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Beef Producer Alliance Preferences for Vertical Coordination: A Bivariate Nested Panel Probit Approach

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Using a nested bivariate panel probit model, we quantify the perceived attribute values (PAV) that beef producers place on different information flows and alliance attributes. Our framework allows us to quantify the monetary value of individual rather than fixed sets of attributes. Results indicate that young producers are most likely to join an alliance, and high participation fees are a significant deterrent to joining an alliance. A PAV of $12.64/head is attached to an alliance that enforces restrictions on vaccinations and antibiotic use. For small producers, not having a required minimum number of animals has a PAV of $9.65/head.

Key words: cognitive survey burden, conjoint analysis, participation fees, perceived attribute value, stated preferences

Introduction

Since the late 1970s, the U.S. beef industry has faced several challenges, including a substantial decrease in per capita beef consumption, from 88.2 lb in 1975 to 55.5 lb in 2016, and loss of market share to poultry. Over the same period, per capita consumption of pork increased modestly, from 43.0 lb to 50.0 lb, and per capita consumption of chicken more than doubled, from 39.4 lb to 89.6 lb (Livestock Marketing Information Center, 2017). Although beef prices have been relatively favorable for cow–calf producers in recent years, beef's share of total U.S. meat expenditures over 1975–2016 dropped from 60.5% to 46.4%, while pork increased slightly (from 26.1% to 26.3%) and poultry increased substantially (from 13.4% to 23.8%).

Reduced beef consumption relative to poultry consumption can be explained by factors that include relative prices and changes in consumer preferences and tastes (Gillespie et al., 2006; Mulrony and Chaddad, 2005; Schroeder and Mark, 2000; Schroeder, Marsh, and Mintert, 2000). Health concerns associated with eating red meat and offering differentiated and more desirable products that meet consumers' new expectations relative to their tastes and preferences are also an issue for the beef industry (Gillespie et al.; Purcell and Hudson, 2003; Schroeder and Kovanda, 2003). Relative improvements in the quality and consistency of chicken compared to beef products are also cited as important contributing factors (Purcell, 2000, Schroeder, Marsh, and Mintert). Additionally, increases in production efficiency and reductions in marketing costs through greater vertical coordination for poultry and pork than for beef have allowed these industries to be more price competitive (Gillespie et al.).

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In contrast, the beef industry is characterized by a lack of coordination between its stages of production, making it difficult to convey consumer preferences from the retail marketplace to each link in the production chain (Lamb and Beshear, 1998). Ward (2004, p. 1) argues that "this segmentation potentially creates impediments to the efficient flow of information up and down the production-marketing channel." Following Peterson, Wysocki, and Harsh (2001), we recognize that a continuum of vertical coordination can exist, with spot markets and vertical integration on the extremes and alliances between these endpoints. In moving to vertical integration, the nature of control changes from predominantly *ex ante* to *ex post*; centralized control rather than single ownership is necessary for vertical integration. Although some studies have quantified producer alliance preferences in the pork industry (Roe, Sporleder, and Belleville, 2004) and vegetable (Vassalos et al., 2016), no such studies exist for the U.S. beef industry. Mulrony and Chaddad (2005) note that this is a needed area of research.

This study quantifies the significance and monetary value that participants place on different information flows and alliance attributes for a coordinated beef alliance. Another goal is to present a methodology for quantifying individual and joint attributes conditional on prior answers using our proposed bivariate nested panel probit framework. Given that many online survey platforms have the capacity to take respondents on different paths conditional on prior answers, our nested bivariate framework provides an alternative to more traditional exhaustive multiple choice and multinomial models. By restricting the number of combinations each respondent sees, our framework limits the cognitive burden placed on survey participants (Akaichi, Nayga, and Gil, 2013). While we use most of the same questions as Steiner et al. (2012) to assess producers' alliance preferences, we use a nested bivariate panel probit model to quantify the value of individual attributes rather than multinomial logit estimates of some predefined attribute combinations.

Our first stage uses producer characteristics to quantify producers' willingness to join an alliance. The second stage quantifies attribute preferences of those producers willing to join an alliance. Our second-stage questions are identical in their variations and attribute levels to those in Steiner et al. (2012). However, unlike Steiner et al., we estimate this stage as a panel probit rather than as a single cross-sectional equation because each producer was asked to choose between two different sets of alliances (A or B) four times with different alliance configurations in each questionnaire. In such panel type situations, random effects estimators explicitly account for unobserved heterogeneity and provide better estimates.

