011). We chose a cheddar cheese in this experiment for broad consumer appeal but the flavor differences would be expected to be a little less dramatic with a variety like cheddar, which is typically sold as an aged cheese. A professional sensory analyst suggested that the pasteurized cheese used in this research had superior mouthfeel likely caused by the homogenization of the milk that occurs during pasteurization which gives it a more uniform texture that is now more mainstream due to the prevalence of pasteurization.

Attitudes about food safety

We asked a series of questions to gauge consumers' perceptions of safety and risk as it relates to food and the responses are reported in table 5. Other authors have found that attitudes towards technology, nature and food affect individuals' perceptions of the benefits and risks of production technologies like genetic modification (Bredahl, 2001).

On average the artisan cheese consumers who participated in the study worry about food safety. They don't particularly trust that government food safety regulations protect them but they would like to see stronger food safety regulations imposed. This suggests there may be some debate about exactly what stronger regulations would entail and what food safety means to participants. Subjects say they would pay more for a product with higher food safety. Participants appear to be very concerned about expiration dates despite the inconsistency and lack of regulation governing the use of expiry dates. Overall, subjects were neutral about food that falls on the floor while being prepared but notably there was wide variation in these responses, suggesting that some participants do and some do not. On average participants think it is safe to drink unpasteurized milk if they know the source and presumably those that chose the unpasteurized cheese were more likely to agree with this statement. On average participants in the study indicated that they aim to eat natural foods. Presumably the differences in the attitudes of participants about food safety can help explain their choice between pasteurized and unpasteurized cheese. We explore the responses to these attitudinal questions and other determinants of choosing a pasteurized or aged cheese in the next section.

Table 5. Summary statistics and definitions of attitudinal variables

Variable	Description (1=disagree; 10=agree)	Mean (SD)
worry	I worry about the safety of the food I buy	6.79 (2.99)
trust_gov	I trust that government food safety regulations protect me adequately.	4.35 (2.82)
standards	I would like to see stronger food safety standards imposed in the US.	6.22 (2.75)
pay more	I would pay more for a product with a higher than average level of food safety.	6.60 (2.75)
expiration	I check the expiry or "best before" date on food before purchasing it.	8.12 (2.48)
floor	I throw out any food that falls on the floor while being prepared.	4.91 (4.73)
raw milk	I think it is safe to drink unpasteurized milk if I know the source.	6.71 (2.80)
natural	I usually aim to eat natural foods.	7.87 (2.07)

Determinants of choosing unpasteurized cheese and aged cheese

In this section we look at the determinants of a) the probability that a consumer chose the unpasteurized cheese over the pasteurized cheese in the first round and b) the probability that a consumer chose the unpasteurized aged cheese over the unpasteurized unaged cheese in round 2. To do this we estimate logistic regressions with the dependent variable as the cheese that was chosen in each round, even in cases where the endowed cheese was chosen and the bid was zero.

In round 1, the odds of whether a participant chooses unpasteurized over pasteurized are largely based on sensory ratings of the cheese and consumer attitudes about food safety. The higher participants rated the smell and taste of the unpasteurized cheese (and the lower they rated the smell and taste of the pasteurized cheese), the more likely they were to choose the pasteurized cheese. Responses to a number of the questions designed to gauge consumers' attitudes about food safety had statistically significant coefficients. Participants who want stronger food safety standards imposed in the US were more likely to choose the pasteurized cheese. Participants that check expiry dates before purchasing food are less likely to purchase unpasteurized cheese. Participants that would consume raw milk if they knew the source are less likely to choose the pasteurized cheese.

Participants endowed with pasteurized cheese were more likely to choose pasteurized cheese, supporting the notion that many consumers took the endowed cheese because it was free. We also included a dummy variable for whether participants' taste preferences were consistent with their choices in the pasteurization round. We found that those whose choice was inconsistent with their taste preference were less likely to choose the pasteurized cheese, implying that advocates of raw milk cheese chose it simply because the cheese was identified as unpasteurized. Finally, participants who participated in the study in Vermont and New York were more likely to choose pasteurized cheese than those in Michigan.

Table 6. Logistic regression of the odds of choosing a pasteurized or aged cheese

	Pasteurized		Aged		
variables	Coef.	Std. Err	Coef.	Std. Err	variables
Demographic variables					
Gender	0.22	(0.31)	0.41	(0.35)	Gender
Age (in years)	0.00	(0.01)	-0.01	(0.01)	Age (in years)
Income (>80,000)	0.21	(0.43)	0.53	(0.48)	Income (>80,000)
Income (30-80,000)	-0.09	(0.41)	0.37	(0.45)	Income (30-80,000)
Income (not reported)	0.87	(0.55)	0.31	(0.60)	Income (not reported)
College graduate	0.60	(0.50)	1.20**	(0.54)	College graduate
Post graduate	0.98	(0.55)	1.88***	(0.62)	Post graduate
Children (dummy)	0.00	(0.17)	0.11	(0.19)	Children (dummy)
Primary shopper	0.12	(0.40)	-0.48	(0.43)	Primary shopper
Cheese consumed (lbs)	-0.02	(0.09)	0.14	(0.08)	Cheese consumed (lbs)
Artisan (percent)	0.00	(0.01)	0.00	(0.01)	Artisan (percent)
Sensory variables					
R60_visual	-0.10	(0.12)	-0.05	(0.14)	R60_visual
R60_smell	-0.26***	(0.10)	-0.38***	(0.12)	R60_smell
R60_taste	-0.60***	(0.11)	-0.82***	(0.12)	R60_taste
P60_visual	0.10	(0.14)	-0.12	(0.15)	R90_visual
P60_smell	0.22	(0.12)	0.33***	(0.14)	R90_smell
P60_taste	0.60***	(0.11)	1.08***	(0.15)	R90_taste
Attitudinal variables					
worry	-0.01	(0.06)	0.13**	(0.06)	worry
trust_gov	-0.03	(0.05)	0.07	(0.06)	trust_gov
stronger_standards	0.15***	(0.07)	-0.01	(0.07)	stronger_standards
pay_more	-0.07	(0.08)	-0.11	(0.08)	pay_more
expirydate	0.15***	(0.06)	-0.08	(0.07)	expirydate
floor	-0.07	(0.05)	-0.04	(0.06)	floor
raw_milk	-0.11**	(0.05)	-0.01	(0.06)	raw_milk
natural	-0.10	(0.07)	0.10	(0.09)	natural
Other variables					
Food poisoning	0.30	(0.29)	0.28	(0.33)	Food poisoning
Endowment (dummy)	0.92***	(0.32)	0.37	(0.34)	Endowment (dummy)
Inconsistent choice	-1.49***	(0.43)	--	--	
Consistent choice	0.18	(0.33)	--	--	
Vermont	0.74**	(0.34)	-0.11	(0.37)	Vermont
New York	0.76**	(0.34)	-0.06	(0.39)	New York
Constant	-1.97	(1.17)	-2.66**	(1.29)	Constant
Pseudo R-squared	0.2978			0.3823	Pseudo R-squared

