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The Effect of Value-Added Management on Calf Prices at Superior Livestock Auction Video Markets

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Value-added management practices for cow-calf producers have become prevalent as feeders have recognized the value of calves raised with certified health and weaning programs. Export markets requiring age and source verification or non-hormone treated cattle and advancement of markets for naturally raised cattle have also presented profit opportunities for cow-calf producers. This study estimates the value of value-added calf production and marketing programs. Weaned steer calves sold with certified health programs realized \$7 to \$10 per cwt premiums. Age- and source-verified steers received \$1 to \$2 per cwt premiums exceeding added costs of about \$0.67 per cwt in 2010 despite rapidly expanding supply.

Key words: feeder calf prices, hedonic models, value-added calf price

Introduction

Value-added opportunities for cow-calf producers have expanded in recent years. Over time, the beef industry has gained a better understanding of how calf weaning, preconditioning, and health programs affect efficiency and performance during growing, finishing, and slaughter phases of beef production (McNeill, 2001). As a result, cattle feeders are more aware of the potential value of calves produced using specific management practices. Furthermore, changes in beef export market access since the December 2003 discovery of bovine spongiform encephalopathy in the United States has increased value associated with age-and-source verification of calves necessary for export to specific countries (Schroeder and Tonsor, 2012). The rapid changes in value-added opportunities motivate our study to determine how these evolving changes are being valued in the market place over time. Furthermore, many value-added certifications available to cow-calf producers have a myriad of production requirements bundled together and better information is needed on the individual values of the bundled traits.

The numerous new market signals cow-calf producers face make it difficult to trace price differences back to individual management decisions. For example, estimating the marginal values of weaning, preconditioning, specific health programs, implant strategies, naturally-raised, and age and source verification requires considerable data analysis. Common certification programs combine several of these attributes together. Much of the existing hedonic calf pricing research was completed before several current calf management attributes existed. Furthermore, the current body of research has not adequately separated the individual impacts of these bundled traits on calf prices. The objective of this study is to determine the implicit prices of individual value-added calf attributes.

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This study estimates the marginal value of value-added production practices on feeder calf prices in the Superior Livestock Auction (SLA) video market. The research determines how traditional animal characteristics (i.e., animal weight, breed, frame size, etc.) as well as evolving, value-added production and marketing practices (i.e., specific health programs, implants, naturally-raised, age and source verification, etc.) affect feeder cattle prices. We also quantify how implicit prices for these attributes have changed over time and we relate these changes to evolving market conditions.

The information generated in this study is important to a variety of beef industry stakeholders. Cow-calf producers directly benefit from having information to help them quantify the price impacts of various individual management practices. With the plethora of evolving value-added opportunities, cow-calf producers need to know the expected value of adopting individual management practices, all of which increase production and marketing costs. Cattle buyers also benefit by understanding the market value of calves having specific attributes. Buyers can better manage calf-procurement strategies, cattle finishing, and marketing programs by having information on implicit prices for specific calf attributes. Overall, consumers and the beef industry as a whole benefit from improved information that enhances cattle production efficiency and beef product quality.

Background and Previous Literature

Superior Livestock Auction (SLA) is the largest auction market in the United States. The video auction market has sold more than two million head of cattle annually since 2001 (Bailey and Peterson, 1991; Bailey and Hunnicutt, 2002; Superior Livestock Auction, 2010). Cattle can sell through three formats at SLA: video auction, Internet auction, or private-treaty Internet listings. This study focuses on the video auction market. Cattle are represented on SLA video auctions through a video and written lot description. A market representative videotapes and photographs the cattle in their natural surroundings and works with the seller to prepare a consignment contract describing the cattle and outlining the sale terms and conditions. A video-auction catalog is mailed to prospective buyers and made available on the Internet one week prior to the auction. Buyers and sellers can be present at the auction site on sale day, or they can view the auction on satellite television. Video of the cattle is shown while a live auctioneer calls for auction-site and telephone bids (Superior Livestock Auction, 2010).

The majority of SLA sales are cash-forward contracts sold for future delivery. A contract is prepared stating sale terms and conditions once cattle are sold. Cattle are shipped directly from the seller's ranch to the buyer's destination. The seller receives a check at delivery from an SLA bonded-custodial account, while the buyer pays for the cattle upon receipt (Superior Livestock Auction, 2010).

There are notable structural differences between video and traditional auction markets. These disparities are important in analyzing results of video market hedonic pricing studies. SLA is a popular market venue for large lots of cattle that can be clearly described and quickly marketed (Bailey and Peterson, 1991). Electronic marketing reduces travel costs, increases access to potential bidders, offers a no-sale option for sellers, and may reduce commissions, animal shrinkage, animal stress, and health concerns from co-mingling (Bailey and Peterson, 1991; Gillespie, Basarir, and Schupp, 2004). Catalog and on-screen information benefits all market participants by creating a greater level of transparency and reducing the risk of asymmetric information. Video auctions signal cattle market conditions on a larger scale than traditional local auctions by representing buyers and sellers from around the nation.

A large body of literature has estimated hedonic feeder cattle pricing models. Traditional variables used in analysis of feeder cattle prices have included weight, weight squared, lot size, lot size squared, sex, frame size, flesh condition, lot uniformity, breed, region of origin, and health (James and Farris, 1971; Menzie, Gum, and Cable, September 1972; Faminow and Gum, 1986; Schroeder et al., 1988).

Coatney, Menkhaus, and Schmitz (1996) presented a case for estimating feeder cattle hedonic models using a system of equations to determine implicit prices for factors that may be interrelated to each other and conditional (e.g., breed, frame size, calf weight). One way to assess whether the approach taken by Coatney, Menkhaus, and Schmitz (1996) is necessary to obtain reliable implicit value estimates is to assess the level of potentially degrading collinearity present in single-equation models (Belsley, Kuh, and Welsch, 1980). If collinearity is not deemed problematic, single-equation models should be sufficient. Alternatively, if degrading collinearity among conditional variables is a concern, then an alternative estimation approach may be preferred.

Over the last decade, cow-calf producers have implemented new value-added management and marketing practices that are increasingly presented at feeder calf auction markets. Preconditioning refers to a generic set of management, vaccination, and weaning practices preparing calves for feedlot or grower environments. Bulut and Lawrence (2007) noted that third-party certification of preconditioning is valuable because it enhances credibility.