Although the questions in our survey of Arizona producers are similar to those of Steiner et al. (2012) for Canadian producers, our methodology differs in two important aspects: First, their estimation method does not explicitly account for the nested nature of questions present in the survey design. Second, because they directly model sets of attributes (rather than individual attributes), their framework cannot tease out the monetary value of individual attributes. Their multinomial logit estimates can only estimate the joint perceived monetary value that producers place on sets of attributes.

As in Steiner et al. (2012), we present several variations and levels of attributes to all producers, even though each producer made no more than four alliance choices. Producer demographics such as education, age, herd size, and the cost information that producers collect for their beef operations are hypothesized to positively impact a producers' willingness to join an alliance. Alliance attributes such as required production protocols, data and profit sharing, and amount of participation fees are also expected to influence producers' willingness to join an alliance. Interactions between fee participation and cost of production information collected are hypothesized to have an impact on the choice of one alliance over another.

Background

U.S. beef has been described as producing a commodity rather than a branded, differentiated product (Gillespie et al., 2006), a situation that Schroeder and Kovanda (2003) argue is due to the resistance of some retailers to develop branded products. Although branded programs like Certified Angus Beef have grown, accounting for 15.9% of all boxed beef cutout loads in 2016 (Livestock Marketing Information Center, 2017), these programs have failed to maintain beef's market share against competing meats.

In general, an alliance consists of two or more firms operating within adjacent stages of the vertical beef supply chain (sectors of seedstock to final consumer) that agree to cooperate for mutual benefit, even though the essential components and definition of a beef alliance are not universally agreed upon (Ward and Raper, 2009). Purfeerst (2017) summarizes 21 of the beef industry's top-value-based marketing alliances for cattle and calves. Requirements on genetics, nomenclature, production practices, minimum head, retained ownership, and alignment of feeders and packers with cow–calf producers vary between and even within alliances. Of 92 certified beef programs listed with the U.S. Department of Agriculture's Agricultural Marketing Service (2018), 58 include the word "Angus" in their names, and many restaurants advertise that their beef comes from Angus cattle. Arby's advertises that they only serve 100% Black Angus beef with their processed product and this leads to Angus confusion (Siebert and Jones, 2013) even though Arby's claim is true. Overall, certified beef programs appear to be somewhat limited in their ability to compete effectively with the highly vertically coordinated production of pork and poultry, in spite of the growth in certified beef programs in recent years.

To overcome challenges facing the beef industry, stakeholders have considered several approaches that would make beef more competitive. Some authors and researchers have suggested that better industry coordination would increase efficiency and reduce costs, thus provide more uniform products that are most highly desired by consumers and are more competitively priced (Gillespie, Basarir, and Schupp, 2004; Lamb and Beshear, 1998; Mulrony and Chaddad, 2005). The beef industry would then be able to reduce their market share losses and improve beef consumption relative to competitors.

Many authors (e.g., Gillespie et al., 2006; Purcell and Hudson, 2003; Schroeder and Kovanda, 2003; Tronstad and Unterschultz, 2005) agree that the beef industry could address the limitations noted above by implementing better organization through greater vertical and horizontal coordination. Strategic alliances are one way of overcoming the industry's lack of coordination. Mohr and Spekman (1994, p. 135) define strategic alliances as "purposive strategic relationships between independent firms that share compatible goals, strive for mutual benefits, and acknowledge a high level of mutual dependence." Strategic alliances would help the competitive position of the beef industry by providing products that are more fully customized for consumers by better accounting for their tastes and preferences. In addition, strategic alliances would benefit cow–calf producers by creating new opportunities in terms of market channels, prices, and better access to information, leading to improved decisions that would lead to greater profits (Gillespie et al., 2006).

Consequently, alliance members have opportunities to access markets through which their animals will be given more value and profitability. However, as Raper et al. (2005) find, joining an alliance creates obstacles related to genetics, production requirements, operation size, and animal health restrictions. Information sharing with the collective development of genetic seed stock and management protocols can contribute to a more consistent and customized product with consumers' desired attributes. Thompson et al. (2017) suggest that genetic testing could eliminate market inadequacies due to asymmetric information between producers and consumers and provide more reliable information regarding beef quality. This could create more value for the beef industry (van Eenennaam and Drake, 2012), but genetic testing costs are likely to fall short of the value that could be generated from targeted genetic sources and prescribed management protocols within an alliance. These information flows can lead the industry to a more competitive product and "alliance participants can respond more quickly and correctly to clearer market signals" (Ward, 2004, p. 1).