Notes: ** indicated significance at the 5% level, and *** indicates significance at the 1% level. Pasteurized is the choice between U60 (unpasteurized aged for 60 days) and P60 (pasteurized aged for 60 days) and aged is the choice between U60 and U90 (unpasteurized aged for 90 days). Inconsistent choice and consistent choice were omitted from the "Aged" regression because the unaged cheese was the endowed cheese every time so "inconsistent" was determined by choice.

The odds of choosing a cheese that is aged, on the other hand, is a function of education and taste and a slight concern about food safety. More educated participants (with a college or post graduate education) are more likely to choose an aged cheese than someone with less

education. The smell and taste of the cheeses was also important in the odds of a participant choosing the aged cheese. Finally there is weak evidence that participants chose the aged cheese because of a safety concern—those that worry about the safety of the food they buy were more likely to choose the aged cheese but the magnitude of this difference is quite small.

Weighing sensory preferences versus safety attributes

In this section and the next we explore the tradeoff consumers make between sensory preferences and safety by checking if participants' choices are consistent with the order of their taste preferences. First we look at whether participants' notions of quality conveyed through sensory ratings are consistent with their choice between the pasteurized and unpasteurized cheese.

First we look at the tradeoffs between sensory preferences and pasteurization status. In step 5 of the auction, 347 subjects had to make a choice between P60 and U60; 186 participants (54%) chose the unpasteurized cheese and 161 participants (46%) chose the pasteurized cheese in the first round, regardless of which cheese they were endowed with. Of the 347 subjects who participated in the experimental auctions, 108 participants (31%) ranked the taste of the unpasteurized cheese higher than the pasteurized cheese (R>P), 138 (40%) ranked the tastes the same (R=P), and 101 (29%) subjects ranked the taste of the unpasteurized cheese higher (R<P).

Fifty-three percent of participants' choices in the first round of the auction were consistent with their taste preferences (see table 7) with slightly more of those choosing pasteurized over unpasteurized cheese. Presumably these participants have a preference for either pasteurized or unpasteurized cheese on principle and prefer the taste of the cheese they selected.

Table 7. Consistency between auction participants' choice and sensory ratings

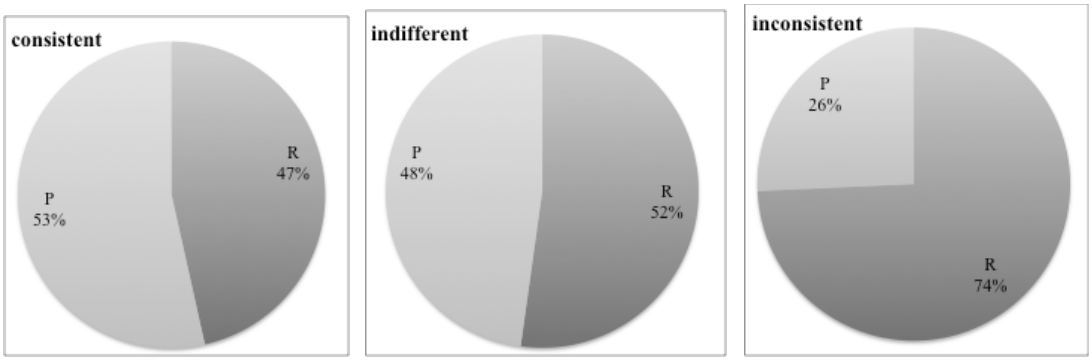
Total sample	Choice[1]	Endowment	taste preference[2]	n for each choice x endowment x taste preference combination	Consistency of choice & taste preference[3]
N= 347	60R (raw) 186	P 99	R>P	47	consistent
			R=P	30	inconsistent
			R<P	22	
		R 87	R>P	40	consistent
			R=P	31	indifferent
			R<P	16	
	60P (past.) 161	P 99	R>P	16	
			R=P	27	
			R<P	56	consistent
		R 62	R>P	5	inconsistent
			R=P	13	
			R<P	44	consistent

[1] The participant's choice is either the endowed cheese (if they did not bid) or the alternative cheese (if they did bid).
[2] 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.
[3] "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).

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. Presumably the preferences of the remaining participants in this group were not strong enough to warrant paying more.