King et al. (2006) was one of the first published studies focused on price effects of certified value-added calf health protocols. Previous studies have considered the value of preconditioning in general. However, King et al. (2006) estimated the price effect of specific calf vaccination programs in SLA video market sales. Kellom et al. (2008) estimated the value of age- and source-verified (ASV) calves using 2008 SLA data. Age- and source-verified calves have commanded statistically significant premiums in auction sales (Blank, Forero, and Nader, 2009; Kellom et al., 2008; King et al., 2006). Sale lots identified as being ASV include ranch-of-origin information in addition to details on the first and last birth date of calves in the group. Blank et al. (2006); Blank, Forero, and Nader (2009) added to the body of recent video market research by estimating feeder calf pricing models using data from Western Video Market.

Blank et al. (2006); Blank, Forero, and Nader (2009) estimated the price effect of individual components of preconditioning protocols and showed statistically significant price influences for weaned and preconditioned calves. Smith et al. (2000), Sartwelle III et al. (January 1996) and Schroeder et al. (1988) showed that premiums existed for healthier-appearing calves, and Dhuyvetter, Bryant, and Blasi (2005) and Lalman and Smith (2001) used hedonic models to reveal preconditioned calves received premiums over non-preconditioned calves.

A number of hedonic pricing studies have quantified the value of preconditioning on calf prices, but only King et al. (2006) estimated the price effects of specialized certified health programs. Additional research is needed to confirm King et al. (2006) and separate effects of weaning and respiratory vaccinations on calf prices. Previous research has not separated individual price effects of integrated calf management practices such as preconditioning (Dhuyvetter, Bryant, and Blasi, 2005; Kellom et al., 2008; Blank et al., 2006; Blank, Forero, and Nader, 2009). The value of weaning and vaccination program management needs to be more clearly separated in feeder calf pricing models to quantify their incremental price impacts.

Emerging marketing programs have created new opportunities for cow-calf producers to document management practices and market their calves as candidates for natural, non-hormone treated cattle (NHTC), and export markets. Blank et al. (2006); Blank, Forero, and Nader (2009) and King et al. (2006) have captured some of the price effects of natural-market eligibility. This study is the first multi-year study that documents the effects of both of these emerging markets on calf prices and separates the price effect of these programs from implanted and non-implanted calves. Estimating separate marginal values for these bundled management practices provides cow-calf producers necessary details on revenue opportunities associated with specific management practices.

Hedonic Model and Data

Calves used in the production of feeder cattle, and ultimately fed cattle and beef, have unique production characteristics that influence value (Lancaster, 1966). Vertical market signals travel upstream from the beef consumer to the ranch in the form of implicit premiums and discounts paid for calf characteristics. Assuming fixed supply at any particular market, demand for a calf is based on how its traits influence aggregate beef production efficiencies and quality attributes (Faminow and Gum, 1986).

Previous research defined calf price as a function of the physical characteristics (C) of a sale lot and the fundamental market forces (M) of aggregate supply and demand for feeder calves at the observed time,

$$Price_{it} = \sum_k V_{ikt}C_{ikt} + \sum_h R_{ht}M_{ht}, \tag{1}$$

where i is an individual lot of calves, k is a specific trait, h is the market influence, and t is the auction date. The value of a specific trait in a sale lot is represented by V, and the effect of individual market forces on price is represented by R (Schroeder et al., 1988). Equation (1) indicates the price per hundredweight for each lot of calves is equal to the sum of the marginal values of production for each lot characteristic and the sum of market forces at a particular auction.

The hedonic pricing model estimated in this study was based on previous research and the novel characteristics of calves from the data described later. The price of an individual lot of cattle i on auction date t is dependent on the individual lot characteristics and auction day market forces. The empirical model can be generalized as:

$$\begin{aligned} &Price_{it} = f(Lotsize_{it}, Weight_{it}, Weightvariation_{it}, Frame_{it}, Flesh_{it}, Implant_{it},\\ &Weaningstatus_{it}, Vaccination_{it}, Hsomni_{it}, BVDPIneg_{it}, Bangs_{it}, Agesource_{it}, Horns_{it},\\ &Breed_{it}, Region_{it}, Daystodelivery_{it}, Feederfutures_{t}). \end{aligned} \tag{2}$$

Table 1 provides a summary of the specific variables utilized for each model characteristic. Lot size (and lot-size squared), weight (and weight squared), days between sale and delivery dates, and the feeder cattle futures prices are continuous variables. The price effects of remaining characteristics are measured through binary variables for each respective calf management trait.

The empirical model was developed augmenting previously published research models with new animal characteristics presented in the SLA video market lot descriptions. The variables used to represent genetic influence, vaccination protocol, and weaning strategies were adapted from work by King et al. (2006), and Blank et al. (2006); Blank, Forero, and Nader (2009). The SLA lot descriptions provided new opportunities to build hedonic pricing models to estimate the influence of new vaccination protocols, weaning strategies, ASV, and natural and NHTC calves. The study analyzed transaction data on 20,089 steer and 13,043 heifer lots sold from 2001 to 2010 through video auctions coordinated by SLA. Sale data were collected for each year during the SLA peak feeder calf sale months of June to September. Forward contract sales are a key component of the video auction market, and the research focuses on sale lots marketed for September to December delivery. The majority of SLA forward contract cattle deliveries occur during these months. The data represent nearly four million head of calves. The final bid price and written descriptions for each lot of cattle provided the genetic, management, and marketing characteristics used in estimating the feeder calf hedonic price models.

The feeder cattle futures price quoted on the day before the SLA sale that was the nearby contract at the calf delivery date for each sale lot was included in the model to account for changing market conditions across sale dates. The difference between sale and delivery date was used to account for forward-contract price effects. Weaned and non-weaned calf sales during this period represented calves with base weights ranging from 275 to 1,085 lbs. The auction allows the sale of mixed-gender lots. Bailey and Peterson (1991) and Schroeder et al. (1988) highlighted the importance of stratifying feeder cattle auction market data based on gender, calf age, and weight. Steer and heifer sales were analyzed in separate models and mixed gender lots were removed from the dataset. A narrower weight range was selected for the models to make price comparisons among biologically similar-aged cattle. The weight ranges were 450 to 750 lbs. for steers and 400 to 700 lbs. for heifers.

