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Understanding U.S. Consumer Demand for Milk Production Attributes

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A choice experiment was used to examine the value of various fluid milk attributes. Respondents were surveyed regarding half or whole gallon milk purchases. A split-sample design was used to examine consumer inferences regarding food safety. Willingness to pay for verification of production process attributes varied across attributes and verifying entity. Consumers were generally willing to pay substantial premiums for milk produced without the use of rbST, on local family farms, with assured food safety enhancement, and for these claims to be verified by the U.S. Department of Agriculture.

Key words: milk, food safety, grazing, rbST, family farm, local, willingness to pay

Introduction

Beverage milk in the United States is a staple of many family diets and is a key supplier of calcium and vitamin D. Innovations in milk product offerings and milk marketing in recent decades have included marketing half-gallons rather than whole gallons, individual sized containers for on-the-go consumption, chocolate and other flavors, and a wide variety of fat contents. In more recent years, U.S. consumers have demonstrated an increasing concern with farm production methods (Olynk, Tonsor, and Wolf, 2010). Retailers responding to these demands have utilized labels to differentiate milk production practices employed at the farm level. For example, "rbST-free" labels are now common on milk containers.[1] Other farm-level attributes used in marketing and labeling fluid milk include "family" farm, local, and grazing. Many recent studies have examined consumer demand for individual production attributes and organic milk production.

The objective of this research was to analyze a comprehensive set of milk production attributes and consider the role that food safety and verification of these processes plays in consumer demand for these attributes. To accomplish this goal, we used an online choice experiment of 1,007 U.S. consumers. We find that half-gallon milk consumers have different preferences than those that regularly purchase milk in gallons. We also find that enhanced food safety programs could offset many other milk attribute concerns that consumers have with respect to milk production attributes. Finally, we find evidence that for consumers who regularly purchase gallons without enhanced food safety programs, the wording of rbST-free labels can have a differential effect on milk demand.

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[1] We use the term "rbST-free" to indicate that the milk was produced without rbST hormone supplementation. We recognize that the milk still has a standard bovine somatotropin content, but our use is consistent with marketing practices and a general level of knowledge.

Milk Production Attributes

There are 65,000 U.S. milk cow operations and milk production methods and practices are heterogeneous across farm size, region, and time (U.S. Department of Agriculture, National Agricultural Statistics Service, 2010). Milk production practices include large confinement operations as well as many generally smaller operations that use varying degrees of animal grazing. Nutrition, reproduction, and other technologies vary widely across dairy farms. A growing body of literature has examined U.S. consumer willingness to pay for agricultural production process attributes. For example, a number of recent studies have assessed consumer willingness to pay (WTP) for animal welfare attributes in livestock products (Carlsson, Frykblom, and Lagerkvist, 2007a,b; Lusk, Norwood, and Pruitt, 2006). Olynk, Tonsor, and Wolf (2010) examined consumer WTP for verified production process attributes while addressing potential verifying entities. With respect to milk, relevant production attributes include hormone use, feeding practices (grazing), farm organization, and farm proximity.

Recombinant bovine somatotropin (rbST) is a replica of a naturally occurring growth hormone in cattle that encourages milk production. The approval of rbST for commercial sale to US dairy farms in 1994 occurred following a great deal of consternation by some consumer and producer groups that continues to this day. In the past few years, rbST detractors have gained traction and several major U.S. retailing chains moved towards procurement of beverage milk supplies from cows not treated with rbST (Roseboro, 2007; Reuters, 2008; Meijer, Inc., 2008). rbST has remained a controversial milk production technology for several reasons. First, despite U.S. Food and Drug Administration (FDA) conclusions, many consumer groups are concerned about unknown food safety aspects of milk produced with supplemental hormones. Second, some concerns exist regarding the effects of supplemental rbST on cow health and welfare. Third, many dairy farmers–especially those with smaller herds–opposed the technology because of its potential effect on aggregate milk supply and decreases in farm milk price. Fourth, the FDA decision that milk produced with rbST would not require a label was controversial. Rather than label milk produced using rbST, the FDA ruled that milk produced without the hormone supplement could be labeled as such and recommended labeling verbiage.

Organic milk production requires at least some grazing, the use of organic feed, and a prohibition on the use of antibiotics and supplemental hormones (e.g., rbST). Organic milk production has increased at a rapid rate-25% annually between 2000 and 2005. However, the total organic share of the milk market remains relatively small-3% in 2008 (McBride and Greene, 2009). The growth of organic milk share in the marketplace is dampened because its retail price is often double that of conventional milk. The high price of organic milk has prompted retailers to seek a middle ground of production attributes somewhere between conventional and organic milk production (Webwire, 2009). Bernard and Bernard (2009) used auction experiments to examine willingness to pay for organic, rbST-free, and milk produced without antibiotics compared to conventional milk production. They found that the sum of willingness to pay premiums of rbST-free and milk produced without antibiotics were not significantly different than organic premiums and suggested that other aspects of organic milk production (e.g., use of organic feed) were not highly valued by consumers. Brooks and Lusk (2010) combined stated (choice experiment) and revealed (scanner) preference data to examine willingness to pay for organic, cloned, and rbST-free milk. They found that consumers were willing to pay three times as much to avoid milk from cloned cows (almost $5/gallon) compared to organic or rbST-free (about $1.50/gallon).