The third group, approximately 20% of the sample, made a choice that was either 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.

Figure 1. Portion of participants whose choices were consistent, indifferent, and inconsistent with the taste ratings they gave to the pasteurized (P) and unpasteurized cheese (R).



Notes: consistent implies that participants rated cheese P higher and chose P, indifferent implies that the participant rated them equally or rated the opposite cheese (R) higher but took the free endowed cheese (P), and inconsistent implies that they rated the opposite cheese (R) higher or equal (to P) but chose the cheese that required them to bid.

Figure 1 illustrates the categorizations outlined above broken down by participants' choices. Fifty four percent of participants made choices that were consistent with their taste preference, 26% were indifferent (rated them equally or took the free one despite rating the other one higher), and 20% were inconsistent (their highest taste rating differed from their choice). A slight majority of participants whose choices were consistent with their sensory ratings preferred the pasteurized cheese. Among participants who took the free or endowed cheese they were almost equally divided as well with slightly more taking the unpasteurized cheese. Among participants whose sensory ratings were inconsistent with their choice we see a large difference. Approximately ¾ of these participants chose the unpasteurized cheese, suggesting that they would choose an unpasteurized cheese over a pasteurized cheese on principle.

Table 8 reports the attitudinal responses of participants by each of the consistency groups described above. Statistically the consistent group, who voted with their taste buds, is the same regardless of what choice they made (between raw and pasteurized). An attitudinal divide however, emerges with the inconsistent group.

Table 8. Attitudinal responses by consistency group

	consistent		p-	inconsistent		p-	indifferent		p-
Description (1=disagree;	Raw	Past	value	Raw	Past	value	Raw	Past	value

10=agree)									
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	

*Notes: "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). P-values report ANOVA test of difference between ratings (0-10).

Within the inconsistent group, participants choosing the pasteurized cheese over the raw cheese trust government regulations and would like to see stronger food safety standards imposed. They also prefer to take food safety into their own hands, reportedly checking expiration dates more, but they are less likely to entrust their safety to someone else—knowing the source of a food with controversial safety is not enough for them. The participants that chose the pasteurized cheese are also less fervent about eating natural foods than the group who chose the unpasteurized cheese.

The indifferent group was statistically quite similar except that respondents who chose pasteurized milk were less likely to trust government food safety regulations and less likely to throw out food that falls on the ground. This suggests that the indifferent group is generally more carefree about food safety than the other groups.

Next we look at the tradeoffs between sensory preferences and age (table 9). All participants were endowed with the 60R cheese and asked to choose between 60R and 90R in step 6 of the auction. Of the 347 participants, 139 chose the 60-day unpasteurized cheese (60R) and 208 chose the 90-day unpasteurized cheese (90R). The unpasteurized 60-day cheese was the default cheese for all consumers in this round.

Sixty-eight percent of participants had sensory preferences for either the 90-day aged cheese or the 60-day aged cheese that were consistent with their choice of cheese. The vast majority of these participants (70%) had higher sensory ratings for the 90-day aged version. Twenty-one percent of participants were either indifferent to the sensory attributes of the two cheeses or preferred the 90-day aged cheese but took the unpasteurized 60-day cheese because it was the endowed cheese. Some of these participants were indifferent based on their sensory

ratings (rated them equally) so it makes perfect sense to take the endowed cheese since it is free. The rest of the participants in the indifferent group rated the aged cheese higher so their preferences were not strong enough to justify switching or they did not like the idea of more aged cheese.

Table 9. Consistency between participants' choices and sensory ratings of aged cheese

Total sample	Choice[1]	taste preference[2]	n for each choice x endowment x taste preference combination	Consistency of choice & taste preference[3]
N= 347	60R (raw) 139	60>90	67	consistent
		60=90	41	indifferent
		60<90	31	
	90R (aged) 208	60>90	10	inconsistent
		60=90	28	
		60<90	170	consistent

[1] The participant's choice is either the endowed cheese (60-day aged cheese if they did not bid) or the 90-day aged cheese (if they did bid).
[2] 60>90 indicates the participant has a sensory preference for the 60-day cheese over the 90-day, 60<90 indicates a sensory preference for the 90-day cheese, and 60=90 indicates indifference between the two.
[3] "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 endowed/free cheese).

The remaining 11 percent of participants chose a cheese inconsistent with their taste preferences. Some of these participants rated the taste equally but bid on the aged cheese after seeing that it was aged longer, while the others preferred the 60-day cheese but chose the 90-day cheese aged cheese, either because they think aged cheese is supposed to be higher quality or because they think it is safer.

WTP and effect of cheese type and location on WTP

Next we look at the experimental auction bids for each of the three cheeses: unpasteurized, pasteurized and aged. Summary statistics of the mean auction bids and mean auction bids with the non-zero bids excluded are reported in table 10. Of the 347 people sampled, in step 5 of the auction 198 (57%) were endowed with pasteurized cheese and invited to bid to switch to an unpasteurized version and 149 (43%) were endowed with unpasteurized cheese and invited to bid to switch to a pasteurized version. The mean price difference that the 198 participants endowed with pasteurized cheese were willing to pay for half a pound of the unpasteurized cheese was $1.20 and when zero bids were removed (99) consumers were willing to pay on average $2.40 to upgrade. The mean price difference that the 149 participants endowed with unpasteurized cheese were willing to pay for half a pound of the pasteurized cheese was $0.94 and $2.26 when we removed the zero bids.

