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Verifying Credence Attributes in Livestock Production

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Livestock producers can respond to increasing consumer demand for certain production process attributes by providing verifiable information on the practices used. Consumer willingness to pay data were used to inform producer decision-making regarding selection of verification entities for four key production process attributes in the production of pork chops and milk. The potential for informing farm-level decision-making with information about consumer demand for product and production process attributes exists beyond the two products assessed as example cases in this analysis.

Key Words: animal welfare, certification, credence attribute, producer decision support, response to consumer demand, verification, willingness to pay

JEL Classifications: Q11, Q12, Q19

Today′s consumers are concerned about the treatment of livestock and welfare of animals used to produce meat and milk products (Frewer et al., 2005). Food product safety and the characteristics of the processes used in the production of food products are increasingly important in the operation of food systems (Caswell, 1998). Livestock producers can respond to consumer concerns by providing verifiable information regarding production process attributes. Many of the claims regarding process attributes are credence attributes of the production processes. Caswell and Mojduszka (1996) define a credence attribute as an attribute in which quality cannot be assessed even after the product is purchased and consumed (Caswell and Mojduszka, 1996). Producers cannot provide verification of credence attributes through traditional testing methods. This informational asymmetry begs questions surrounding how producers will convey information to consumers.

Information on production processes used must be conveyed to the consumer by the producer through an avenue that consumers trust.[1]

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[1] In reality, the entire supply chain must be convinced of the value of the verification for these production process attributes. On-farm production practices must be verified by (or beginning with) the livestock producer. Consumer willingness to pay was assessed in this analysis because it is ultimately the consumers' preferences and consumer demand that drive what will be produced or the attributes of what will be produced. It is, however, worth noting that although production practices must be conveyed by the producer to the consumer in a way in which consumers trust, the actual conveying of this information is likely to be through the supply chain, which may include multiple steps depending on the specific livestock product.

Specific to livestock rearing, claims surrounding handling and housing practices are credence attributes of the production processes used. For example, at no point before, after, or during consumption of a pork chop is the consumer able to determine the housing system used to raise the hog. Along the same lines, at no point before, during, or after consumption could a consumer of milk determine if the cows that produced that milk had access to pasture.

Producers can seek to maximize profit through their selection of verified production process attributes to provide to the market. Producers will not decide to supply these production process attributes unless 1) they are required to do so; or 2) they find it profitable to supply (Caswell and Mojduszka, 1996). If a specific production process attribute is already present in the systems used on an operation, producers can seek to maximize profit by selecting from alternative verification methods used to communicate that attribute to the consumer. Tonsor, Olynk, and Wolf (2009) describe ballot initiatives that have passed in several states that would phase out the use of gestation crates (also known as stalls) in pork production. In these cases, the individual livestock producer would not seek to determine whether it is economically advantageous to produce without individual crates. Instead, a producer operating under a ban on the use of gestation crates would maximize expected profit by choosing the optimal verifying entity. Even in the case in which the production practice used is predetermined, the profit maximizing choice of verifying entity may not be the lowest cost entity, but will be the verifying party that yields the highest net return to the livestock producer. It is conceivable that the verification method in which consumers place the highest value (e.g., a federal government system) is simply too costly for producers to pursue, whereas a relatively lower-valued program or verification party (e.g., a private third party) in the eyes of consumers provides higher net returns for producers.

As noted by Lusk and Hudson (2004), willingness to pay (WTP) is usually discussed in the context of consumer utility maximization, although the concept can also be applied to producers. Recently, several studies have assessed producer willingness to change operational practices. Schulz and Tonsor (2010) identified preferences of U.S. cow–calf producers for traceability systems and found heterogeneity among producers not only in their preferences, but also in the welfare effects of mandating traceability. Norwood et al. (2006) provide information from Oklahoma cattle producers regarding preferences of the design of voluntary checkoff programs. Roe, Sporleder, and Belleville (2004) examined hog producer preferences for hog marketing contract attributes and found producers value window contract ceiling and floor prices differently. Davis and Gillespie (2007) found that hog producers differ in their valuations of autonomy and risk acceptance in selecting from alternative business arrangements. Norwood, Luter, and Massey (2005) conducted a survey to measure crop producers' WTP for manure from livestock operations. These examples demonstrate increasing evaluations of producer preferences and willingness to change with applications being applied to agricultural producers of all levels, from individual farm-level producers to agribusinesses and marketing firms.