Local foods have received a great deal of attention in recent years. For example, research has examined the definition of local (Darby et al., 2008) and the demand for local produce (e.g., Schneider and Francis, 2005; Loureiro and Hine, 2002). Park and Gomez (2011) used price data from five U.S. metropolitan areas and found that consumers were willing to pay a 16.2% premium for labeled, local milk. Unless sold directly by producers to consumers, milk is not usually marketed

as a local product. Relevant considerations include what "local" means to milk consumers, whether a market exists for "local" milk, and economies of scale issues.

This research considers a portfolio of milk production process attributes to assess consumers' preferences for further fluid milk market segmentation. We also consider the verifying entity on these claims, half-gallon versus gallon purchasing behavior, and enhanced food safety claims.

Survey and Choice Experiment

This study uses data from a survey administered in October and November of 2008 of 1,007 U.S. residents. The survey was designed primarily to obtain data on consumer perceptions, current knowledge, and preferences with particular attention to milk production attributes. Internet surveys were administered to U.S. households online with participants being recruited from a large opt-in panel maintained by Survey Sampling International that is representative of U.S. grocery shoppers (Tonsor, 2011). Because of relatively fast completion times and low costs, online surveys are increasingly used by researchers (Louviere, Hensher, and Swait, 2000; Gao and Schroeder, 2009). Hudson et al. (2004) found that Internet surveys did not exhibit non-response bias. Fleming and Bowden (2009) and Marta-Pedroso, Freitas, and Domingos (2007) found similar results from applying a web-based survey with conventional mail and in-person interview surveys, respectively.

In addition to socio-demographic information about each respondent, milk consumption habits and other data were collected. Each respondent also completed a choice experiment designed to elicit the amount consumers were willing to pay for various milk attributes. Choice experiments simulate real-life purchasing situations and permit evaluation of multiple attributes, which facilitates estimation of tradeoffs among alternatives (Lusk, Roosen, and Fox, 2003). In this choice experiment, consumers were presented with a series of simulated shopping scenarios, each of which involved choosing a preferred alternative from two milk options with a variety of attributes and a third "no purchase" option.

All questions about milk consumption were in terms of either gallons or half-gallons depending on individual respondents' indicated purchasing preference.[2] One-half of the survey sample included respondents that primarily purchased whole gallons and the other one-half consisted of respondents who primarily purchased half-gallons. Four different price levels were selected to be consistent with existing retail price ranges (table 1). The split sample method provides respondents with products most closely related to their typical consumption patterns. In addition to price, the milk attributes varied by feeding/housing practices and milk production practice (table 1). One-half of respondents also had "enhanced food safety" (FS) as one of the attributes in the choice experiment while the other one-half did not. Finally, rbST-free labels varied randomly over three claims. These samples provide insights on how demand for milk can vary depending on the entire set of attributes.

An orthogonal fractional design was used to select scenarios in which milk prices were uncorrelated, and which allowed for identification of own-price, cross-price, and alternative specific effects (Kuhfeld, Tobias, and Garratt, 1994). Specifically, the SAS procedures *PLAN* and *OPTEX* were used to identify an experimental design maximizing D-efficiency (93.81 without enhanced food safety and 91.99 with the enhanced food safety attribute). The final choice design when food safety was included resulted in 21 choice sets which were divided into three blocks of seven to keep the task for individual participants reasonable (Tonsor et al., 2005; Savage and Waldman, 2008; Tonsor, 2011). When the enhanced food safety attribute was not included in the choice experiment, the final choice design resulted in 18 choice sets which were blocked into three groups of six. To mitigate any potential ordering impacts, the choice set order was randomized (Loureiro and Umberger, 2007).

The choice experiments were hypothetical in that they did not include exchange of actual money or milk. Our instructions included the statement: "*Experience from previous similar surveys is that*

[2] The internet firm administered the survey through the use of a large opt-in panel continued random sampling until a sample which included 50% gallon-preferring consumers and 50% half-gallon preferring consumers was obtained.

Table 1. Milk Attributes and Levels Evaluated in Choice Experiment

Product Attribute	Milk Attribute Levels
Price	\$2.99/gallon \$1.79/half-gallon
	\$3.99/gallon \$2.39/half-gallon
	\$4.99/gallon \$2.99/half-gallon
	\$5.99/gallon \$3.59/half-gallon
Milk production method	Labeled rbST/rbGH free
	No claim
Feeding/housing practices	Intensive grazing
	Moderate grazing
	No claim
Organization	Family farm
	No claim
Location	Local
	No claim
Food safety[a]	Enhanced
	No claim
Certification	Private, 3rd Party
	USDA
	No claim

Notes: [a] Half of the sample saw Enhanced Food Safety as a potential attribute in the choice experiment while the other half did not.

people often state a higher willingness to pay than what one actually is willing to pay for the good. It is important that you make your selections like you would if you were actually facing these choices in your retail purchase decisions." This statement was included as part of a "cheap-talk" strategy to reduce hypothetical bias. This strategy has been useful in previous choice experiments (Lusk, 2003; Cummings and Taylor, 1999). Recent research also suggests cheap talk scripts are effective in online survey applications (Tonsor and Shupp, forthcoming). Given that our principal interest was to ascertain differences in willingness-to-pay amounts for products (attribute bundles) that were not necessarily available, we were less concerned with the hypothetical nature of our survey. This reassurance is based upon Lusk and Schroeder (2004) research, which suggested that hypothetical willingness-to-pay for desirable attributes was not significantly different from non-hypothetical valuations. The attributes that we examined included rbST/rbGH free, grazing practices, farm organization (i.e., family farm), local, enhanced food safety, and verification entity. Descriptions included in the choice experiments of the specific product attributes are in Appendix A.