Table 1. Description of Variables used in Hedonic Models

Characteristic (units)	Description	Model Variable
Lot size (head)	Number of head	*LOT*
	Number of head squared	LOT^2
Weight (lbs.)	Average base weight of lot	*WT*
	Average base weight of lot squared	WT^2
Frame (0,1)	Small to medium (default)	*SM_FM*
	Medium to medium-large mix	*MML_FM*
	Medium-large to large	*MLM_FM*
Flesh (0,1)	Light to light-medium (default)	*LLM_FL*
	Light-medium to medium mix	*LMM_FL*
	Medium	*M_FL*
	Medium to medium-heavy mix to heavy	*MMHH_FL*
Weight variation (0,1)	Even to fairly even (default)	*EFE_WV*
(*uniformity*)	Uneven	*UE_WV*
	Very uneven	*VE_WV*
Implant (0,1)	Not implanted (default)	*NOIMP*
	Natural eligible - Not implanted	*NAT_NOIMP*
	NHTC eligible - Not implanted	*NHTC_NOIMP*
	Unknown or some implanted	*UKN_IMP*
	Implanted	*IMP*
Certified vaccination (0,1)	Not vaccinated (default)	*NOVAC*
(non-weaned)	VAC24 Protocol	*VAC24*
	VAC34 Protocol	*VAC34*
	VAC34 Plus Protocol	*VAC34P*
Certified vaccination (0,1)	VAC45 Protocol	*VAC45*
(weaned)	VAC Precondition Protocol	*VACPC*
General vaccination (0,1)	One respiratory vaccination	*1VAC*
(non-weaned or weaned)	Two or more respiratory vaccinations	*2VAC*
Weaning status (0,1)	Weaned	*WEANED*
H. somni vaccinated (0,1)	Vaccinated at least once for *H. somni*	*HSOMNI*
BVD PI-negative (0,1)	Tested negative for BVD	*PINEG*
Bangs vaccinated (0,1)	Vaccinated for bangs	*BANGS*
Age-source-verified (0,1)	Verified age and source of animals	*ASV*
Horns (0,1)	Some, tipped, or all horns	*HORNS*
Breed (0,1)	Cattle w/ear (default)	*EAR*
	English & English cross	*ENG*
	English/Continental cross	*ENG_CON*
	Continental & Continental cross	*CON*
	Black & black-white-faced	*BLK*
	Predominantly Angus	*BLK_ANG*
Origin region (0,1)	West - California, Oregon, Washington, Idaho, Nevada, and Utah	*WEST*
	Rocky Mountain/North Central - Colorado, Wyoming, Montana, North Dakota, South Dakota, and Nebraska	*NC*
	South Central - Arizona, New Mexico, Texas, Oklahoma, Kansas, Missouri, and Arkansas (default)	*SC*
	Southeast - Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Tennessee, Kentucky, Virginia, and West Virginia	*SE*
Days to delivery (days)	Days between sale and delivery date	*DATEDIF*
Feeder futures ($ per cwt)	Feeder cattle futures price	*FDRFTRS*

Observations included forward-contract terms ranging from immediate to ten-month delivery targets after the sale date. The majority of calves were delivered within three months of the sale day, and more than 60% of lots were delivered within 30 days of selling. Less than 0.1% of calves were sold more than six months in advance of delivery. Lots sold more than six months beyond delivery were removed from the dataset.

Data included a state of origin for each lot sold. States of origin were grouped into regions and included states located in the West (*WEST*), Rocky Mountain/North Central (*NC*), South Central

(*SC*), and Southeast (*SE*) regions of the United States (table 1). The dataset had less than 1% of observations combined from states located in the Midwest and Northeast regions of the United States.[1] Therefore, following King et al. (2006), the Midwest and Northeast regions were excluded from the analysis.

Breed influence has been modeled a variety of ways. Schulz and Waggoner (March 2010), King et al. (2006), and Smith et al. (2000) showed that breed has a statistically significant influence on calf sale price. Feedlot and stocker cattle buyers use breeds to predict growth and carcass quality. Breed influence was defined through twenty-one different breed- and color-based variables provided through the SLA video market lot descriptions. For models in this research, breed was defined in six categories: 1) Brahman and Brahman cross (*EAR*), 2) English and English cross (*ENG*), 3) Continental and Continental cross (*CON*), 4) English-Continental cross (*ENG_CON*), 5) black or black-white faced (*BLK*), and 6) predominantly black Angus (*BLK_ANG*).

Lots classified as English, Continental, or English-Continental included calves predominantly from breeds in those categories with less than 90% black hide or Angus influence. At least 90% of calves in a lot needed to have predominantly black-hide color and no Brahman influence to be classified as black or black-white faced. Likewise, lots characterized as predominantly Angus were 90% black or black-white faced and written descriptions indicated the calves came from Angus breeding stock. Mexican-, Longhorn-, Corriente-, and Dairy-influenced calves accounted for 0.3% of observations in the database and were therefore omitted from the analysis.

Accounting for the price effect of weaning and vaccination protocols has become more complicated with the industry adoption of value-added calf (VAC) protocols. Promoted through the Texas A&M Ranch to Rail Program, preconditioning practices include dehorning, castration, and combinations of vaccination, weaning, and parasite management practices (McNeill, 2001). Specific SLA certified VAC programs evaluated in this study are defined on the auction market's program website, www.superioranimalhealth.com (Superior Animal Health). Specific respiratory vaccination program variables were assigned binary variables for pens receiving no vaccinations, one or two general vaccinations, or a specific certified vaccination program. The lot descriptions also noted sale lots that tested negative for persistent BVD infection and included information for lots vaccinated against *Haemophilus somni* and heifers vaccinated against brucellosis.

The five SLA certified vaccination protocols were included as separate variables in the models. Calves not meeting one of the protocols were designated as receiving no, one, or multiple respiratory vaccinations. Eight binary variables were used to account for calf respiratory vaccination programs in the hedonic model. Non-weaned calves participated in programs represented by four variables: 1) No respiratory vaccination, 2) *VAC24*, 3) *VAC34*, and 4) *VAC34P*. Two programs required weaning in addition to other vaccination requirements: 5) *VAC45* and 6) *VACPC*. Specific protocols for these programs are listed in table 2. The remaining two programs were non-certified health programs and allowed for calves to be non-weaned or weaned: 7) One respiratory vaccination (*1VAC*) and 8) Multiple respiratory vaccinations (*2VAC*). The *VAC34P* protocol was added in 2008, while the remaining protocols were present throughout the time of the study.[2]

Separating the price effect of weaning in the presence of VAC programs can be a challenge due to the combined influence of vaccinations and weaning in these protocols. Published research has not sufficiently separated these price effects while analyzing the value of preconditioning. King et al. (2006) eliminated weaned calves that did not meet *VAC45* or *VACPC* health protocols to avoid confounding effects between weaning and vaccination program effects in their pricing model. Blank et al. (2006); Blank, Forero, and Nader (2009) found statistically significant premiums for weaning and preconditioning. However, their research did not reveal defined preconditioning standards or determine price effects of different vaccination programs.