Table 10. Summary statistics of WTP by cheese type and location

Round	N	Mean WTP	Std. Dev	Min WTP	Max WTP	Non-zero Obs	% Non-zero	Non-zero Mean WTP	Non zero Std Dev.
All States									
Unpasteurized	198	$1.20	$1.55	0	5	99	50%	$2.40	$1.38
Pasteurized	149	$0.94	$1.44	0	5	62	42%	$2.26	$1.41
Aged	347	$1.54	$1.66	0	6	208	60%	$2.57	$1.40
Michigan									
Unpasteurized	79	1.59_a$	$1.74	0	5	46	58%	$2.73	$1.44
Pasteurized	74	0.62_a$	$1.09	0	4	25	34%	$1.82	$1.15
Aged	153	1.52_a$	$1.73	0	6	88	58%	$2.64	$1.50
New York									
Unpasteurized	55	0.91_b$	$1.35	0	5	20	36%	$2.51	$0.98
Pasteurized	43	0.94_a$	$1.50	0	5	16	37%	$2.53	$1.42
Aged	98	1.63_a$	$1.66	0	5	61	62%	$2.62	$1.35
Vermont									
Unpasteurized	64	0.97_b$	$1.37	0	5	33	52%	$1.89	$1.38
Pasteurized	32	1.69_a$	$1.78	0	5	21	66%	$2.58	$1.59
Aged	96	1.50_a$	$1.56	0	5	59	61%	$2.43	$1.29

Notes: Participants either bid to switch to a pasteurized or an unpasteurized cheese and then all participants bid to switch from an unaged to an aged version. All cheese samples were approximately 0.5 pounds. The subscripts report differences between the states within each cheese type. For unpasteurized cheese, the mean WTP was statistically different between Michigan (a) and New York (b) and Vermont (b).

As described above, in step 6 of the auction all 347 participants were given a choice between an unpasteurized cheese aged 60 days and an unpasteurized cheese aged 90 days. Overall they were willing to pay $1.54 for the cheese aged an additional 30 days and $2.57 when non-zero bids are excluded.

Table 11 reports the results of tests of equivalence of the WTP between the three cheese types (unpasteurized 60-day, pasteurized 60-day, and unpasteurized 90-day) for all states. We report the results of a Bonferroni multiple-comparison test, a parametric two-sample t-test and a non-parametric Mann-Whitney U test. In cases where the significance level differs across tests we place more emphasis on the non-parametric test given the non-normality of the data since it is censored. The test results indicate that when we look at the aggregate data across the three states there is a significant difference among the WTP between all pairs of cheeses.

Table 11. Test of equivalence of WTP across cheese by pasteurization and age

Test	P60	U60	
Bonferroni	0.39*	N/A	
Two-sided t	(0.08)**		U60
Two-sample Wilcoxon	[0.05] †		
Bonferroni	0.00	0.04	
Two-sided t	(0.00)	(0.00)	U90
Two-sample Wilcoxon	[0.00]	[0.00]	

Notes: U60= unpasteurized 60-day aged, U90=Unpasteurized 90-day, and P60= Pasteurized 60-day. P-values for a Bonferroni multiple comparison test*, two sided t-test** and two-sample Wilcoxon rank-sum (Mann-Whitney) test of equivalence† of WTP across cheese by pasteurization and age (60-versus 90-day aged, N=347).

In Michigan, the split between participants endowed with the pasteurized cheese versus those endowed with the unpasteurized cheese was much closer than other states, indicating that a greater portion of people in Michigan were either opposed to raw milk or unaware of the raw milk debate. Michigan consumers were willing to pay the most for the unpasteurized cheese. New Yorkers were indifferent between the pasteurized and unpasteurized cheese and had the highest WTP for the aged cheese. In Vermont twice as many consumers were endowed with pasteurized cheese than unpasteurized cheese, indicating that participants in Vermont were more likely to knowingly consume cheese made from unpasteurized milk. The portion of the Vermont consumers who bid on unpasteurized cheese was willing to pay the least out of all three states and the portion of participants in Vermont that bid on pasteurized cheese bid the most for it. When interpreting these results it should be taken into consideration that many participants in Vermont were from out of state and likely tourists.

We also compare the mean difference in WTP between states using one-way analysis-of-variance (ANOVA) reported in table 10 using subscripts. The value of the test statistic is compared with a corresponding significance level (Chi squared with k-1 degrees of freedom). Comparison of the unpasteurized cheese and pasteurized bids across states are significant at about the 1% level (p=0.02 and p=0.00 respectively) indicating that the means are not all equal. There is higher WTP in Michigan for the unpasteurized cheese and higher WTP for the pasteurized cheese in Vermont. This is likely due to the fact that many participants in Vermont were from out of state but we cannot test this since participants' zip codes are not linked to the responses for confidentiality reasons. There is no statistical difference across the states for the aged cheese, indicating roughly equivalent willingness to pay (WTP=1.54 and P=0.82).

Hedonic analysis of auction bids

We perform hedonic analysis of experimental auction bids as per Melton et al. (1996). We use a tobit type model to accommodate the large number of censored bids from consumers who bid zero because they preferred the cheese they were endowed with. We use a random effects specification since each participant bid in each of the rounds and their bids are related in this way.

Artisan cheese consumers who participated in the study are not willing to pay more for pasteurization status but they are willing to pay more for aged cheese. The most important determinant of how much a consumer is willing to pay for artisan cheese is their income level, followed by their taste preferences. As we would expect, consumers in the highest income bracket were willing to pay more than those in the lowest income group to get the cheese they wanted. Taste matters very much to consumers; the higher they rated a given cheese the more they were willing to pay for it. Other determinants of artisan cheese consumer WTP are their age (older consumers pay less for cheese on average) and how much cheese they consume. None of the questions about attitudes towards food safety played a role in determining consumer WTP.