Part of the controversy surrounding rbST has involved labeling "rbST-free" milk. No legal label requirement exists for milk produced with (or without) rbST. The result has been a variety of labels used with much controversy about the appropriateness and effect of each. Because multiple labels have been used, one pertinent aspect of demand for rbST-free milk is label choice. Kiesel, Buschena, and Smith (2005) examined the effect of voluntary rbST labels using supermarket scanner data. They found that labeling permanently increased the demand for rbST-free milk. To examine the informational effect of labels in the choice experiments, the label for "Labeled rbST/rbGH-Free"

milk was randomly varied across three label options.[3] The first label was "No artificial hormones." This label has caused a great deal of controversy among farm and industry groups which argue that the bST content of milk is not changed by supplementation with rbST and, thus, the label is misleading. The second label used was "Our farmers pledge, milk from cows not supplemented with rbST." This label is somewhat controversial with farm and industry groups but is legally demonstrable with signed affidavits (Cook-Mowery, Olynk, and Wolf, 2009). The third label used was "From cows not treated with rbST. No significant difference has been shown between milk derived from rbST-treated and non-rbST-treated cows." The third label is the recommended–but not required–statement according to the Food and Drug Administration.

Livestock and milk production that use grazing as a feeding practice has received increased attention in recent years. We defined two types of grazing on labels: moderate and intensive. Many smaller conventional farms qualify as moderate grazing operations. Large, confinement dairies would not meet either grazing attribute. *A priori*, one might expect that intensive grazing would have greater value to those who care about such production practices but we expected that both grazing practices would be valued by the average consumer.

The media often uses terms like "family farm" and "corporate" or "factory" farm without definition or clarification. We considered farm business organization attributes in terms of whether a "family" farm claim was made. Because there is no official definition of "family" farm, businesses can co-opt such labels for political or marketing purposes. Recently, the United States Department of Agriculture's (USDA) Economic Research Service defined a family farm as "*any farm where the majority of the business is owned by the operator and individuals related to the operator, including relatives who do not live in the operator's household.*" (U.S. Department of Agriculture, Economic Research Service, 2010, p. 2). Under this definition, 97.4% of US dairy farms were family farms in 2007 (Hoppe and Banker, 2010). We did not, however, provide this definition or statistical information to respondents. Thus, they assigned their own meaning to the term. A follow-up question asked respondents to check all attributes that they believed applied to a "family farm." It was our intention to capture some of the concerns related to farm size and organization with the family farm attribute. These concerns were expected to generate a positive value for the "family farm" production attribute.

Similar to the family farm attribute, we included "local" as a production attribute without providing a definition. Darby et al. (2008) used choice based conjoint analysis to assess what "locally grown" meant to consumers. They found that "in-state" and "nearby" had similar values independent of product freshness and farm size. As with the family farm attribute, we followed up the choice experiment with a question to assess respondents' interpretation of the term "local."

We were also interested in assessing whether milk production attribute valuations were influenced by food safety concerns. Food safety has been shown to be an important attribute for many food products (Tonsor, 2011; Tonsor et al., 2009). Novoselova et al. (2002) found that Dutch consumers were willing to pay a price premium above traditional milk purchase prices to avoid perceived risks. Their results indicated that the most important factors for consumers' preference were risk of contamination and the presence of a label. Iwamoto et al. (2003) found that Japanese consumers positively valued HACCP milk labeling. Public opinion surveys have demonstrated that rbST use was related to consumer food safety concerns (Aldrich and Blisard, 1998; Macfarlane, 2002). Thus, the attribute "enhanced food safety" was included in one-half of the respondents' choice experiments. Our definition of enhanced food safety did not provide specific details on additional procedures needed to assure quality relative to the absence of food safety claims (Tonsor et al., 2009). This approach reflects several product descriptions that appear on food products which make broad food safety claims without providing details on underlying procedures to substantiate these claims. USDA Process Verified Programs (PVPs) currently exist that cover dairy cattle and

[3] Proponents of bovine somatotropin tend to utilize the rbST abbreviation for recombinant bovine somatotropin while opponents often utilize rbGH, which stands for recombinant growth hormone. In an effort to be as unbiased as possible, we used "rbST/rbGH" throughout the survey.

verify production practices that may be related (at least indirectly) to food safety such as animal age, hormone use, antibiotic use, certain feed additives, and grazing practices (U.S. Department of Agriculture, 2011).

Finally, production attribute claims may require verification to be effectively used in milk marketing. Olynk, Tonsor, and Wolf (2010) examined verification models for pork chops and beverage milk with a representative set of US consumers. The options included verification by USDA process verified program (PVP) certification, by animal welfare groups, by livestock producers, or by a private, third party that was not associated with either the livestock industry nor a consumer group. They found a positive willingness to pay for verification by industry, consumer groups, and the USDA, but a significantly negative WTP for private, third parties. USDA was consistently found to have the highest WTP. In our analysis, we used three different verification attributes: none, USDA, and private, third-party verification. An example choice scenario is displayed in Appendix B.[4]