It is imperative for producers to understand the preferences of consumers and to consider how animal-rearing methods are taken into account in food purchasing decisions. The major focus of much consumer WTP work has been on theoretical issues, methodological questions surrounding estimating WTP, or policy issues rather than on making adoption or pricing decisions of producers (Lusk and Hudson, 2004). Estimates of consumer WTP can be beneficial in decision-making for agribusinesses as they move toward serving a more consumer demand-riven market (Lusk and Hudson, 2004). Lusk and Hudson (2004) explicitly sought to provide insight into the benefits and challenges of the use of consumer WTP data for decision-making in agribusinesses. Estimates of consumer demand could be particularly useful when agribusinesses or agricultural producers are assessing provision of new products or services. For example, in this analysis, it is shown that livestock producers can use estimates of consumer WTP to

assess the potential net benefits associated with providing certain verified attributes.

Incorporating both the value and cost of verification programs is essential to selecting the optimal verification method for livestock producers. This approach includes both demand-side impacts and supply-side cost impacts and this analysis develops and applies a conceptual model for this situation. In particular, we focus on two livestock products (pork chops and milk) and four production process attributes (individual crates or stalls, pasture access, antibiotic use, and certified trucking or transport). The incorporation of consumer demand data, or estimates of WTP, to support decision-making of livestock producers is demonstrated. This analysis allows producers to select among four potential verifying methods, including self, consumer group, private party, or USDA Producer Verified Program (PVP)[2] verification. Two different decisions can be informed for producers through this analysis. Producers may wish to determine which attributes to adopt concurrent with the decision of how to verify those attributes, or if a producer is already using a production process with certain attributes, they may wish to investigate how to verify those processes. Examples provided throughout this analysis are focused on decision support for the scenario in which a producer is already providing a certain attribute but is seeking how to verify that process attribute. The conceptual application of using WTP estimates to support farm-level decision-making is much more widely applicable than the examples provided in this analysis.

Research Design

Estimates of consumer value, or consumer WTP, were included in this analysis to calculate estimates of the potential producer benefits of providing a verified attribute. Critical points were sought to identify the ranges of costs over which verification by certain entities was optimal for livestock producers. Critical points were first assessed using mean WTP estimates. Then, assuming that livestock producers face heterogeneous cost structures associated with providing verified attributes, or switching processes to provide specific verified attributes, implications of adjustment costs are discussed. For discussion throughout this analysis, it is assumed that livestock producers can be broken into two distinct groups, namely low or high adjustment cost groups.[3] Adjustment costs are expected to vary greatly across farms. Differences in costs to provide a verified attribute could be the result of a number of reasons, including, but not limited to, economies of scale, economies of scope, or ease of verification resulting from other farm-specific factors. For example, if a farm, before the decision to provide a verified attribute, already had in-depth records of production processes and documented processes, including the attributes they wished to verify, adjustment costs would be expected to be lower than on a farm that kept no records of production practices. The two cost groups are used to illustrate the potential impacts of varying relative costs of providing verified attributes on the decisions of livestock producers.

Producer Decision Support Model Specification and Data Used

Estimates of consumer WTP for verified production process attributes were obtained for this analysis from Olynk, Tonsor, and Wolf (2010). Four livestock production process attributes, four verifying entities, and two livestock products were included in this analysis. The four livestock production process attributes

[2] The Grain Inspectors, Packers and Stockyards Administration (GIPSA) PVP has official procedures in place for verification of products assigned to GIPSA and services associated with marketing these products (USDA, 2007). Verification services through GIPSA are voluntary and provided to producers, marketers, processors, and other associated service providers of agricultural products for a fee (USDA, 2007).

[3] The low adjustment cost group is expected to have relatively lower adjustment costs associated with verification and adoption of different production processes, whereas the high adjustment cost group has a relatively higher cost of adjustment and verification.

investigated in this analysis included whether individual crates/stalls were permitted or not permitted, pasture access was required or not required, antibiotic use was permitted or not permitted, and whether certified trucking/transport was required or not required. The two livestock products analyzed were pork chops and milk. Throughout the analysis, to provide verified attributes to consumers, livestock producers could choose to verify claims themselves (self verification), to use a private third party, to use a consumer group, or to use the USDA PVP (Olynk, Tonsor, and Wolf, 2010). Self-verification can be accomplished through documenting production processes in various ways using video, photographs, or even detailed written records of production practices. Alternatively, consumer groups may have programs in place that may be applicable to livestock producers wishing to provide verified attributes. An example of verification through a consumer group is the Certified Humane Raised and Handled® program by the Humane Farm Animal Care Program. Verification by a private third party could include products being marketed under a specific brand because many private brands make claims regarding the practices used to produce their product. A livestock producer may choose to sell their meat or milk to be marketed under a specific brand name that makes claims regarding and verifies the production practices used. As another alternative available to livestock producers, the USDA PVP provides verification of program-approved claims (USDA, 2007). Table 1 summarizes the product attributes and verification entities included in this analysis.