[1] Midwest - Iowa, Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio; and 6) Northeast - Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

[2] Because of insufficient observations each year from 2001-2004, *VACPC* calves were dropped from these years.

Table 2. Summary of Specific Calf Vaccination Programs Analyzed in Hedonic Models

Vaccination Program	Management Requirements	Timing
VAC24	Vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way, and Parasite control (optional)	Calves vaccinated on cows at 2 to 4 months of age.
VAC34	Vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way, and Parasite control (optional)	Calves vaccinated on cows 2 to 6 weeks prior to shipping.
VAC34P	First-round vaccinated against: IBR and PI3, BVD and BRSV, Clostridial 7-way Second-round vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way, and Parasite control (optional)	Calves first-round vaccinated at branding and receive booster vaccinations 2 to 6 weeks prior to shipping.
VAC45	Pre-weaning: first-round vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way Weaning: second-round vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way, and Parasite control (optional)	(Option 1) Calves first-round vaccinated 2-6 weeks prior to weaning, receive booster vaccinations at weaning, weaned 45+ days prior to shipping. (Option 2) Calves first-round vaccinated at weaning, receive booster vaccinations at least 14 days prior to delivery, weaned 45+ days prior to shipping.
VACPC	Pre-weaning: first-round vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way Weaning: second-round vaccinated against: IBR and PI3, BVD and BRSV, *Mannheimia haemolytica* and/or *Pasteurella multocida*, Clostridial 7-way, and Parasite control (optional)	Designated for calves from various sources. Calves are first-round vaccinated at arrival and receive booster vaccinations according to vaccine label instructions. Booster vaccines must be given at least 14 days prior to delivery. Calves are weaned 60+ days prior to shipping.

Notes: See http://www.superiorlivestock.com/Superior.sla?sp=vp for additional details.

SLA protocols for *VAC24*, *VAC34*, and *VAC34P* do not require weaning (table 2). Producers use these programs to benefit from third-party certification without weaning calves. Cow-calf producers wanting a value-added vaccination protocol for weaned calves likely manage them to meet *VAC45* (weaned for at least 45 days) or *VACPC* (weaned for at least 60 days) requirements. Therefore, the market value of a *VAC45* or *VACPC* program is determined by adding the parameter estimates for these programs plus the weaning coefficient estimate. Calves vaccinated through non-certified programs were also represented in the data as receiving one vaccination or multiple vaccinations. Both weaned and non-weaned calves were represented among lots vaccinated through non-certified health programs. Similarly, few non-vaccinated calves were also weaned. Based on these interactions, weaned calves were identified in the model with a binary variable to estimate the price effect of weaning. The impact of different numbers of days calves were weaned prior to shipping is embedded in the different vaccination programs and cannot be estimated separately.

The model also included binary variables to account for calves that tested negative for persistent infection of bovine virus diarrhea (*PINEG*) or received *Haemophilus somni* (*HSOMNI*) or brucellosis (*BANG*) vaccinations. The first two variables were added to SLA sale catalogs in 2008. Brucellosis vaccinations were included in lot descriptions over the duration of the study period, but not recorded consistently until 2008. Brucellosis vaccinations are generally reserved for higher quality heifers raised with the intent to be purchased as breeding herd replacements. The price effect of the bangs vaccination determines whether buyers perceive these animals as higher quality.

The SLA lot descriptions included information on age and source verification (*ASV*) of calves beginning in 2005. Age- and source-verification systems require each calf to use a program-specific individual-identification tag. Producers must pay enrollment fees that generally cover RFID tag, administration, and database-management costs. Exact costs can vary considerably depending on program details (Barnham, 2007). Potential sale premiums are generated based on the additional beef export marketing opportunities available for calves enrolled in ASV programs. *ASV* was included as a binary variable equal to one if the calves were ASV and zero otherwise.

Superior Livestock Auction started the Certified Natural Cattle program in 2004 and the Non-Hormone Treated Cattle (NHTC) program in 2008 (King, 2010). Producers managing cattle for a natural market are faced with more feed and antibiotic-use restrictions than the NHTC market. Conversely, non-implanted cattle, without natural-market certification, can be purchased for natural production if a buyer can verify ranch-level management practices. Documentation for NHTC markets is more stringent and requires the ranch to be approved for the designation before cattle leave the operation. Once a ranch is approved for NHTC production, calves from the ranch are eligible for the European Union export market (IMI Global, 2010). The requirements for each program differentiate the value of non-implanted calves on SLA video markets. To estimate the price effect of these programs, three variables were developed for 1) non-implanted, 2) natural, non-implanted, and 3) NHTC, non-implanted calves. Superior Livestock Auction requirements for listing calves as participants in an ASV, natural, or NHTC program can be found on the SLA website (Superior Animal Health).

The data was stratified further to estimate hedonic pricing models for each year to quantify how price determinants have changed as production practices and marketing programs have evolved in the beef industry. Descriptions of lots offered for sale in SLA remained relatively unchanged through the early 2000s, but more management and marketing characteristics began to be added to lot descriptions in 2005 and expanded again in 2008. New characteristics were added to the hedonic models as they were included in lot descriptions.

Results

The hedonic models were estimated using OLS regression analysis. Individual hedonic pricing models were estimated for each of steers and heifers across the ten years (2001-2010). The models were estimated by year to identify emerging trends and to add new variables to the hedonic models as they have been introduced. Variables for ASV, natural and NHTC implant protocols, BVD-PI negative tested, VAC34P, VACPC, brucellosis vaccination, and *Haemophilus somni* vaccination were added to models as they were included in SLA lot descriptions.