Estimation Methods

Random utility theory frequently underlies analyses that use choice experiments and assumes that economic agents seek to maximize their expected utility subject to a given choice set. An individual's utility is considered a random variable because researchers have incomplete information. Choice experiments (CE) are based upon the assumption that individual i receives utility (U) from selecting option j in choice situation t. Utility is represented by deterministic [V(x_{ijt})] and stochastic (ε_{ijt}) components and is specified here as:

$$U_{ijt} = V(x_{ijt}) + \varepsilon_{ijt}, \tag{1}$$

where x_{ijt} is a vector of milk attributes and ε_{ijt} is the stochastic error component that is *i.i.d.* over all individuals, alternatives, and choice situations (Revelt and Train, 1998). Alfnes (2004) notes that this describes a panel data model where the cross-sectional element is individual i and the time-series component is the t choice situations. That is, the data are treated as a panel because each person faces six or seven choice sets. Respondents' choices (e.g., their familiarity with milk production) are consistently latent across CE designs and effectively have a systematic omitted variables effect on the errors associated with each CE observation. We capture some of this influence by allowing the errors to be correlated across CE scenarios for a given person. Consequently, our model estimation procedures use the panel data specification procedure in LIMDEP (Greene, 2002).

Our estimated models specify the systematic portion of the utility function as:

$$V_{ijt} = \alpha' P_{ijt} + \beta_i \boldsymbol{x}_{jt} \quad \forall\ j = A, B, \tag{2}$$

$$V_{ijt} = \delta \quad \forall\ j = C, \tag{3}$$

where P_{ijt} is price and $\boldsymbol{x}_{jt}$ is a vector of milk attributes that include

$$LabeledrbST - free_{jt}, IntensiveGrazing_{jt}, ModerateGrazing_{jt}, FamilyFarm_{jt},$$
$$Local_{jt}, EnhancedFoodSafety_{jt}, ThirdPartyCertification_{jt}, USDACertification_{jt},$$

where 'A' and 'B' refer to the two milk choices, while 'C' indicates that the respondent would choose to purchase neither (see example in Appendix B). Note that $\boldsymbol{x}_{jt}$ is an 8x1 vector if enhanced food safety claims are included, but a 7x1 vector if they are not. The base set of attributes includes no claims regarding rbST use, grazing, family farm, local, enhanced food safety or certification of

[4] To summarize the choice experiment, there were potentially 12 versions of the survey (2 for size (gallon/half), 2 for food safety (enhanced/not), and three for rbST labels). Below we test whether these versions can be pooled together.

production practices.[5] The remaining terms in equations (2) and (3) - α, β, and δ - are parameter vectors to be estimated.

Equations (1)-(3) can be estimated with homogeneous or heterogeneous preferences for the evaluated sample of consumers. Recent research suggests consumers often possess heterogeneous preferences. Therefore, a model that allows for and evaluates preference heterogeneity is appropriate (Lusk, Roosen, and Fox, 2003; Alfnes and Rickertsen, 2003; Alfnes, 2004; Tonsor et al., 2005). Our analysis examines preference heterogeneity by estimating a random parameters logit (also known as mixed logit) model. Random parameters logit (RPL) models nest traditional models that assume preference homogeneity and provide valuable insights into differential welfare effects on a sample of potentially heterogeneous consumers. The RPL model allows for random taste variation within the surveyed population, is free of the independence of irrelevant alternatives (IIA) assumption (i.e., the assumption that choosing one alternative over another is unaffected by the presence of additional alternatives), and allows correlation in unobserved factors over time. This eliminates three limitations of standard logit models (Train, 2003; Revelt and Train, 1998). In the context of our study, the RPL approach is appealing because some of the milk attributes presented in our choice experiment are similar which makes the IIA assumption overly restrictive. We estimated RPL models allowing preferences to vary normally in the population evaluated.

The RPL approach is applied to general random utility of equation (1) as:

$$U_{ijt} = \lambda_i' x_{ijt} + \varepsilon_{ijt}, \tag{4}$$

where x_{ijt} is a vector of observed variables, λ_i is unobserved for each individual and varies within the population with density $f(\lambda_i|\theta^*)$ where θ^* are the true parameters of this distribution, and ε_{ijt} is the stochastic error component *i.i.d.* over all individuals, alternatives, and choice situations (Revelt and Train, 1998). For maximum likelihood estimation of the RPL model we must specify the probability of each individual's sequence of selections. Let $j(i,t)$ denote the alternative that individual i choose in period (or choice set) t. The unconditional probability of subject i's sequence of selections is given by (Revelt and Train, 1998):

$$P_i(\theta^*) = \int \prod_t \frac{e^{\lambda_i' x_{ij(i,t)t}}}{\sum_j e^{\lambda_i' x_{ijt}}} f(\lambda_i|\theta^* d)\lambda_i. \tag{5}$$

Willingness to Pay Estimation

Mean WTP estimates for the RPL models are calculated as the negative ratio of the estimated coefficient on the verified attribute to the price coefficient. The coefficient on the verified attribute k is multiplied by two in the WTP ratio in this analysis because of effects coding (Lusk, Roosen, and Fox, 2003). The WTP for verified attribute k in this analysis was calculated as $WTP_k = -\left(\frac{2\beta_k}{\beta_c}\right)$, where β_k is the coefficient on a verified attribute and β_c is the coefficient on price. If the standard deviations of the attribute constants are not statistically different from zero, the estimated mean WTP can be interpreted as representative for the entire surveyed consumer group. In this case, the RPL interpretation reverts to that of the standard multinomial logit (MNL) model and indicates a lack of heterogeneity. Evidence of preference heterogeneity exists if standard deviations are statistically jointly significant, in which case mean WTP estimates calculated cannot be interpreted as being representative for the entire sample. The delta method was used to estimate a 95% confidence interval for mean WTP values and consider statistical variability in estimates of WTP.