Producers' preferences and decisions to join an alliance can be explained by their desire to lessen and minimize transaction costs. Hobbs (1997) uses transaction cost theory to investigate why producers choose one distribution channel over another in the United Kingdom. Brocklebank and Hobbs (2004) also use the transaction cost theory framework to investigate the attributes of different types of beef supply chain alliances. Child and Faulkner (1998) characterize transaction costs as those that arise when arranging, managing, and monitoring transactions across markets, including negotiation, search, and information costs. In addition to transaction costs theory, Lajili et al. (1997) also use agency theory to support the investigation of farmers' preferences for contract terms. They find that asset specificity and individual characteristics have a significant impact on producers' preferences for contract terms in crop production contracts. The signaling problem is related to the adverse selection problem. In the former, the agent can send a signal that is observed by the principal after learning the characteristics of the agent (Macho-Stadler, Pérez-Castrillo, and Watt, 2001). Therefore, the agent can adopt actions before signing contracts that influence the beliefs of principals about the agent's identity. The optimal contract scheme contains appropriate incentives for the agent to behave or create output in such a way that maximizes the returns to the principal and total surplus of both parties.

Lan (2007, p. 31) notes that with regard to beef alliances, the theory of incomplete contracts approach is relevant, "since the issue of residual rights of control relates directly to the marketing problems of various forms of formal beef alliances." This implies also that the boundaries of asset ownership and the incentives related to them can help distinguish beef alliances. Raper, Black, and Hilker (2008) find that premiums are the highest motivation for both specialized and integrated cow–calf producers to join an alliance or be part of a vertical marketing arrangement. However, because of the difference of their respective operations, their expectations and perceptions of alliance performance are also different.

Data and Conceptual Framework

We designed a survey to capture insights into beef producers' characteristics, their production practices, and their willingness to join a beef alliance under varied circumstances. Our two-step approach first identified participants who were not willing to participate in a beef alliance under any conditions. Then, we solicited a second set of responses from participants open to paying or valuing certain alliance attributes. Following Steiner et al. (2012) and Hensher, Rose, and Greene (2005), we generated a choice experiment design using an orthogonal fractional factorial design to obtain a sample of 32 treatments with four beef alliance choice tables (i.e., choice of A versus B) per questionnaire and individual. Thus, eight unique sets of choices were distributed. In an unlabeled experiment design, the choice alternatives are normally labeled as "Alternative A" and "Alternative B," such that the labels attached to each choice alternative convey no information beyond that provided by their attributes (Louviere, Hensher, and Swait, 2000).

Respondents were identified through USDA/NASS (i.e., producers at large) and the Beef Quality Assurance (BQA) program within the state of Arizona. The USDA/NASS questionnaires were sent in Fall 2007, and 146 useable questionnaires (i.e., those that included at least partial completions for at least one variable) were received (a 14.7% response rate). In Spring 2008, the questionnaire was also sent to BQA producers within the state. Of 423 surveys sent, 107 were returned, resulting in a response rate of 25.3%. Overall, both sets of surveys yielded 253 questionnaires filled at least partially, for a 17.9% response rate. It is possible that a few cattle producers could have been solicited twice, although we believe the overlap to have been minimal and would only have occurred if the rancher had forgotten about filling out an earlier questionnaire.

The survey design and bivariate construct are such that only producers who were willing to join an alliance were asked to respond to the questions of the choice experiment. Table 1 illustrates how two alliances for one scenario were presented to producers. In the sample shown, the choices differ in all attributes except for production protocols; for some alliance choice sets, every attribute but one might be identical.