The livestock producer must choose the verification entity that maximizes profit by taking into account the expected revenue and costs associated with each verification method. The producer's maximization problem is $Max[\alpha' X] - [\beta' X]$, where $\alpha = [\alpha_1, \alpha_2, \alpha_3, \alpha_4]$ is the per unit revenue for the producer for participating in verification method $i = 1, 2, 3,$ or 4; $X = [x_1,\ x_2,\ x_3,\ x_4]$ is the choice of verification method i; and $\beta = [\beta_1, \beta_2, \beta_3, \beta_4]$ is the per unit cost to the producer of verification method i. Taking the first-order condition of the producer's maximization problem with respect to the choice variable, X, yields the optimal condition that $\alpha' = \beta'$, or that the marginal revenue must equal the marginal cost for the producer.[4,5] Solving the producer's maximization problem yields a decision rule of the form $X^*(\alpha,\beta)$.

Table 1. Product Attributes and Certification Entities

Product Attributes	Attribute Levels
Individual crates/stalls	Not permitted
	Permitted
Pasture access	Not required
	Required
Antibiotic use	Not required
	Required
Certified trucking/transport	Not required
	Required
Certification entities	Self-certification
	Consumer croup
	Private, third party
	USDA-PVP

PVP, Producer Verified Program.

Consumer WTP estimates for verification of key production process attributes by specific verifying entity were taken from Olynk, Tonsor, and Wolf (2010). The values for α, which were obtained from random utility models, identify the WTP of consumers for verified attributes in pork chops or milk (Olynk, Tonsor, and Wolf, 2010). A total of 1334 respondents completed the survey: 669 respondents completed the survey with a choice experiment for

[4] Note that this maximization problem is solved considering each combination of livestock production process attribute (pasture access, individual crates/stalls, antibiotic use, and certified trucking or transport) and verifying entity (self-verification, private third party verification, consumer group, and USDA PVP). If the problem is constrained to making a decision regarding verifying a specific attribute such as the use of crates in pork production in our example application, the maximization problem is reduced to selecting the optimal verifying party from the four potential verifiers.

[5] This simplified framework assumes that the volume impacted is not sufficient to influence prices and that all cross-price impacts (both within a firm's product line and in aggregate markets) are zero.

pork chops and 665 respondents completed the survey with a choice experiment for milk (Olynk, Tonsor, and Wolf, 2010). The information and definitions provided to consumers participating in the survey with regard to the production process attributes and verifying entities are presented in Appendix 1.

The consumer WTP values were adjusted according to the portion of retail value expected to be conveyed through the supply chain to the livestock producer to obtain α, the per unit revenue associated with providing a verified attribute. Estimates of the farmers' share of the retail value of the livestock products must be incorporated in this analysis because the consumer WTP estimates are providing estimates of the total value to consumers, whereas the livestock producer receives only a portion of this amount. The estimate of the farmers' share of the retail pork and milk (using whole milk sold in gallons) value used in this analysis was 28.1% (U.S. Department of Agriculture [USDA], 2009a) and 53% (U.S. Department of Agriculture [USDA], 2009b), respectively. It is assumed throughout this analysis that the farmers' share of the retail value of the verification (the increase in value resulting from verification) will be the same as the share of the retail value that the producer receives on the product overall.[6] For example, using the data from pork chops, in the case of consumer group-verified pasture access, the estimate of consumer WTP was \$1.74/lb, whereas the portion that the livestock producer is expected to receive is only \$0.49/lb, as can be seen in Table 2.[7]

It is conceivable to think that consumers might exhibit some bias when answering questions related to animal welfare attributes because animal welfare can be a socially charged issue. Social desirability bias reflects the fact that people often have incentives to provide answers to self-reported questions about happiness, well-being, health, and attitudes that deviate from true answers to comply with what is socially acceptable (Lusk and Norwood, 2009). As a result of the tendency for people to overstate their own values to conform to social norms, and the resulting inflation of WTP estimates that could occur in such a situation, the indirect estimates of WTP are likely to be more indicative of consumers' actual WTP than direct estimates.[8] Olynk, Tonsor, and Wolf (2010) found evidence of social desirability bias. Estimates of WTP obtained through indirect questioning were used throughout this analysis as a result of the recognition that direct questioning may lead to inflated values of consumer WTP attributable to the presence of social desirability bias and in an effort to provide conservative estimates of consumer demand to support producer decision-making. Point estimates of consumer WTP obtained through indirect questioning for pork chops and milk can be seen in Table 2.