Table 12. Hedonic analysis of experimental auction bids

WTP	Coef.	Std.	z
Pasteurized	-0.20	(0.44)	-0.47
Aged	0.73***	(0.28)	2.62

Age (years)	-0.02**	(0.01)	-2.09
Income (>80,000)	0.75**	(0.33)	2.30
Income (30-80,000)	0.18	(0.30)	0.60
Income (not reported)	1.12***	(0.42)	2.69
College graduate	-0.10	(0.37)	-0.27
Post graduate	0.00	(0.40)	-0.01
Pounds	0.13**	(0.06)	2.04
Taste 60R (0-10)	-0.31***	(0.07)	-4.48
Taste 60P (0-10)	-0.14**	(0.07)	-1.92
Taste 90R (0-10)	0.53***	(0.07)	7.14
worry	0.07	(0.04)	1.57
trust_gov	0.04	(0.04)	0.90
stronger_standards	-0.05	(0.05)	-0.93
pay_more	-0.01	(0.06)	-0.20
expirydate	-0.05	(0.05)	-1.05
floor	-0.03	(0.04)	-0.78
raw_milk	0.04	(0.04)	0.80
natural	0.07	(0.06)	1.08
Endowment (dummy)	0.36	(0.32)	1.13
Constant	-1.54	(0.90)	-1.71
Sigma u	0.11	(1.88)	0.06
Sigma e	2.53	(0.14)	18.12
Rho	0.00	(0.07)	0.00
Observations	690		
Censored	337		

Notes: ** indicated significance at the 5% level, and *** indicates significance at the 1% level.

Conclusions

Hedonic analysis of both the retail data and the experimental auction data demonstrates that consumers of artisan cheese are not willing to pay more for pasteurization. On the contrary, artisan cheese consumers pay more for unpasteurized cheese both in the current market and in an experimental setting. All else equal, artisan cheese consumers are also willing to pay more for an aged cheese in both analyses but it appears that this decision is mostly related to an improvement in the quality of taste rather than an improvement in the safety.

One important feature of artisan products is heterogeneity. We are able to partially capture this heterogeneity through various independent variables used in the hedonic analysis of retail prices (about 50% of it). There is however, a large amount of variation in price that cannot be accounted for and this appears to be related to the elasticity of artisan cheese demand. Producers reportedly set prices based on what they think the cheese is worth and what it takes to cover their lifestyle and keep them milking cows and making craft cheese (Paxson, 2013). The heterogeneity of cheese and the emphasis on creativity and originality also means that styles of cheese are difficult to characterize and frequently changing as are US consumers' preferences.

Consumer preferences are also heterogeneous. In blind tasting there was no significant difference in the ratings between pasteurized and unpasteurized cheese. More than half of consumers in the study chose the cheese they gave the highest taste ratings to, one quarter took the free cheese, and only one fifth of consumers seem to have based their decision on whether or not the cheese was pasteurized and most of those participants chose the unpasteurized cheese. This heterogeneity in preferences could provide justification for policy that allows two distinct

markets to exist. The science is ambivalent on the safety of artisan cheese and this research shows that consumer opinions and values do not indicate that consumers are concerned about the safety of unpasteurized cheese. While there are many consumers who are indifferent there are also consumers with strong preferences for both pasteurized and unpasteurized cheese, particularly in favor unpasteurized artisan cheese.

Consumers' attitudes about food safety were an important determinant of their decision to choose one cheese or the other and this difference is seemingly ideological. Consumers who chose pasteurized cheese on principle (i.e. 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 not regulated by the government but rather sold directly by the producer.