[5] Effects coding means that the eight attributes in equation (2) take on a value of 1 when applicable, a value of -1 when the base milk attribute applies, and zero otherwise. Effects coding is used to avoid confounding with the *Opt Out* coefficient (δ) (Ouma, Abdulai, and Drucker, 2007).

Results and Discussion

Respondents self-selected into gallon and half-gallon purchasers. We then drew a sample that consisted of one-half of each. We further randomly assigned the choice experiments so that one-half of the sample included enhanced food safety attribute information. In addition, one-third of the sample each randomly received information regarding one of the three rbST-free labels. Hence, several potential sample pooling alternatives were available. We estimated models that: (*a*) pooled across half and whole gallon treatments, (*b*) across treatments including and excluding enhanced food safety (FS), and (*c*) across the three rbST-free label information treatments. Likelihood ratio tests compared each of these pooled samples to independent samples. These tests indicated that the gallon and half-gallon treatments could not be pooled. The same was true for treatments including and excluding food safety attributes. With respect to half-gallons with and without food safety and gallons with food safety, consumer choice experiment responses were found to be insensitive to the information treatment. That is, we failed to reject the hypothesis that we can pool observations across consumers receiving the three alternative information statements. This result is similar to that of Lusk, Norwood, and Pruitt's (2006) swine production. Therefore, we had six distinct samples to analyze: 1) half-gallon with FS (253 respondents), 2) half-gallon without FS (253 respondents), 3) gallon with FS (251 respondents), 4) gallon without FS and label information treatment (No artificial hormones) (83 respondents), 5) gallon without FS and label information treatment 2 (Our farmers pledge) (83 respondents), and 6) gallon without FS and label information treatment 1 (FDA recommended label–no significant difference) (84 respondents).

Summary data of selected demographic attributes of survey respondents are provided in table 2 where the first column summarizes the entire sample. Our survey targeted the principal household grocery or food purchaser and resulted in the majority of respondents being female (Loureiro, McCluskey, and Mittelhammer, 2003). Respondents averaged 54 years of age for the entire sample. Half-gallon purchasers were older. Approximately one-third of respondents had earned a college degree. Nearly all respondents were at least occasional milk consumers, with more than 92% consuming milk each week. Across the six sub-sets, primary shoppers from households that purchased gallons were on average younger, less educated, had lower incomes, and larger families.

Respondents overwhelmingly agreed that their definition of family farms included family ownership and were smaller than the average dairy farm (table 3). The majority of respondents were unwilling to consider corporate ownership as part of family farming–although we did not make a distinction between publically traded corporations (which are uncommon for U.S. farms) and closely-held corporations or limited liability corporations (LLC's) which are increasingly common. A majority of respondents were, however, willing to include hired labor in their definition of a family farm. With respect to "local" milk definition, the modal categories were "within 50 miles" and "within the state" (table 3). "Within the state" as a definition of local was consistent with the finding of Darby et al. (2008).

The results for the half-gallon and gallon models are presented in tables 4 and 5. Because the MNL model was rejected in favor of the RPL for the half-gallon consumers (both with and without enhanced food safety), only RPL estimates are presented in table 4. In contrast, for the gallon purchasers without enhanced food safety assurance, the MNL was not rejected for all three label information treatments. Thus, the results in table 5 reflect the appropriate estimation model in each case.

All six sub-samples valued milk in their choice set as evidenced by consistently negative and significant coefficients on "opt out" (i.e., choosing neither option A nor B). Milk that was "rbST-free" had a positive and significant coefficient in all cases. Similarly, milk from "family farms," process verification by the USDA, and enhanced food safety (where applicable) had positive and significant coefficients.

Consumer response to the grazing attributes was not significant in many cases and in other cases either intensive or moderate grazing was significant but never both. *A priori* we expected

Table 2. Definitions of Variables

Variable	Definition	Entire Sample	Half gallon, Food safety	Half gallon, No Food safety	Gallon, Food safety	Gallon, No food safety Info 1	Gallon, No food safety Info 2	Gallon, No food safety Info 3
Respondents	Sample size[a]	1,007	253	253	251	83	83	84
Gender	Female (%)	70.6	73.9	70.0	68.1	75.9	71.1	64.3
Age	Average age (yrs)	54.2	56.0	57.2	51.5	53.5	51.4	51.8
Education	College degree (%)	33.6	35.6	36.4	31.9	26.5	27.7	36.9
Adults	Number	1.97	1.81	1.96	2.07	2.00	2.06	2.09
Kids	Number	0.40	0.20	0.13	0.64	0.58	0.61	0.63
				Percentage (%)				
Household Income	< $20,000	16.2	17.4	15.8	19.5	15.7	9.6	10.7
	$20,000 - $39,999	26.3	30.4	22.9	26.3	19.3	36.1	21.4
	$40,000 - $59,999	20.5	15.4	20.6	22.7	22.9	22.9	23.8
	$60,000 - $79,999	15.8	13.8	19.0	12.0	18.1	14.5	22.6
	$80,000 - $99,999	8.6	7.1	8.7	8.8	12.1	4.8	13.1
	$100,000+	12.6	15.8	13.0	10.7	10.1	10.1	8.3
				Percentage (%)				
Milk Consumption	None	7.3	5.1	5.9	9.2	8.4	10.8	7.1
	<0.5 gal./week	29.6	48.6	49.4	9.2	13.3	29.6	9.5
	0.5-1.0 gal./week	32.6	31.6	30.4	31.9	41.0	28.9	39.3
	1.1-2.0 gal./week	18.9	11.1	12.3	25.5	21.7	37.4	21.4
	2.1-3.0 gal./week	6.5	2.0	0.8	12.8	9.6	9.6	11.9
	>3.0 gal./week	5.3	1.6	1.2	11.6	6.0	3.6	10.7