Reliable estimates for the costs associated with providing verified attributes were unavailable. Given the wide range of producer costs for verifying the production process

[6] This estimate of the farmers' share of the retail value is likely conservative because it is likely that those producers seeking voluntary verification of production process attributes would also be seeking other ways to obtain a larger share of the retail value. In other words, although the averages for farmers' share of retail value are used in this analysis, the farmers engaging in verification of process attributes are likely obtaining a higher than average share of the retail value as a result of the increased likelihood to participate in other activities (beyond this verification) which increase their share of the retail value. The average value is used throughout this analysis as a conservative estimate of the farmers' share of the retail value.

[7] In Table 2, the farmers' share of the retail value is presented as the maximum cost that farmers could pay to rationally provide a verified attribute. Conceptually, the total farmers' share of the retail value is the most that a farmer could spend to provide the attribute (without incurring a loss to do so).

[8] Fisher (1993) compared direct and indirect questioning in an effort to determine the ability of indirect questioning to reduce social desirability bias and found that indirect questioning reduced social desirability bias on those variables that were subject to social influence (and had no significant effect on socially neutral variables). Specifically focusing on the topic of farm animal well-being, Lusk and Norwood (2009) have tested indirect questioning as a method to mitigate social desirability bias.

Table 2. Consumer Willingness to Pay (WTP) and Share of WTP to Livestock Producer

Livestock Product	Pork Chops		Milk	
Verified Attribute	Consumer Value from Indirect Questioning	Breakeven Producer Cost to Provide Verified Attribute	Consumer Value from Indirect Questioning	Breakeven Producer Cost to Provide Verified Attribute
Self-verified pasture access	$0.41	$0.00	$0.20*	$0.11
Private party-verified pasture access	$(3.30)*	$0.00	$(1.63)*	$0.00
Consumer group-verified pasture access	$1.74*	$0.49	$1.17*	$0.62
USDA-verified pasture access	$6.30*	$1.77	$2.14*	$1.14
Self-verified individual crates/stalls	$2.66*	$0.75	$0.50*	$0.26
Private party-verified individual crates/stalls	$1.23*	$0.35	$(0.43)	$0.00
Consumer group-verified individual crates/stalls	$(0.04)	$0.00	$(0.08)	$0.00
USDA-verified individual crates/stalls	$2.58*	$0.73	$1.02*	$0.54
Self-verified antibiotic use	$0.40	$0.00	$(0.02)	$0.00
Private party-verified antibiotic use	$(3.43)*	$0.00	$(2.12)*	$0.00
Consumer group-verified antibiotic use	$0.29	$0.00	$0.53*	$0.28
USDA-verified antibiotic use	$4.27*	$1.20	$1.08*	$0.57
Self-verified certified trucking/transport	$(0.25)	$0.00	$0.18	$0.00
Private party-certified trucking/transport	$(7.01)*	$0.00	$(3.20)*	$0.00
Consumer group-certified trucking/transport	$(1.46)*	$0.00	$(0.42)*	$0.00
USDA-verified certified trucking/transport	$(1.30)*	$0.00	$(0.05)	$0.00

Indirect estimates of consumer value (WTP) are taken from Olynk, Tonsor, and Wolf (2009). Asterisk (*) indicates statistical significance at the 0.05 level. The farm shares of the retail value used for pork chops and milk throughout this analysis were 28.1% (USDA, 2009a) and 53% (USDA, 2009b), respectively). Breakeven producer costs for the verified attributes are provided for those attributes for which there was positive and statistically significant mean WTP identified; otherwise, the verified attribute is dropped from the analysis because the cost of providing the attribute would always exceed the value of provision to the livestock producer.

attributes through the four different potential verifying entities, identification of critical values at which the optimal verifying entity changes can aid in supporting decisions across a wide range of producers. To support producer decision-making, critical points for relative costs to the livestock producer between verification methods (verifying through different entities) that change the optimal producer verification method choice were identified. Through this analysis, decision rules regarding the verifying entity that would be optimal for ranges of relative costs will be identified for each of the livestock products and production process attributes included. Such rules will enable producers to incorporate their own information to determine the optimal verification program and ensure that the results are applicable over a wide range of producer cost structures.

Percent of Consumers Willing to Pay at Different Levels

Point estimates of consumer WTP values and the variance of those WTP estimates were used

to identify the distribution of consumer WTP under the assumption that WTP estimates are normally distributed (Alfnes, 2004). This analysis allows the percentage of consumers that have a higher WTP than some critical level to be estimated. Producer decision-making can be more completely informed by analyzing the distribution of consumer WTP values rather than relying on a single WTP estimate. Analyzing the percentage of consumers that have a WTP higher than some predetermined level can aid in determining the share of the market that producers can seek to serve. Producers can use their own cost estimates to determine the segment of the consumer population that has a WTP high enough to provide a return to providing the verified attribute. Producers must, however, also recognize that as the WTP for verified attributes increases, so does the number of producers who are willing and able to provide that attribute.