Residuals in each model were tested for heteroskedasticity using White's test (White, 1980). All models exhibited heteroskedasticity and thus reported statistical significance was estimated using White's adjusted standard errors. Potentially degrading collinearity was tested using the procedures suggested by Belsley, Kuh, and Welsch (1980). Collinearity was not a concern based on the diagnostic test results for each model.[3]

Tables 3 (steers) and 4 (heifers) summarize results for selected parameters of the regression models estimated separately for each year. The models have adjusted R-squared values ranging from 0.58 to 0.82. Root-mean-squared errors range from \$2.78 to \$4.69 per cwt. Most coefficient estimates have the anticipated signs and are statistically different from zero at the 0.05 level.

[3] Potentially degrading collinearity was common in the annual models between the intercept, weight, and weight-squared and between the intercept and the feeder cattle futures price. The weight and weight-squared variables always had statistically significant coefficient estimates, so we did not concern ourselves with this potential collinearity. The feeder cattle futures during some years did not vary much across auction dates, so it being correlated with the intercept was not unexpected. Since we do not dwell on the value of the feeder cattle futures coefficients, we are not concerned with this potential collinearity.

Table 3. Summary of Selected Hedonic Model Parameter Estimates of Superior Livestock Auction 450-750 Pound Steers, by Year, 2001-2010

	Year									
Variable Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NOIMP (default)										
NAT_NOIMP					0.34	0.81**	0.26	0.38	0.12	−0.11
NHTC_NOIMP								2.79**	0.47	1.81**
UKN_IMP	−2.19**	−0.57	−2.05**	−1.64**	−0.60	−1.10*	−0.09	−1.59**	−1.82**	−0.07
IMP	0.20	−0.26*	−0.49**	−0.08	0.46**	−0.02	−0.11	−0.23	0.61**	0.23
ASV					0.99**	1.83**	1.57**	1.94**	1.59**	1.67**
NOVAC (default)										
VAC24 (non-weaned)	3.45**	2.30**	1.54**	1.89**	1.10*	0.54	2.02**	2.12**	1.04	1.94**
VAC34 (non-weaned)	2.88**	1.90**	3.63**	3.45**	2.57**	2.81**	4.32**	4.29**	3.43**	3.63**
VAC34P (non-weaned)								4.27**	3.52**	3.56**
VAC45 (weaned)	1.82**	2.19**	4.71**	4.32**	2.43**	3.46**	1.91**	3.43**	1.47	3.17**
VACPC (weaned)	0.76	0.01	−0.40	2.52**	1.42*	3.38**	5.73**	4.92**	1.20	3.10**
1VAC (weaned or non-weaned)	1.38**	1.07**	1.93**	2.04**	1.22**	0.64	1.22**	2.55**	0.63	1.68*
2VAC (weaned or non-weaned)	2.00**	1.26**	3.43**	2.61**	0.72	1.46*	0.82	2.30**	0.81	2.03**
WEANED	1.88**	2.92**	3.16**	3.17**	3.08**	3.65**	4.80**	5.05**	5.42**	3.47**
HORNED	−0.95**	−1.33**	−1.07**	−1.43**	−0.40	0.28	0.35	−0.28	−0.90*	−0.28
HSOMNI								0.08	0.45*	0.26
PINEG								−0.53	−0.07	−0.71
ENG	1.67**	1.64**	2.92**	4.09**	2.35**	4.42**	3.21**	4.03**	3.90**	3.36**
ENG_CON	2.34**	1.71**	3.06**	3.91**	2.44**	4.72**	2.97**	4.22**	3.46**	2.86**
CON	2.52**	1.71**	2.55**	3.69**	2.75**	4.22**	2.48**	3.85**	3.65**	3.74**
BLK	3.75**	2.82**	4.25**	5.55**	3.90**	6.72**	4.57**	5.92**	5.06**	4.18**
BLK_ANG	4.40**	3.54**	4.90**	5.94**	4.74**	7.03**	5.38**	6.53**	5.95**	4.60**
SC (default)										
WEST	−1.61**	−2.58**	0.94**	−0.85**	−3.84**	−2.56**	−3.11**	−4.10**	−2.45**	−1.55**
NC	1.98**	0.24	3.12**	0.74**	1.12**	2.52**	2.14**	1.47**	1.42**	2.46**
SE	−4.42**	−3.85**	−2.93**	−4.38**	−4.86**	−5.31**	−4.92**	−10.58**	−5.75**	−4.58**
DATEDIF	0.02**	−0.02**	−0.05**	0.02**	0.04**	−0.01*	−0.02**	−0.01	−0.01**	−0.02**
Adjusted R-squared	0.78	0.76	0.79	0.77	0.82	0.81	0.77	0.71	0.73	0.79
RMSE	3.31	2.78	3.51	4.15	4.14	4.52	4.08	4.34	3.89	3.69
Avg. Feeder Price ($/cwt)	105.16	85.87	101.97	126.99	123.01	127.01	123.22	115.47	105.94	122.56
Observations	1,538	1,401	1,972	1,949	2,296	1,911	2,296	2,165	2,195	2,366

Notes: Single and double asterisks (*, **) indicate statistical difference from zero at the 10% and 5% level. Adjusted R-squareds for each model when the feeder cattle futures variable was excluded were: 2001=0.77; 2002=0.76; 2003=0.78; 2004=0.75; 2005=0.79; 2006=0.80; 2007=0.76; 2008=0.71; 2009=0.71; 2010=0.77.

Table 4. Summary of Selected Hedonic Model Parameter Estimates of Superior Livestock Auction 400-700 Pound Heifers, by Year 2001-2010