Notes: [a]Each respondent answered six or seven choice scenarios (to which they were randomly assigned) making the total choice observations the production of respondents (83 to 253 depending on distinct subsample) and the number of presented scenarios (six or seven).

that intensive grazing would be more valued that moderate grazing. Perhaps controlling for "family farm," which was correlated with herd size and grazing (Gillespie et al., 2009). Either of these two variables could have captured some of these concerns as no clear pattern of grazing practice value emerged across groups. It is also possible that respondents do not value grass-fed milk production or differentiate between the "moderate" and "intensive" grazing attributes.

Table 3. Responses to rbST, Family Farm, and Local Definitions

Question	Response (%)
Over the past three years have you reduced your milk consumption because of concerns with use of rbST/rbGH? (% 'Yes')	14.5
If yes, reduced by roughly ___%	50.7
What does your definition of "Family" farm entail? (check all that apply)	
Family owned	96.4
Corporate ownership	5.3
Only family labor	31.5
Hired labor allowed	78.5
Smaller than average size	75.0
Which of the following best describes the proximity from your home you consider "local" food to originate from?	
10 miles	12.6
20 miles	18.7
50 miles	26.7
100 miles	13.4
Within state	26.9
Other	1.7

Willingness to Pay

The coefficients were converted to mean WTP values (table 6). The half-gallon WTP values are presented in dollars per half gallon or dollars per gallon depending on the allocated CE treatment. For reference, the average half-gallon price was $2.69 and the average gallon price was $4.49. Half-gallon purchasers expressed an average WTP of more than $1/half-gallon for rbST-free milk when presented choices with or without the enhanced food safety attribute. Respondents were willing to pay approximately 10% more for milk from cows that were moderately grazed. Locally-produced milk had about the same premium. Half-gallon purchasers also expressed a high WTP for USDA verification but a significantly negative WTP for private, third-party verification. This result is consistent with that of Olynk, Tonsor, and Wolf (2010). We cannot ascertain whether respondents assumed that the milk industry would have undue influence on private verifiers, but clearly, the government was the preferred verification agent.

Differences between WTP with labeled enhanced food safety and that without a food safety claim reveals that, for half-gallon purchasers, intensive grazing may have captured some of the enhanced food safety effect. However, this result was not found with gallon purchasers. Gallon purchasers with enhanced food safety were willing to pay an average premium of about 20% for rbST-free milk. In other respects, gallon purchasers of milk with food safety claims were almost identical to half-gallon purchasers with enhanced food safety claims. The primary difference being that half-gallon purchasers were willing to pay more for each attribute.

Label information effects were significant for consumers who purchased fluid milk in gallons without food safety claims. Respondents shown the first label ("No artificial hormones") had the smallest WTP for local and family farm attributes. Respondents shown the second label ("Our farmers pledge...") had the highest WTP for rbST-free, local milk, and USDA verification. Finally, respondents shown the third label ("From cows not treated with rbST. No significant difference..."), which is arguably the most scientific, had the lowest value for USDA verification. Differences in preferences for gallon purchasing consumers shown the three various labels warrant continued discussion and research on marketing campaigns and food labeling. Clearly the choice of label, even though the same production process is described, impacted the preferences of consumers who

Table 4. Random Parameters Logit Estimates, Half-gallons

	Half Gallon with Food Safety RPL		Half Gallon without Food Safety RPL	
Variable	Coeff (Std Err)	Std Dev (Std Err)	Coeff (Std Err)	Std Dev (Std Err)
Price	-0.79***		-0.89***	
	(0.07)		(0.07)	
rbST-free	0.49***	0.51***	0.48***	0.31***
	(0.05)	(0.07)	(0.06)	(0.11)
Intensive Grazing	0.02	0.16	0.14**	0.51***
	(0.07)	(0.23)	(0.07)	(0.10)
Moderate Grazing	0.11*	0.09	0.09	0.005
	(0.06)	(0.25)	(0.07)	(0.11)
Family Farm	0.15***	0.002	0.21***	0.0004
	(0.04)	(0.08)	(0.05)	(0.08)
Local	0.09*	0.01	0.08*	0.002
	(0.04)	(0.11)	(0.05)	(0.07)
USDA Verification	0.79***	0.55***	0.75***	0.54***
	(0.07)	(0.09)	(0.08)	(0.11)
Private Verification	-0.17***	0.06	-0.41***	0.55***
	(0.06)	(0.13)	(0.08)	(0.14)
Enhanced Food Safety	0.33***	0.02		
	(0.04)	(0.21)		
Opt Out	-2.12***		-2.20***	
	(0.18)		(0.20)	
Log-likelihood	-1,718		-1486	

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

usually purchased gallon containers. Perhaps of particular interest to marketers and researchers is the fact that while the label mattered to survey respondents who purchased milk by the gallon, the label did not matter for half-gallon consumers. Respondents purchasing milk in half-gallon containers had differences beyond quantity of milk purchased or container size.