Results And Discussion

Estimates of consumer WTP for verification of various livestock production process attributes were used to establish the potential benefits to livestock producers associated with providing verified attributes. Consumer WTP for verified attributes differed across both livestock species and attributes. As a result, the critical points in producer verification costs at which a producer should switch verifying entities also differed by both the livestock product and the attribute in question.

The producer decision support mechanism described in this analysis can be used in two different manners. Producers can use such a mechanism to determine which verified attributes to adopt or to determine how to verify production process attributes that already exist on their operation. Results presented here assume that producers are already providing the production process attribute in question and are seeking to determine the profit maximizing verification method to verify the specific attribute. This use of the mechanism for decision support described is rather limiting, because it only applies to those producers who are providing the attribute in question. However, there are several groups of producers who fall into this category of needing to select the optimal verifying entity for a predetermined attribute, whether the attribute is legislatively determined, determined by retailers providing market access, or producers have simply already chosen a certain production system for other reasons. The presented model could easily be applied to producers evaluating the value in changing on-farm production practices following similar logic.

Critical Points Identified

The simplest criteria for whether producers may want to verify a specific production process attribute is whether the mean estimate for consumer WTP is positive. Table 2 highlights mean WTP estimates for pork chops and milk and the farm share of the retail value of the WTP. In the case of pork chops, mean estimates of WTP were negative and significant at the 0.05 level for private verification of pasture access and antibiotic use as well as for verification of certified trucking or transport by a private third-party, consumer group and USDA PVP. Clearly if the mean WTP was negative, a producer would not rationally voluntarily spend money to provide the verified attribute. Self-verified pasture access, consumer-verified individual stall or crates, self-verified antibiotic use, consumer group-verified antibiotic use, and self-verified certified trucking or transport had mean WTP estimates for pork chops that were not different from zero at the 0.05 significance level. For those attributes for which the mean WTP estimate was not different from zero, the maximum amount that the producer could spend on verification was also assumed to be zero, again because a rational producer would not spend a positive amount to provide an attribute for which consumers did not have a positive value.

When assessing mean estimates of WTP for milk, negative WTP estimates that were significant at the 0.05 level were observed for private party verification of pasture access, antibiotic use, or certified trucking or transport and consumer group verification of certified trucking or transport. Mean estimates of WTP

that were not statistically different from zero at the 0.05 level for milk production were private party or consumer group verification of individual crates or stalls, self-verified antibiotic use, and self- or USDA PVP-verified certified trucking or transport.

Operating under the assumption that swine producers in question already have access to pasture for their pigs, the question remains as to which verifying entity is the best choice for a producer. To obtain critical points, or the points at which producers should switch verification entities to obtain optimal returns, the ordering of costs of verification must be known. It was assumed that self-verification was the least costly consumer group and private third party the next most costly verification entities and that USDA PVP is the most costly verification entity. Using the mechanism described, and assuming that the cost for consumer group verification of pasture access was $0.01 as a starting point,[9] the optimal decision for the producer would be to switch to USDA PVP verification if it could be obtained for less than $1.29/lb. Regardless of other verification options presented as competing options, the producer should not incur costs of over $0.49/lb for providing consumer group verification of pasture access. Alternatively, assuming consumer group verification costs $0.15/lb, participation in an USDA PVP is optimal if feasible for less than $1.43/lb; otherwise, consumer group verification is the optimal choice.

Verification of individual crates or stalls for the production of pork chops presents an interesting case because even if the cost of verification through self, private party, and USDA PVP were $0.01/lb, the optimal verification method would be self-verification, which would return $0.74/lb in profit to verifying compared with $0.72/lb for USDA PVP and $0.34/lb for private party verification. In this case, self-verification is optimal under the assumption that self-verification is the lowest cost option.

Verification of antibiotic use in the production of pork chops presents a case in which the only statistically significant evidence of positive consumer demand is for verification by USDA PVP. If USDA PVP verification can be obtained for less than $1.20/lb, USDA PVP verification becomes the optimal decision. If USDA PVP verification cannot be obtained for less than $1.20/lb, verification through any of the four potential entities included here is not optimal.

Looking at verification of production process attributes in milk production, USDA PVP verification has the highest value to consumers for each attribute. In the case of verifying pasture access, if self-verification costs $0.01/gallon, the producer should switch to consumer group verification if it can be obtained for less than $0.52/gallon or USDA PVP verification if it can be obtained for less than $1.04/gallon. For verification of individual crates or stalls, assuming self-verification costs $0.01/gallon, the producer should switch to USDA PVP verification if it can be obtained for less than $0.29/gallon. In the case of verifying the use of antibiotics for milk production, the producer's decision is between consumer group verification and USDA PVP verification, because these are the two verification entities with positive mean WTP values. In this case, if it is assumed that consumer group verification costs $0.01/gallon, the producer should switch to USDA PVP verification if it can be obtained for less than $0.30/gallon. Because it is unlikely that consumer group verification could be obtained for $0.01, the starting value for consumer group verification cost was updated to $0.10 for comparison. If verification by consumer group costs $0.10, then the producer should switch to USDA PVP verification if it can be obtained for less than $0.39.