	Year									
Variable Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NOIMP (default)										
NAT_NOIMP					0.21	1.09**	0.43	0.73**	0.25	0.14
NHTC_NOIMP								1.48	0.65	2.78**
UKN_IMP	−0.41	−0.69*	0.05	0.53	−0.43	−0.25	−0.58	−0.04	−1.23**	0.15
IMP	0.15	−0.40*	−0.28	−0.64**	0.18	−0.44	−0.09	0.06	0.02	0.18
ASV					1.09**	1.59**	1.39**	2.75**	1.55**	1.91**
NOVAC (default)										
VAC24 (non-weaned)	2.29**	2.11**	1.58**	1.18	0.16	1.13	2.99**	1.73	−0.74	2.25**
VAC34 (non-weaned)	2.09**	1.22**	3.10**	2.73**	1.30*	2.47**	4.53**	3.06**	1.32	3.04**
VAC34P (non-weaned)								2.95**	2.02	3.43**
VAC45 (weaned)	0.81	1.13**	4.13**	3.32**	1.21	3.31**	3.25**	2.99**	0.1	1.94*
VACPC (weaned)					0.50	3.12**	2.83**	−1.42	−1.08	−0.9
1VAC (weaned or non-weaned)	0.87**	0.37	1.59**	0.71	0.45	1.08	1.96**	2.18*	−1.88	1.5
2VAC (weaned or non-weaned)	1.29**	1.52**	2.47**	1.38	−0.46	2.17*	2.30**	2.23*	−0.2	1.16
WEANED	1.99**	2.95**	2.86**	2.76**	2.90**	2.60**	3.88**	4.08**	5.15**	4.48**
HORNED	−1.01**	−1.22**	−1.22**	−1.61**	−0.98**	−0.98**	0.06	−1.30*	−0.64	−0.04
HSOMNI								−0.40	0.21	0.1
PINEG								0.41	0.91	0.87
BANG								−0.65	−0.19	−0.31
EAR (default)										
ENG	1.67**	1.47**	2.66**	3.18**	2.81**	3.97**	4.09**	5.17**	4.93**	4.61**
ENG_CON	1.82**	1.36**	2.15**	2.93**	2.16**	2.79**	2.90**	4.29**	3.12**	2.88**
CON	1.21*	1.64**	1.75**	1.80*	1.28	1.45	3.80**	3.18**	1.87**	3.07**
BLK	3.74**	3.33**	4.26**	4.65**	4.17**	4.77**	4.43**	5.89**	4.39**	4.15**
BLK_ANG	4.93**	5.02**	5.41**	7.25**	6.55**	5.89**	5.40**	6.20**	5.48**	5.42**
SC (default)										
WEST	−1.31**	−2.64**	0.66	−0.56	−3.50**	−1.09**	−2.87**	−3.39**	−1.76**	−0.97**
NC	2.92**	0.09	2.61**	1.38**	0.86**	3.02**	1.52**	0.97*	1.96**	2.80**
SE	−4.53**	−3.39**	−2.97**	−3.02**	−2.68**	−4.33**	−5.36**	−10.74**	−5.53**	−3.23**
DATEDIF	0.00	−0.01**	−0.02**	0.00	0.03**	0.00	−0.02**	−0.01**	−0.02**	−0.02**
Adjusted R-squared	0.75	0.72	0.74	0.74	0.76	0.77	0.67	0.58	0.65	0.69
RMSE	3.33	2.85	3.51	4.42	4.15	4.53	4.44	4.69	4.00	4.05
Avg. Feeder Price ($/cwt)	99.56	81.41	98.87	122.55	118.44	121.59	117.02	102.83	98.59	114.75
Observations	1,080	1,018	1,337	1,330	1,473	1,183	1,497	1,344	1,361	1,420

Notes: Single and double asterisks (*, **) indicate statistical difference from zero at the 10% and 5% level. Adjusted R-squareds for each model when the feeder cattle futures variable was excluded were: 2001=0.73; 2002=0.72; 2003=0.73; 2004=0.73; 2005=0.73; 2006=0.76; 2007=0.66; 2008=0.58; 2009=0.64; 2010=0.66.

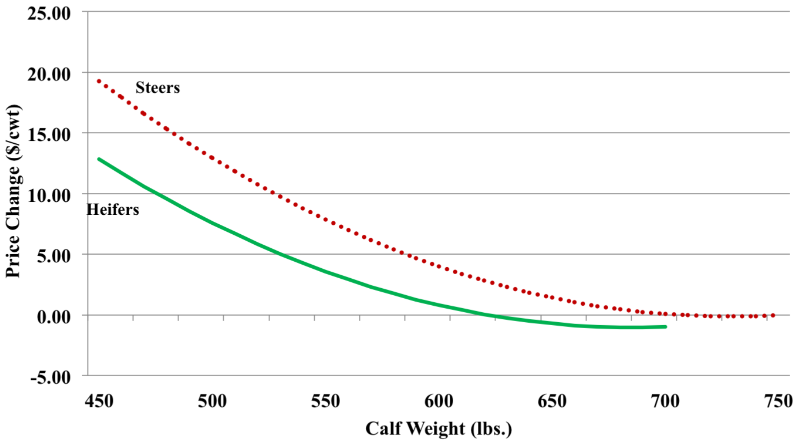

Figure 1. Estimated Impact of Calf Weight on Price from Hedonic Model of Superior Livestock Auction Data, 2010 (both lines are set equal to $0.00 at 750 lbs).

Traditional Lot Characteristics

Weight had a nonlinear impact on price, with price declining at a declining rate as weight increased (not reported in tables). The impact of weight on price for steers and heifers for the 2010 models is illustrated in figure 1. A 500 lb. steer (heifer) brought about $9 per cwt ($6.70 per cwt) more than a 600 lb. animal, ceteris paribus, consistent with Dhuyvetter and Schroeder (2000). Frame size was important, especially for small-framed animals, bringing discounts of $0.25 to $0.77 per cwt compared to medium-framed calves (not reported in tables). These discounts are considerably less than other studies focusing on frame size in regional auction markets. For instance, Lambert et al. (1989) found large discounts for small frame size in Kansas markets ranging from $4.10 to $9.80 per cwt. Lots with relatively little weight variation received more than $2 per cwt in premiums for certain model periods, and lots classified as being very uneven received discounts as high as $1.67 per cwt compared to lots with more typical weight variation. In addition, lots with very uneven weights of calves received statistically significant discounts typically ranging from $1 to $3 per cwt depending upon year and gender. Consistent with previous research, lot size was non-linear (not reported in tables). Heifer prices were greatest for lot sizes of around 300 head with a premium of about $1.75 per cwt over a 100-head lot. Steer prices also increased at a declining rate with lot size with a $2.50 per cwt premium for 400-head relative to 100-head lots. Bailey and Peterson (1991) found preferred lot sizes of around 240 head using SLA data. These are larger lot sizes than are generally preferred in local auction markets of truck-load lots of around 60 head (Faminow and Gum, 1986; Schroeder et al., 1988).

Discounts were paid for calves originating from the Southeast ($3 to $6 per cwt) and West ($1 to $4 per cwt) regions in most years compared to calves from the South Central region. In contrast, North Central calves realized premiums generally of $1 to $2 per cwt (tables 3 and 4). Blank et al. (2006); Blank, Forero, and Nader (2009) found similar results for calves from the West. The discounts in the West are consistent with approximate transportation costs from that region to the main cattle feeding regions (i.e., South Central and North Central). Discounts for the Southeast region include transportation costs and may also include buyers' animal health concerns or quality perceptions associated with calves from that region.