The rbST-free label did not have a differential effect on consumer valuation for half-gallon purchasers with or without labeled food safety enhancement. On the other hand, these consumers were willing to pay a premium that averaged 40-45% for rbST-free milk. Essentially, these consumers expressed a willingness-to-pay for milk produced without rbST regardless of labeling strategy. For gallon purchasers of milk that lacked food safety enhancement claims, the label in which farmers pledged not to use rbST (info 2) resulted in a WTP that was twice the size of the other two labels. As other research has shown, farmers appear to be trusted by U.S. consumers (Ellison, Lusk, and Briggeman, 2010).

These results suggest that there is a market for milk produced without rbST and, perhaps, it may not be that food safety concerns drive the result. Some consumers were willing to pay extra for milk from cows that grazed–even controlling for family farm considerations. Consumers value "family farm" as a concept and believe the moniker is correlated with non-corporate business structures and smaller-than-average operations.

U.S. milk is marketed through producer-owned cooperatives. In most cases, these cooperatives consist of heterogeneous milk producers in terms of farm size, ownership structure, and grazing

Table 5. Multinomial and Random Parameters Logit Estimates, Gallon Purchases

	Gallon with Food Safety		Gallon without Food Safety by Label Information Treatment		
			1[a]	2[b]	3[c]
Variable	RPL Coeff (Std Err)	RPL Std Dev (Std Err)	MNL Coeff (Std Err)	MNL Coeff (Std Err)	MNL Coeff (Std Err)
Price	-0.67***		-0.87***	-0.68***	-0.91***
	(0.04)		(0.08)	(0.07)	(0.08)
rbST-free	0.29***	0.37***	0.38***	0.57***	0.39***
	(0.05)	(0.07)	(0.09)	(0.09)	(0.09)
Intensive Grazing	0.14**	0.01	-0.01	0.24***	0.14
	(0.07)	(0.27)	(0.11)	(0.10)	(0.11)
Moderate Grazing	0.05	0.02	0.06	-0.13	-0.10
	(0.06)	(0.24)	(0.11)	(0.11)	(0.12)
Family Farm	0.17***	0.001	0.14*	0.17**	0.23***
	(0.04)	(0.08)	(0.07)	(0.07)	(0.08)
Local	0.06	0.005	-0.02	0.17**	0.17**
	(0.04)	(0.11)	(0.08)	(0.08)	(0.08)
USDA Verification	0.66***	0.42***	0.58***	0.66***	0.43***
	(0.07)	(0.10)	(0.11)	(0.11)	(0.11)
Private Verification	-0.17***	0.006	-0.32***	-0.22*	-0.21*
	(0.06)	(0.15)	(0.12)	(0.12)	(0.12)
Enhanced Food Safety	0.28***	0.01			
	(0.04)	(0.18)			
Opt Out	-2.66***		-4.04***	-2.90***	-3.83***
	(0.18)		(0.35)	(0.33)	(0.35)
% Opt Out			38.6	30.5	34.3
Log-likelihood	-1,702		-452	-466	-453

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.
[a] Information treatment 1 was the rbST/rbGH-free label "No artificial hormones."
[b] Information treatment 2 was the rbST/rbGH-free label "Our farmers pledge, milk from cows not supplemented with rbST"
[c] Information treatment 3 was the rbST/rbGH-free label "From cows not treated with rbST. No significant difference has been shown between milk derived from rbST-treated and non-rbST-treated cows."

operations. Dairy cooperatives often find it cost prohibitive to segregate and market milk based on production attributes such as rbST-free or grazing (Cook-Mowery, Olynk, and Wolf, 2009). Hence, most dairy cooperatives either market all milk as rbST-free or not. Large cooperatives which operate across multiple production regions might segregate supplies so that some regions are rbST-free while others are not. Our results suggest that there may be opportunities to segregate and verify production attributes and increase revenues from milk sales. However, such gains must be large enough to offset the costs of segregation.

Organic milk commands a large premium with an expanding market share in recent years. The retail price of organic milk tends to be twice that of conventional milk. Similar to Bernard and Bernard (2009), we found that many attributes of organic milk production (i.e., rbST-free and grazing) are significantly valued by consumers. Thus, there likely exists opportunities for retailers to segment the milk market by offering products with attributes that lie between

Table 6. Consumer Willingness-to-Pay for Milk Production Attributes

	Half Gallon with Food Safety	Half Gallon without Food Safety	Gallon with Food Safety	Gallon without Food Safety and Label Info. 1[a]	Gallon without Food Safety and Label Info. 2[b]	Gallon without Food Safety and Label Info. 3[c]
Variable	**$/half-gallon**		**$/gallon**			
rbST-free	1.23*	1.09*	0.88*	0.88*	1.68*	0.87*
Intensive Grazing	0.06	0.32*	0.41*	-0.02	0.70*	0.31*
Moderate Grazing	0.28*	0.21*	0.14	0.14	-0.37*	-0.21
Family Farm	0.39*	0.46*	0.52*	0.33*	0.50*	0.51*
Local	0.22*	0.19*	0.19*	-0.04	0.51*	0.37*
USDA Verification	2.00*	1.69*	1.99*	1.33*	1.95*	0.94*
Private Verification	-0.44*	-0.92*	-0.50*	-0.74*	-0.64*	-0.46*
Enhanced Food Safety	0.83*		0.83*			-4.27*
Opt Out	-2.70*	-2.48*	-3.98*	-4.66*	-4.27*	-4.27*