Statistical evidence of positive consumer demand for verification of certified trucking or transport was not found for any of the four verifying entities included in this analysis for either pork chops or milk. This suggests

[9] Note that although the cost of self-verification relative to other verification entities was assumed to be the lowest, in the case of self-verified pasture access for swine production, consumer WTP estimates were not different than zero. Therefore, the analysis for pasture access for swine begins with consumer group verification of pasture access.

a rational producer would not pay any positive amount to provide this verified attribute given the lack of positive consumer demand.

Incorporating Distribution of Consumer WTP Values

Using the distributions obtained surrounding these mean consumer WTP values, the percent of consumers that would be willing to pay more than a specified amount for verification of a given attribute can be determined. Because heterogeneity is expected in the cost structures of livestock producers, it is illustrative to think about the high-cost and low-cost producers outlined earlier. Table 3 shows the percent of consumers with total WTP greater than specified values for verified pork chop attributes in $0.50/lb increments of consumer WTP. For interpretation from the livestock producers' perspective, it is the farm share of the consumer WTP that is enlightening. Using Table 3, for example, 92.86%, 16.71%, and 88.64% of consumers have a WTP greater than $3.00/lb for USDA PVP-verified pasture access, individual crates/stalls, and antibiotic use, respectively. A more intuitive way for producers to interpret these numbers is to assess the percent of consumers that are willing to pay more than the cost of the verification. This allows producers to assess the farm share of a given WTP value and determine if their cost of providing the attribute is less than that farm share of the WTP. For example, a high-cost producer with a cost of providing self-verified individual crates or stalls approaching $0.98/lb can take note that only 7.90% of consumers have the WTP of $3.50/lb that is needed to provide $0.98/lb payment at the farm level. A low-cost producer, however, may be able to provide self-verified individual crates or stalls for nearly $0.28/lb, at which point 99.73% of consumers possess a WTP greater than the $1.00/lb necessary to provide $0.28/lb income at the farm level. Complicating the decisions facing these producers is the fact that likely far fewer producers can provide the attribute at $0.28/lb than can provide the attribute at $0.98/lb. Not only is the segment of the consumer market that is willing to pay the $3.50/lb far smaller than the

Table 3. Percent of Consumers with Willingness to Pay (WTP) Greater than Specific Increments for Verified Pork Chop Attributes with Statistical Evidence of Positive Consumer Demand

Consumer WTP	$0.00	$0.50	$1.00	$1.50	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50	$5.00
Farm share of rRetail WTP value	$0.00	$0.14	$0.28	$0.42	$0.56	$0.70	$0.84	$0.98	$1.12	$1.26	$1.41
Verified Attribute	Percent (%) of Consumers Willing to Pay More than the Above-Stated WTP										
Consumer group-verified pasture access	100.00	100.00	99.77	82.31	16.20	0.19	0.00	0.00	0.00	0.00	0.00
USDA-verified pasture access	99.74	99.50	99.07	98.35	97.19	95.43	92.86	89.32	84.65	78.80	71.81
Self-verified individual crates/stalls	100.00	99.99	99.73	97.41	86.57	60.52	28.35	7.90	1.22	0.10	0.00
Private party-verified individual crates/stalls	99.92	96.95	72.36	24.64	2.47	0.06	0.00	0.00	0.00	0.00	0.00
USDA-verified individual crates/stalls	100.00	100.00	99.99	99.40	91.20	57.68	16.71	1.68	0.05	0.00	0.00
USDA-verified antibiotic use	100.00	99.98	99.91	99.58	98.46	95.38	88.64	76.77	60.08	41.27	24.31

Only those verified attributes for which statistically significant evidence of positive mean WTP was found are included here for further analysis regarding the distribution of consumer WTP values. The farm share of the retail value used for pork chops throughout this analysis was 28.1% (USDA, 2009a).

portion willing to pay $1.00/lb, but the number of producers seeking to provide the attribute at this higher price is also likely much larger.