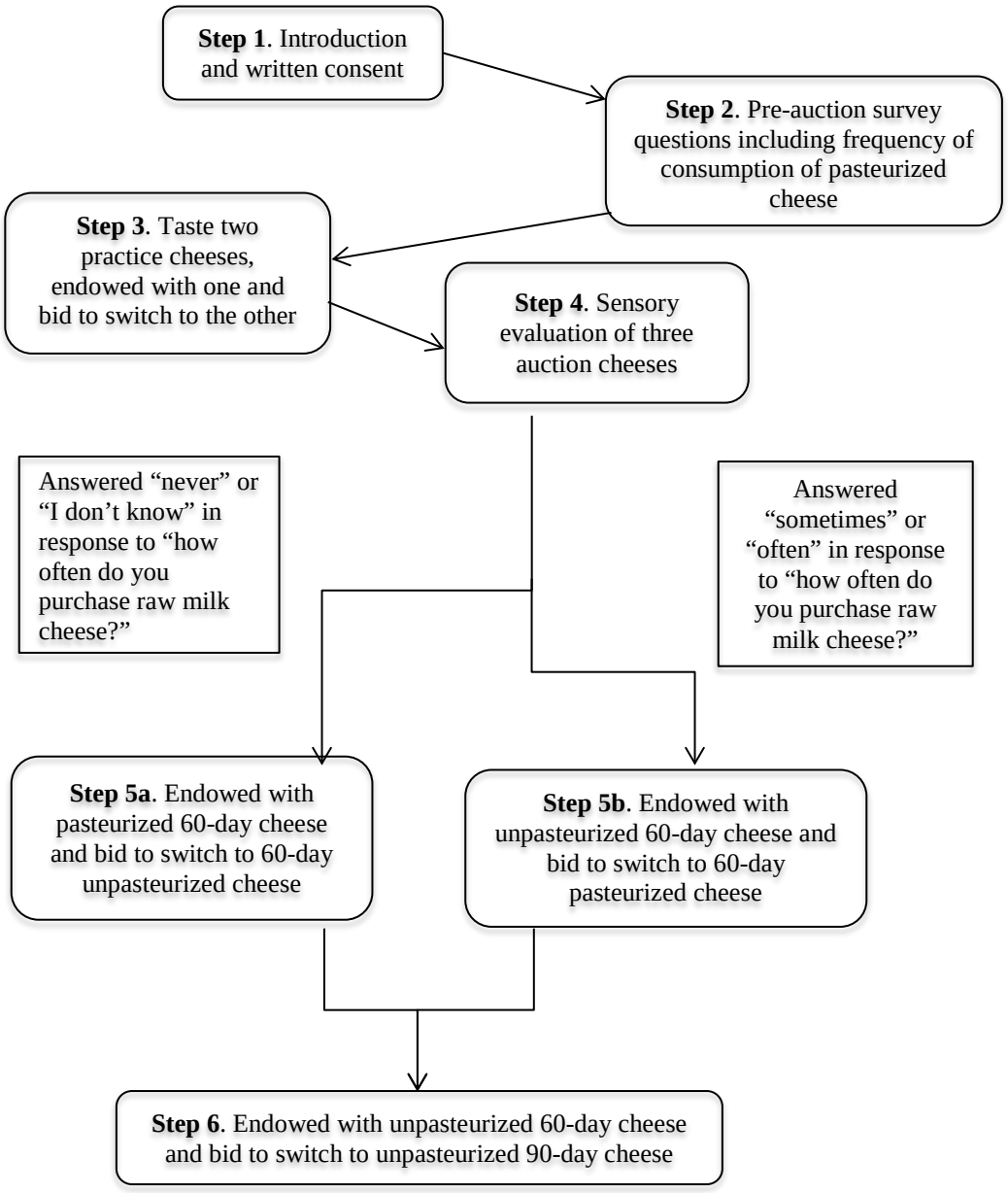
Lusk (2012) found that people think about food policy and regulation differently than other types of issues and concluded "food ideology represents a unique construct in its own right". In this sample it appears that there are a range of attitudes about what constitutes a risk as well as a difference in opinions of how involved the government should be in food safety. While the safety of raw milk cheese appears to be an ideological decision to some artisan cheese consumers, the majority makes purchasing decisions consistent with their taste preferences. Other consumers do not view pasteurization of milk used in cheesemaking as a safety concern and make their decisions based on price when they consider the two products of equal taste. The majority of the sample who made the decision seemingly on ideological grounds chose the unpasteurized cheese.

Many studies assume that attitudes about controversial production practices or food technologies can be explained by a lack of consumer education or negative media attention. Numerous studies in the economics literature make this assumption and frame their research in terms of acceptance of a new technology following new information, for example with the use of irradiation to increase the safety of meat products (Fox et al., 2001; DeRuiter and Dwyer, 2002; Nayga, 2003). There is evidence here that decisions about food safety may be based more on attitudes that are related to the changing food system, particularly the greater interest in artisan, local, and natural foods. These findings are consistent with research in psychology and sociology that finds that consumer risk assessment is a more complex context specific expression of personal values (Hansen et al., 2003; Finucane and Holup, 2005; Korthals, 2001; Sapp et al., 1995). These results suggest that a divide may be forming between FDA policy and consumer demand on matters such as the safety of artisan foods.

Current FDA regulation governing the production of cheese made from unpasteurized milk infringes on consumer choice and decreases profits for many artisan producers who prefer to produce cheese made from unpasteurized milk. Impending FDA regulation based on a simulated risk assessment suggests more stringent regulation is planned in the future (FDA, 2012), which threatens consumers and producers in the artisan cheese market. In the absence of empirical evidence that unpasteurized cheese is less safe than pasteurized cheese the results of this study support the use of mandatory labeling for unpasteurized cheese products but offer no justification for other restrictions on cheese made from unpasteurized milk.

APPENDIX

Figure 2. Schematic of auction procedure


Step 1. Introduction and written consent
Step 2. Pre-auction survey questions including frequency of consumption of pasteurized cheese
Step 3. Taste two practice cheeses, endowed with one and bid to switch to the other
Step 4. Sensory evaluation of three auction cheeses
Answered "never" or "I don't know" in response to "how often do you purchase raw milk cheese?"
Answered "sometimes" or "often" in response to "how often do you purchase raw milk cheese?"
Step 5a. Endowed with pasteurized 60-day cheese and bid to switch to 60-day unpasteurized cheese
Step 5b. Endowed with unpasteurized 60-day cheese and bid to switch to 60-day pasteurized cheese
Step 6. Endowed with unpasteurized 60-day cheese and bid to switch to unpasteurized 90-day cheese

REFERENCES

American Cheese Society (2013). Comments in response to Joint FDA/Health Canada quantitative assessment of the risk of *Listeriosis* from soft ripened cheese consumption in the United States and Canada: Draft Report. Retrieved from: https://www.cheesesociety.org/wp-content/uploads/2013/04/American-Cheese-Society-ACS-Comment.pdf

Anderson, S. T., & West, S. E. (2006). Open space, residential property values, and spatial context. *Regional Science and Urban Economics*, *36*(6), 773–789. doi:10.1016/j.regsciurbeco.2006.03.007

Bajari, P., & Benkard, C. L. (2005). Demand Estimation with Heterogeneous Consumers and Unobserved Product Characteristics: A Hedonic Approach. *Journal of Political Economy*, *113*(6), 1239–1276. doi:10.1086/498586

Becker, G. M., Degroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral Science*, *9*(3), 226–232. doi:10.1002/bs.3830090304