Notes: Single asterisk (*) indicates that the 95% confidence interval for that willingness-to-pay value does not contain zero.
[a] Information treatment 1 was the rbST/rbGH-free label "No artificial hormones."
[b] Information treatment 2 was the rbST/rbGH-free label "Our farmers pledge, milk from cows not supplemented with rbST"
[c] Information treatment 3 was the rbST/rbGH-free label "From cows not treated with rbST. No significant difference has been shown between milk derived from rbST-treated and non-rbST-treated cows."

conventional and organic milk. The organic market has been served by smaller dairy cooperatives that operate separately from conventional cooperatives rather than as niche ventures by conventional cooperatives. Even though many of the practices examined in our experiment already occur on many dairy farms, the co-mingling of milk at processing plants inhibits market segmentation opportunities. If retailers were to offer milk with multiple attribute combinations, then the current milk marketing system might not be sufficient in many areas to economically supply these products. One result might be increased pressure on the current dairy processing industry to make milk segregation investments.

Summary and Conclusions

This research examined U.S. consumer willingness to pay for milk production attributes. Respondents were offered milk in half-or whole gallons depending on their usual consumption patterns. Production attributes included rbST-free, grazing, family farm, local production, USDA or private verification, and enhanced food safety. Tests rejected pooling results for gallon or half-gallon consumers as well as with or without an enhanced food safety attribute. Although statistical tests rejected pooling these groups, there were many consistent findings across the groups. Results indicated a significant WTP for rbST-free production, family farm, and local production as well as for food safety enhancement and USDA verification.

With respect to half-gallons with and without food safety and gallons with food safety enhancement, consumer choice experiment responses were found to be insensitive to the rbST-free label. Differences in preferences for gallon purchasing consumers shown the three various labels warrant continued discussion and research on marketing campaigns and food labeling. Clearly respondents purchasing milk in these differing quantities have differences extending beyond quantity of milk purchased or container size.

Because we were interested in sets of milk production attributes that are not currently marketed (although some may apply to milk available in any given store), we used hypothetical choice experiments. We found significant premiums in many cases – for example, 20 to 40% for rbST-free milk. The use of non-hypothetical methods is important to complement this study as hypothetical bias is a well known aspect of contingent valuation approaches (Lusk, 2003; Lusk and Schroeder, 2004). Accordingly, our WTP estimates should be considered upper bounds of true WTP valuations.

This research considered consumer preferences for fluid milk. Further research investigating preferences for various production process attributes for milk used to produce cheeses, yogurt, and other dairy products is warranted. Consumers may have different preferences for beverage milk than for milk used to produce dairy products. In particular, are consumers of high-value specialty cheeses looking for specific production process attributes in those cheeses that differ from those in fluid milk? Are similar production process attributes desired regardless of the dairy product being sold? Other issues left to future research include more specific definitions of food safety attributes and whether these effects differ by fat content of milk.

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Appendix A: Attribute Definitions

Milk production method is the method used in producing the milk where:

- **Labeled rbST/rbGH-Free** milk was labeled using one of three labels randomly assigned
  1. "No artificial hormones."
  2. "Our farmers pledge, milk from cows not supplemented with rbST."
  3. "From cows not treated with rbST. No significant difference has been shown between milk derived from rbST-treated and non-rbST-treated cows."
- **No claim** is made about production practices.

Feeding/housing practices refers to practices on the farms the milk came from where:

- **Intensive grazing** means the milk was produced on a farm that utilizes pasture grazing for most of its forage feed with cows outside on pasture when not being milked,
- **Moderate grazing** means the milk was produced on a farm that utilizes some pasture grazing with cows outside on pasture when conditions are favorable,
- **No claim** indicates that nothing is stated about feeding or housing practices.

Organization refers to the farms the milk came from where:

- **Family farm** means the animal was raised on an operation marketing itself as a "Family Farm,"
- **No claim** indicates that no claims on farm organization are made.

Location refers to the proximity of the source farms to your home:

- **Local** means the milk was produced on a farm that is near your home.
- **No claim** is made about the location of the source farms.

Food Safety refers to the potential presence of additional food safety measures beyond current laws:

- **Enhanced** food safety practices are assured,
- **No claim** is made about additional food safety programs.

Certification refers to the process used in verifying all claims made on the milk label where:

- **USDA** means the label is backed by a producer's participation in a certification and verification program managed by the United States Department of Agriculture (USDA),
- **Private, 3rd party** means the label is backed by a producer's participation in a certification and verification program managed by a private, third party company,
- **No claim** indicates that no claims on certification procedures are made.

Appendix B: Example Choice Scenario

Milk Attribute	Option A	Option B	Option C
Price ($/gallon)[a]	$3.99	$5.99	
Milk Production Method	No claim	Labeled rbST-free	I choose
Feeding/Housing Practice	Moderate grazing	Moderate grazing	not to
Organization	Family farm	No claim	purchase
Location	Local	Local	either
Food Safety[b]	Assured	No claim	of these
Certification	Private, 3rd party	Private, 3rd party	products.
I choose...			

Notes: [a] Price was in terms of $/gallon for respondents who indicated they usually purchased gallons and in $/half-gallon for those who usually purchased milk in half-gallons.
[b] Half of respondents saw "enhanced food safety" as a potential attribute.