Table 4 shows the percent of consumers with total WTP greater than specified values for verified milk attributes in $0.20 or $0.10 increments of consumer WTP.[10] Farm share of retail WTP is shown in Table 4 to allow comparison similar to that presented for pork chops. Interestingly, 100% of consumers have a WTP high enough (WTP of greater than $1.00/gallon) to have a farm share of the retail WTP of $0.53/gallon for consumer group-verified pasture access, although only 16.06% are willing to pay the $1.20/gallon required to provide a farm share of WTP of $0.64/gallon. This large drop in the segment of the consumer population that is willing to pay this additional $0.20/gallon for this verified attribute can provide valuable information to producers who are making decisions regarding which verified attributes to provide on their operation. If a dairy producer is unable to provide consumer group verification for less than $0.53/gallon, the segment of consumers with WTP enough to justify the cost to the producer is shrinking quickly beyond this price point. Additionally, the portion of producers that can produce this attribute is increasing as the price increases, resulting in more competition to serve this shrinking consumer segment.

Conclusions

The use of consumer WTP estimates in farm-level decision-making regarding the provision of verified attributes was demonstrated in this analysis. A key contribution of this work is to demonstrate the link between consumer demand assessments and livestock producer decision-making. Critical points in verification program costs at which the optimal program for a producer changes were illustrated. Distributions of consumer WTP were used to determine the percent of consumers with WTP greater than specific cutoff points. Acknowledging the heterogeneous cost structures across farms associated with providing these verified attributes, it was demonstrated that the size of consumer segments with WTP at various levels can be identified. Producer decisions can be informed regarding whether to provide verified attributes if it is known that only 2% of consumers have a WTP sufficiently high enough to support the provision of the verified attribute vs. 98% having a WTP high enough. Producers from all different cost structures can benefit from this analysis. Low-cost producers are clearly more likely to engage in the provision of verified attributes and to have larger consumer segments with WTP high enough to support the provision of that verified attribute. High-cost producers can also benefit by observing that, depending on their costs of provision and the percent of consumers with a WTP sufficiently high enough to cover the costs of providing that verified attribute, that they should not adopt unprofitable verification strategies.

The producer decision support tool described in this analysis can be used in two distinct ways: 1) to inform producer decision-making regarding which production process attributes to adopt and how to verify those attributes; and 2) to aid producers who are already using certain production processes that are desirable to consumers in deciding which verifying method is optimal. In both cases, the consumer value or consumer WTP must be incorporated into the decision. The data regarding costs, however, is quite different for the two uses described. To determine adoption of and verification of production process attributes, accurate cost data must be obtained for not only verifying the attribute to the consumer, but also for the actual costs associated with altering the production processes. More data are necessary regarding the actual production-related costs associated with these production processes. These costs are expected to vary widely across farms, although cost estimates for production with access to pasture, for example, would aid in creating baseline assumptions for analyses regarding the adoption and verification of such production systems.

[10] Increments of $0.20 or $0.10 were used for the verified attributes in milk rather than the $0.50 increments as a result of the different WTP distributions observed in the milk analysis.

Table 4. Percent of Consumers with Willingness to Pay (WTP) Greater than Specific Increments for Verified Milk Attributes with Statistical Evidence of Positive Consumer Demand

Consumer WTP ($0.20 increments)	$0.00	$0.20	$0.40	$0.60	$0.80	$1.00	$1.20	$1.40	$1.60	$1.80	$2.00
Farm share of retail WTP value	$0.00	$0.11	$0.21	$0.32	$0.42	$0.53	$0.64	$0.74	$0.85	$0.95	$1.06
Verified Attribute	Percent (%) of Consumers Willing to Pay More than the Above-Stated WTP										
USDA-verified individual crates/stalls	100.00	100.00	100.00	100.00	100.00	85.58	0.00	0.00	0.00	0.00	0.00
Consumer group-verified pasture access	100.00	100.00	100.00	100.00	100.00	100.00	16.06	0.00	0.00	0.00	0.00
USDA-verified antibiotic use	100.00	100.00	100.00	100.00	100.00	99.72	0.00	0.00	0.00	0.00	0.00
USDA-verified pasture access	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.66
Consumer WTP ($0.10 increments)	$0.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00
Farm share of retail WTP value	$0.00	$0.05	$0.11	$0.16	$0.21	$0.27	$0.32	$0.37	$0.42	$0.48	$0.53
Verified Attribute	Percent (%) of Consumers Willing to Pay More than the Above-Stated WTP										
Self-verified individual crates/stalls	100.00	100.00	100.00	100.00	100.00	48.57	0.00	0.00	0.00	0.00	0.00
Self-verified pasture access	100.00	100.00	63.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer group-verified antibiotic use	100.00	100.00	100.00	100.00	92.80	0.00	0.00	0.00	0.00	0.00	0.00

Only those verified attributes for which statistically significant evidence of positive mean WTP was found are included here for further analysis regarding the distribution of consumer WTP values. The farm share of the retail value used for milk throughout this analysis was 53% (USDA, 2009b).