Angus and black or black-white faced calves consistently received premiums. Angus calves generated an additional $3 to $7 per cwt compared to the base Brahman-influenced cattle. Premiums for Angus cattle were typically larger than for black (but not Angus) cattle by $0.30 to $0.90 per cwt for steers (table 3) and by $0.30 to $1.70 per cwt for heifers (table 4) across years. The greater premiums for heifers compared to steers for Angus may be associated with heifers being bought for breeding herd replacements and garnering greater prices for specific genetic preferences. Horned calves were typically discounted by about $1 per cwt, though estimated discounts were zero in some years depending upon gender.

Value-Added Programs

Buyers preferred weaned calves with at least two rounds of respiratory vaccinations compared to the base non-vaccinated and non-weaned calves. Premiums for calves receiving a *VAC45* protocol were typically $2 to $4 per cwt for steers (table 3) and $1 to $2 per cwt for heifers (table 4). However, in some years, *VAC45* premiums were not statistically significant (e.g., 2005 and 2009 heifers). In addition to the vaccination premium, *VAC45* calves are also weaned for 45 days. Thus, *VAC45* lots received an additional $2 to $5 per cwt for weaning beyond the vaccination premium. Calves treated with *VAC45* programs generally had statistically significant advantage compared to calves receiving two general respiratory vaccinations. However, the difference in value between these varied across years. For example, in 2001 *VAC45* steers and heifers received prices that were not statistically different from *2VAC*. Whereas during most other years *VAC45* steers received more than $1 per cwt and heifers more than $0.70 per cwt premiums compared to *2VAC*.

The value of weaning calves has tended to be higher in recent years (2008-2010) than it was in the early 2000s. For example, in 2001 weaning brought premiums of about $2 per cwt for both steers and heifers. In contrast, the average *WEANED* premium from 2008-2010 was more than $4.50 per cwt ($4.56 for steers and $4.80 for heifers). The 2008-2010 estimated values for weaning are consistent with Schumacher, Schroeder, and Tonsor (2012) who found feedlots were willing to pay $5.35 per cwt premiums for 650 lb. steer calves weaned for 30 days. Increased premiums for weaned calves in recent years may reflect the fact that more information has become widely available regarding benefits to cattle feeders of weaned calves. For example, recent animal science literature demonstrates reduced cattle morbidity if calves have been weaned at least 30 to 45 days, with associated health programs administered, before being shipped to a feedlot (Step et al., 2008). This alone is not necessarily new information, but it has elevated in importance as more feedlots have adopted value-added feeding programs and vertical marketing agreements and alliances.

The main difference between *VAC45* and *2VAC* is having third-party certification of vaccination and assured weaning under *VAC45*. In 2009, *VAC45* was not statistically significant for steers or heifers for which we have no explanation and we consider an anomaly. Consistent with our general findings, Schumacher, Schroeder, and Tonsor (2012) estimated that feedlot operators were willing to pay an average of $0.85 per cwt more for feeder cattle having a third-party certification of the animal health program compared to only a seller claim and $2.37 per cwt more for USDA certification. Cow-calf producers that do not wean their calves, but do administer respiratory vaccinations may want to consider the *VAC34* or *VAC34P* protocols. *VAC34* and *VAC34P* calves typically received premiums of about $2 to $4 per cwt relative to *NOVAC*. *VAC34P* protocol includes a first-round (at marking or branding) and second-round (2-6 weeks prior to shipping) of selected vaccinations compared to only a single round (2-6 weeks prior to shipping) for *VAC34* (table 2). Thus, *VAC34P* would cost the producer more because of the extra vaccination at branding. Premiums for *VAC34P* and *VAC34* were similar for both steers and heifers, making it unclear whether producers are getting paid the additional value to offset added costs of *VAC34P*.

Genetic, management, and marketing trait descriptions have statistically significant influence on calf prices. Producers who generically described their calves as weaned, non-implanted, black-hided calves with all their shots missed chances for additional revenue that more specific descriptions may have provided. Buyers appeared to be more discriminating in seller management and marketing claims. In each model, statistical price differences existed between Angus and black or black-white faced calves. Similar differences were observed when verified health claims for *VAC34*, *VAC34P*, and *VAC45* protocols were compared to non-certified respiratory vaccination programs.

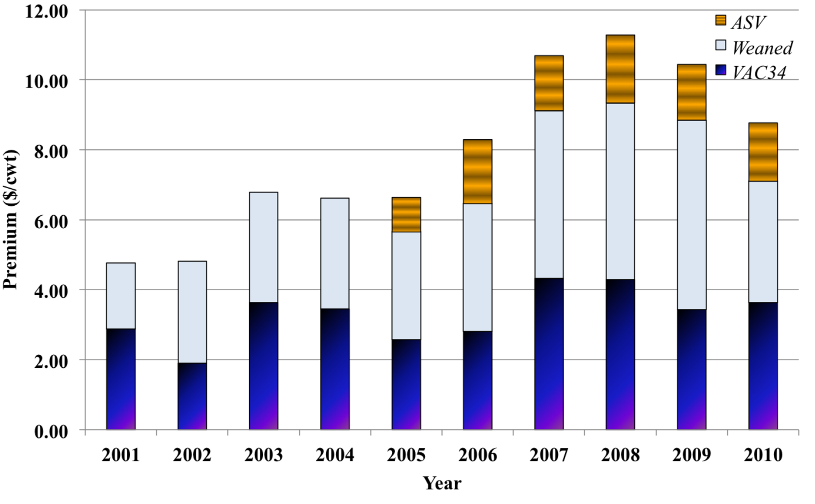

Figure 2. Estimated Premiums over Time for *VAC34*, Weaning, and Age-and-Source Verification for Steers by Year, 2001-2010.

Marketing programs for ASV, natural, and NHTC certified cattle emerged in the last six years as domestic and international consumers have demanded specific management practices from U.S. beef producers. Age and source verification presented an economically important opportunity with statistically significant premiums ranging from about $1 to $2.75 per cwt for steers and heifers. *ASV* calves realized premiums that increased from $1.09 in 2005 to $2.75 per cwt in 2008 and declined to $1.91 per cwt in 2010 for steers (table 3). A similar pattern was present for heifers with ASV premiums going from $0.99 in 2005 up to $1.94 in 2008 only to decline back to $1.67 per cwt in 2010 (table 4).