Benfratello, L., Piacenza, M., & Sacchetto, S. (2009). Taste or reputation: what drives market prices in the wine industry? Estimation of a hedonic model for Italian premium wines. *Applied Economics*, *41*(17), 2197–2209. doi:10.1080/00036840701222439

Brandt, K., Leifert, C., Sanderson, R., & Seal, C. J. (2011). Agroecosystem Management and Nutritional Quality of Plant Foods: The Case of Organic Fruits and Vegetables. Critical Reviews in Plant Sciences, 30(1-2), 177–197. doi:10.1080/07352689.2011.554417

Bredahl, L. (2001). Determinants of Consumer Attitudes and Purchase Intentions With Regard to Genetically Modified Food – Results of a Cross-National Survey. *Journal of Consumer Policy*, *24*(1), 23–61. doi:10.1023/A:1010950406128

Brooks, K., & Lusk, J. L. (2010). Stated and revealed preferences for organic and cloned milk: Combining choice experiment and scanner data, *92*(4), 1229–1241.

Brown, J., Cranfield, J. A. L., & Henson, S. (2005). Relating consumer willingness-to-pay for food safety to risk tolerance: An experimental approach. *Canadian Journal of Agricultural Economics/Revue Canadienne D'agroeconomie*, *53*(2-3), 249–263. doi:10.1111/j.1744-7976.2005.00356.x

Brown, J. N., & Rosen, H. S. (1982). *On the Estimation of Structural Hedonic Price Models* (Working Paper No. 18). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/t0018

Castriota, S., Curzi, D., & Delmastro, M. (2012). Tasters' Bias in Wine Guides' Quality Evaluations. *American Association of Wine Economists Working Paper*, (98). Retrieved from http://food-economics.org/workingpapers/AAWE_WP98.pdf

Colonna, A., Durham, C., & Meunier-Goddik, L. (2011). Factors affecting consumers' preferences for and purchasing decisions regarding pasteurized and raw milk specialty cheeses. *Journal of Dairy Science*, *94*(10), 5217–5226. doi:10.3168/jds.2011-4456

Combris, P., Lecocq, S., & Visser, M. (2000). Estimation of a hedonic price equation for Burgundy wine. *Applied Economics*, *32*(8), 961–967. doi:10.1080/000368400322011

Combris, P., Lecocq, S., & Visser, M. (2003). Estimation of a hedonic price equation for Bordeaux wine: does quality matter? *The Economic Journal*, *107*(441), 390–402.

Corrigan, J. R., & Rousu, M. C. (2006). The effect of initial endowments in experimental auctions. *American Journal of Agricultural Economics*, *88*(2), 448 –457. doi:10.1111/j.1467-8276.2006.00870.x

Court, A. T. (1939). Hedonic price indexes with automotive examples. In *he Dynamics of Automobile Demand*. New York: The General Motors Corporation.

Cross, R., Plantinga, A. J., & Stavins, R. N. (2011). What is the Value of Terroir? *American Economic Review*, *101*(3), 152.

DeRuiter, F. E., & Dwyer, J. (2002). Consumer acceptance of irradiated foods: dawn of a new era? *Food Service Technology*, *2*(2), 47–58. doi:10.1046/j.1471-5740.2002.00031.x

Food and Drug Administration (2012). Joint FDA/Health Canada quantitative assessment of the risk of Listeriosis from soft ripened cheese consumption in the United States and Canada. Center for Food Safety and Applied Nutrition, U.S. Department of Health and Human Services. Retrieved from: http://www.fda.gov/downloads/Food/FoodScienceResearch/UCM338618.pdf

Feuz, D. M., Umberger, W. J., Calkins, C. R., & Sitz, B. (2004). U.S. consumers' willingness to pay for flavor and tenderness in steaks as determined with an experimental auction. *Journal of Agricultural and Resource Economics*, *29*(3), 501–516.

Finucane, M. L., & Holup, J. L. (2005). Psychosocial and cultural factors affecting the perceived risk of genetically modified food: an overview of the literature. *Social Science & Medicine*, *60*(7), 1603–1612. doi:10.1016/j.socscimed.2004.08.007

Follain, J., & Jimenez, E. (1985). Estimating the Demand for Housing Characteristics: A Survey and Critique. *Regional Science and Urban Economics*, *15*(1), 77–107.

Fox, J., Bruhn, C., & Sapp, S. (2001). Consumer acceptance of irradiated meats. *CRC Series in Contemporary Food Science*, 139–158.

Griliches, Z. (1961). Hedonic price indexes for automobiles: An econometric analysis of quality change. In *The Price Statistics of the Federal Goverment* (pp. 173–196). NBER.

Hanemann, W. M. (1991). Willingness to pay and willingness to accept: How much can they differ? *The American Economic Review*, *81*(3), 635–647.

Hansen, J., Holm, L., Frewer, L., Robinson, P., & Sandøe, P. (2003). Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. *Appetite*, *41*(2), 111–121. doi:10.1016/S0195-6663(03)00079-5

Huffstutter, P. J. (2011, January 29). Feds nab raw-milk cheese in food safety case. *Los Angeles Times*. Retrieved from http://articles.latimes.com/2011/jan/29/business/la-fi-raw-milk-cheese-20110129

Korthals, M. (2001). Taking Consumers Seriously: Two Concepts of Consumer Sovereignty. *Journal of Agricultural and Environmental Ethics*, *14*(2), 201–215. doi:10.1023/A:1011356930245

Lancaster, K. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, *74*(April), 132–57.