In addition to verification costs varying across farms, it is expected that the costs of verification will vary even within the entities as they have been defined in this analysis. Costs for verification by private party, for example, are expected to differ depending on the specific party.

Four specific production process attributes for two food products were assessed in this analysis. Continued research should include analysis of increased numbers of attributes across a wider range of livestock products. Even across the four production process attributes included in this analysis there exist substantial differences in the optimal producer decision regarding verification. In the case of verifying pasture access for swine, the producer must compare costs of verifying through a consumer group vs. USDA PVP to select the optimal verifying entity. In the case of certified trucking for both milk and pork chops, however, the producer's optimal decision is to not provide the verified attribute because no statistical evidence of positive consumer demand was found.

Although it is demonstrated that producer decision-making can be informed by estimates of consumer WTP for specific verified attributes in pork chops and milk, it should also be acknowledged that actual on-farm decision-making regarding marketing or provision of value-added verified attributes is made on a wider scope than a single product such as pork chop or fluid milk. Pork producers, for example, would want to consider consumer demand for various pork products rather than WTP for attributes of a pork chop solely. In general, consumer demand analyses focus on assessments of demand surrounding individual products, but for the purposes on on-farm decision–making, the marketing of an entire hog (or carcass) is considered rather than marketing of individual pork products. Clearly, the single-product analysis may be an oversimplification of reality, although the degree to which this is true is likely dependent on the specific livestock product and species. Future research could incorporate analyses of consumer WTP across a number of pork products rather than just pork chops. Potential analysis might include assessments of consumer WTP across a number of the higher-end cuts of pork to determine if the consumer value placed on verification of these cuts is sufficient to elicit producers to verify production processes used to raise their hogs when equivalent premiums on lower-valued products may not exist.

Potential extensions of this model could include increased flexibility to assess multiple attribute decisions jointly rather than assessing verification decisions for individual production process attributes. Considerations such as economies of scale and scope to verify multiple attributes may become increasingly important in this case. The potential for multiple verifiers also becomes an issue when assessing verification of multiple process attributes concurrently either as a result of consumer preferences for certain verifiers to verify specific attributes but not other attributes or the result of other on-farm or verifier-specific cost considerations. As verification of production process attributes becomes increasingly common across all products, not just livestock products and the market for verified attributes becomes more developed, model extensions such as those highlighted here should be investigated.

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Appendix 1. Definitions Provided in Survey for Choice Experiment[11]

The final portion of this survey presents you with multiple different sets of hypothetical pairs of boneless pork chops that could be available for purchase in a retail store where you typically shop. Besides the attributes listed, each boneless pork chop is produced in the U.S. and possesses the same characteristics (e.g., similar color, freshness, packaging date, etc.). Prices vary for each product. For each pair of boneless pork chops, please select the one you would purchase or neither if you would not purchase either boneless pork chop. For your information in interpreting alternative boneless pork chops:

Individual Crates/Stalls refers to the use of practices individually confining animals where:

- **Not Permitted** means the animal was raised on an operation certified to *not* confine animals in individual crates or stalls
- **Permitted** indicates that no claims regarding confinement of animals in individual crates or stalls are being made

Outdoor Access refers to the ability of animals to access grass pasture and not be confined solely to indoor production facilities:

- **Required** means the animal was raised on an operation certified to provide animals with access to grass pasture

[11] Note that the text provided here is specific to those consumers completing the survey for pork chops. Consumers completing the survey for milk had "boneless pork chops" replaced with "milk" in the text they were shown.

- **Not Required** indicates that no claims regarding access to grass pasture are being made

Antibiotic Use refers to the use of antibiotics on animals where:

- **Not Permitted** means the animal was raised on an operation certified to *not* administer antibiotics to animals
- **Permitted** indicates that no claims regarding use of antibiotics are being made

Certified Trucking/Transport refers to the use of certified trucking and transportation methods that enhance the care and welfare of animals during transport:

- **Required** means the animal was raised on an operation using certified trucking and transportation methods
- **Not Required** indicates that no claims regarding trucking and transportation methods are being made

Certification Entity refers to the process used in verifying animal welfare and handling claims made on the product label where:

- **USDA-PVP** means the label is backed by a producer's participation in a certification and process verification program (PVP) managed by the U.S. Department of Agriculture (USDA)
- **Self-Certification** means the label is backed by a producer's participation in a certification and verification program managed by the industry itself
- **Private, Third Party** means the label is backed by a producer's participation in a certification and verification program managed by a private, third-party company that is neither associated with the livestock industry nor any consumer groups
- **Consumer Group** means the label is backed by a producer's participation in a certification and verification program managed by a consumer group interested in animal welfare and handling issues