Weaning, certified vaccination programs, and ASV have provided economically significant premium opportunities for cow-calf producers. Figure 2 summarizes estimated premiums for *ASV*, *VAC34*, and *WEANED* attributes over time for steers from the model results reported in table 3. Combined, for steer calves these three value-added practices were worth about $4 per cwt in 2001-02, increased to more than $6 per cwt in 2003-05, and garnered $8-$11 per cwt added revenue during 2006-10. Trends in the supply of weaned, certified vaccination programs, and ASV calves (representing just lots of calves in our data sample, not all SLA feeder cattle sales) are also revealing (figure 3).[4] Weaned calves represented 23% of pens of calves sold in 2001-02 and this gradually increased to 34% by 2010. Certified health programs increased from 53% of pens in 2001 to 88% in 2010. With premiums for weaning and certified health programs increasing over time (figure 2), at the same time supplies of such calves were increasing, this indicates growing demand for these attributes over the 10-year period. Pens of calves sold over time on SLA that were ASV increased from about 10% in 2005 to just under 50% in 2010 (figure 3). Age and source verification provides feedlots with opportunities to capture premiums when finished cattle are sold as ASV beef from cattle under 21 months old eligible for export to Japan. The reduced premiums in 2009 and 2010 relative to their peak in 2008 may be a result of increased supply of ASV filling export demand for Japan. Costs of ASV vary by operation size with estimates from Brester et al. (March 2011) of roughly $4 per head ($0.67 per cwt for a 600 lb calf) for operations with 100 or more cows that are currently tagging all the calves they produce. Thus, even with the reduced premiums present in 2010 of $1.67 to $1.91 per cwt, it was profitable for a lot of producers to age- and source-verify calves.

[4] Figure 3 summarizes trends in supply of steers having specific attributes. Heifers had nearly identical percentage values each year for each attribute reported in figure 3.

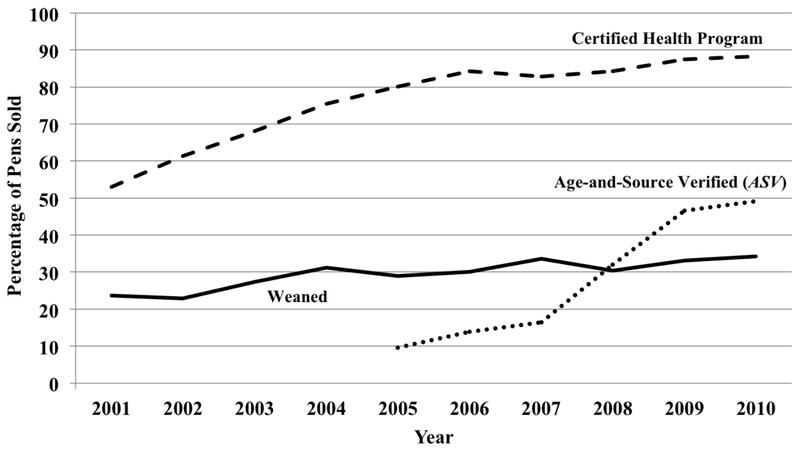

Figure 3. Percentage of Pens of Steer Calves Sold on Superior Livestock Auction that were Weaned, had a Certified Health Program (*VAC24*, *VAC34*, *VAC34P*, *VAC45*, or *VACPC*), or were *ASV*, by Year, 2001-2010.

Natural and NHTC market premiums varied over time. Premiums for natural-market eligible calves (*NAT_NOIMP*) were $0.81 per cwt for steers (table 3) in 2006 and $1.09 per cwt in 2006 and $0.73 per cwt in 2008 for heifers (table 4). No other years had statistically significant premiums for natural-market eligible calves. NHTC-market eligible calves received premiums of $1.81 and $2.78 per cwt for steers and heifers in 2010, respectively, but neither gender received a significant premium in 2009. Lots with an unknown or mixed implant protocol were discounted more than $2 per cwt at times and realized no systematic discount other years. Overall, implanted calves were not penalized with discounts. Cow-calf producers who used implants at the ranch did not receive lower calf prices based on these results. This suggests that if gains from added performance and efficiency accrue to the cow-calf producer who uses implants, as most research has shown, administering them would increase profitability.

Conclusion

The evolution of branded beef programs and international trade restrictions has led to market demand for calves with specific genetic and management characteristics. The industry is also more aware of the effects of health and genetics on cattle feeding performance and on beef product characteristics. This has influenced the premiums offered for preconditioning, vaccination, and related calf management and marketing protocols. Emerging natural and NHTC markets also influence calf prices and are signaling new management systems to cow-calf producers.

Cattle producers striving to improve profit might first focus on improvements in calf weaning and animal health programs as they offer the greatest value-added premiums. For steers, certified weaning is worth $3 to $5 per cwt and has roughly doubled in value since the early 2000s. Certified health programs such as VAC34, VAC34P, or VAC45 generally add more than $3 per cwt to calf value independent of added calf weaning value. Weaning and health program premiums reflect the added value to feedlots of calves that are likely to have less morbidity and better feeding performance. Supply of weaned calves and those treated with certified health programs have both increased over time. This, combined with the increased premiums estimated for these traits, indicates robust demand growth over the past ten years by cattle feeders for these attributes.

Age-and-source verified calves are worth about $2 per cwt more than comparable calves without ASV reflecting the increased value associated with beef export market programs specifically targeted to Japan. Premiums for ASV calves about doubled from 2005 to 2008, during a time supply of ASV calves increased very rapidly from about 10% of SLA pens sold in 2005 to about 30% in 2008. Thus, demand for ASV was growing faster than supply. Premiums for this attribute have declined as the supply of age- and source-verified calves has increased to nearly 50% of lots sold in 2010, but the practice was still profitable during 2010 given current producer costs of age-and-source verifying calves.

Cow-calf producers may profit from adopting additional management and marketing practices, including naturally raised calves and NHTC. Naturally raised calves have realized varied premiums for that attribute at SLA. NHTC has also seen variation in premiums over time. These specialized production programs could become more important as consumer demand increases for the production standards they encompass. Previous research concerning the relationships of traditional price determinants such as frame size, flesh, weight, weight variation and lot size continue to be important price determinants in SLA video market sales.

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