Layton, L. (2011, February 6). FDA ramps up scrutiny on a new area: Cheese. *The Washington Post*. Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2011/02/05/AR2011020502210.html

List, J. A., & Rondeau, D. (2003). The impact of challenge gifts on charitable giving: an experimental investigation. *Economics Letters*, *79*(2), 153–159.

Lusk, J. L., Fox, J. A., Schroeder, T. C., Mintert, J., & Koohmaraie, M. (2001). In-Store Valuation of Steak Tenderness. *American Journal of Agricultural Economics*, *83*(3), 539–550. doi:10.1111/0002-9092.00176

Lusk, J. L., House, L. O., Valli, C., Jaeger, S. R., Moore, M., Morrow, B., & Traill, W. B. (2005). Consumer welfare effects of introducing and labeling genetically modified food. *Economics Letters*, *88*(3), 382–388. doi:10.1016/j.econlet.2005.03.009

Lusk, J. L., & Marette, S. (2010). Welfare Effects of Food Labels and Bans with Alternative Willingness to Pay Measures. *Applied Economic Perspectives and Policy*, *32*(2), 319–337. doi:10.1093/aepp/ppp013

Lusk, J. L. (2012). The political ideology of food. *Food Policy*, *37*(5), 530–542. doi:10.1016/j.foodpol.2012.05.002

Lusk, J. L., & Shogren, J. F. (2007). *Experimental Auctions: Methods and Applications in Economic and Marketing Research*. Quantitative Methods for Applied Economics and Business Research series. Cambridge and New York: Cambridge University

Mead, P. S., Slutsker, L., Dietz, V., McCaig, L. F., Bresee, J. S., Shapiro, C., … Tauxe, R. V. (1999). Food-related illness and death in the United States. *Emerging Infectious Diseases*, *5*(5), 607.

Melton, B. E., Huffman, W. E., & Jason F. Shogren. (1996). Economic values of pork attributes: Hedonic price analysis of experimental auction data. *Review of Agricultural Economics*, *18*(4), 613–627. doi:10.2307/1349594

Millstone, E. (2009). Science, risk and governance: Radical rhetorics and the realities of reform in food safety governance. *Research Policy*, *38*(4), 624–636. doi:10.1016/j.respol.2009.01.012

Nestle, M. (2010). *Safe food: the politics of food safety*. University of California Press.

Neuman, W. (2010, November 19). As Cheesemaking Blooms, So Can Listeria. *The New York Times*. Retrieved from http://www.nytimes.com/2010/11/20/business/20artisanside.html?scp=2&sq=artisan%20cheese&st=Search

Neuman, W. (2011, February 4). Raw Milk Cheesemakers Fret Over Possible New Rules. *The New York Times*. Retrieved from http://www.nytimes.com/2011/02/05/business/05cheese.html?scp=5&sq=artisan%20cheese&st=Search

Noussair, C., Robin, S., & Ruffieux, B. (2004). A comparison of hedonic rating and demand-revealing auctions. *Food Quality and Preference*, *15*(4), 393–402. doi:10.1016/S0950-3293(03)00086-7

Paxson, H. (2013). *The Life of Cheese: Crafting Food and Value in America*. University of California Press.

Platter, W. J., Tatum, J. D., Belk, K. E., Koontz, S. R., Chapman, P. L., & Smith, G. C. (2005). Effects of marbling and shear force on consumers' willingness to pay for beef strip loin steaks. *Journal of Animal Science, 83*(4), 890 –899.

Plott, C. R., & Zeiler, K. (2011). The willingness to pay-willingness to accept gap, the endowment effect, subject misconceptions, and experimental procedures for eliciting valuations: Reply. *The American Economic Review*, *101*(2), 1012–1028. doi:10.1257/aer.101.2.1012

Roberts, J. P. (2007). *Atlas of American Artisan Cheese*. Chelsea Green Publishing.

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy*, *82*(1), 34–55.

Sapp, S. G., Harrod, W. J., & Zhao, L. (1995). Social demographic and attitudinal determinants of consumer acceptance of food irradiation. *Agribusiness*, *11*(2), 117–130. doi:10.1002/1520-6297(199503/04)11:2<117::AID-AGR2720110204>3.0.CO;2-8

Shogren, J. F., Fox, J. A., Hayes, D. J., & Roosen, J. (1999). Observed choices for food safety in retail, survey, and auction markets. *American Journal of Agricultural Economics*, *81*(5), 1192–1199. doi:10.2307/1244106

Smith-Spangler, C., Brandeau, M. L., Hunter, G. E., Bavinger, J. C., Pearson, M., Eschbach, P. J., & Bravata, D. M. (2012). Are Organic Foods Safer or Healthier Than Conventional Alternatives?A Systematic Review. Annals of Internal Medicine,157(5), 348–366. doi:10.7326/0003-4819-157-5-201209040-00007

Teuber, R., & Herrmann, R. (2012). Towards a differentiated modeling of origin effects in hedonic analysis: An application to auction prices of specialty coffee. *Food Policy*, *37*(6), 732–740. doi:10.1016/j.foodpol.2012.08.001

Umberger, W. J., & Feuz, D. M. (2004). The usefulness of experimental auctions in determining consumers' willingness-to-pay for quality-differentiated products. *Applied Economic Perspectives and Policy*, *26*(2), 170 –185. doi:10.1111/j.1467-9353.2004.00169.x

Vaughan, E., & Seifert, M. (1992). Variability in the Framing of Risk Issues. *Journal of Social Issues*, *48*(4), 119–135. doi:10.1111/j.1540-4560.1992.tb01948.x

Witte, A., Sumka, H., & Erekson, H. (1979). An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosen's Theory of Implicit Markets. *Econometrica*, *47*(5), 1151–1173.