To help respondents understand the meaning of each attribute, we supplied attribute definitions before they proceeded to the choice experiment questions:

Table 1. Example of an Alliance Choice Scenario Presented to Producers

	Alliance A	**Alliance B**
Sale type	Retain Ownership, NO profit sharing	Sell to Alliance, NO profit sharing
Type of data sharing	Live performance, individual data	Carcass, individual yield & grade data
Production protocols	Restrictions on vaccination and use of, antibiotics & minimum number of animals required	Restrictions on vaccination and use of, antibiotics & minimum number of animals required
Alliance participation fee	$10/head	$20/head
	Alliance A	Alliance B
I would choose	□	□

1. "Sale type refers to the ways in which you are willing to market your animals with an alliance (e.g., sell animals to alliance, retain ownership)." It includes different combinations of market strategies (sell to alliance or retain ownership) and compensation schemes (profit sharing or no profit sharing among members of the alliance).

2. "Type of data sharing refers to the different levels at which you would want to share data with the alliance." It includes different combinations of collected information strategies and data sharing schemes such as live or carcass performance and individual or group data.

3. "Production protocols refers to the type of production protocols you would agree to related to vaccines, weaning and other production practices." Weaning (specific restrictions or no restriction concerning vaccinations and use of antibiotics) and other production protocols that can be considered as quantity commitments (minimum or no minimum number of animals required). A quantity commitment can be significant in three ways (Ward, 2004). First, volume may be of great significance for cost reductions if an alliance is connected with a processing entity. Second, if an alliance is pursuing a specific branded beef product program, volume may allow enhanced control over the supply of the product. Finally, producers will have an increased interest in the success of an alliance arrangement if they are willing to make a quantity commitment to the alliance.

4. "Alliance Participation Fee refers to the per head cost of participating in the proposed alliance (these costs are in addition to your regular costs of production)." The monetary commitment is of big importance just like the quantity commitment in the sense that a producer's willingness to support these two concepts of an alliance are also expected to have a high interest in the success of an alliance. The monetary commitment interacts with other demographics and allows us to gain insights into the combined effect that the membership fee and other alliance attributes have on the producers' choices for one alliance over the other. In this study, four levels of alliance participation fees ($5, $10, $15, and $20) were included.

Producers were asked to categorize their current beef operations and farm activities. For example, respondents were asked whether they collect cost of production information for different areas of their beef operation. Producers could choose from among "none," "feed costs," "grazing costs," "operating costs," "cash costs," "fixed costs," and "per pound cost of gain."

The second part of the survey includes questions about producers' willingness to join an alliance and the choice experiment. After a brief explanation regarding the opportunity to be part of a beef alliance, the producer was asked whether there were certain circumstances under which they would be willing to participate in an alliance. For producers who were willing to join an alliance, the second stage of four choice sets of alliance attributes was presented.

The third and final part of the survey asks for each producer's sociodemographic characteristics, such age, education, income from on-farm or off-farm activities, herd size, expectations about net income and the market value of cattle sold, and other farm activities.

Econometric Model

Respondents who answered "yes" to "Are you willing to join an alliance under certain circumstances?" were given T $(T = 4)$ more binary questions about which type of alliance they would choose given the set of alliance attributes presented. However, respondents who answered "no" were not asked to select what set of alliance attributes for A or B they prefer. Therefore, for these latter respondents we have only one observation whereas for those who answered "yes" to the initial question, we have four more observations. The nested nature of the questions does not necessarily force respondents to choose from among choices in which they might otherwise be uninterested.

As is typical in stated preferences studies, we assume a random utility specification in which participants choose an alternative that maximizes their expected utility. For example, among producers who expressed interest in joining an alliance under some circumstances, the utility of choosing option A for producer i in the tth choice set is given by

(1) $$U_{itA} = \mathbf{z}'_{itA}\boldsymbol{\beta}_2 + \varepsilon_{itA},$$

where $\boldsymbol{\beta}_2$ is a vector of parameters that need to be estimated, $\mathbf{z}_{itA}$ is a vector of observed attributes of option A in choice set t, and ε_{itA} is the random error term. Producer i will choose option A over option B if

(2) $$U_{itA} - U_{itB} = (\mathbf{z}'_{itA} - \mathbf{z}'_{itB})\boldsymbol{\beta}_2 + \varepsilon_{itA} - \varepsilon_{itB} > 0.$$

An important implication of equation (2) is that explanatory variables in any regression model for estimating equation (2) should enter as differences in attributes between the two options under consideration.

Based on the survey design, we develop a bivariate nested panel probit model to quantify producers' alliance choice behavior. Accordingly, we use the following model to jointly estimate producers' first- and second-stage choices:

(3) $$y^*_{1i} = \boldsymbol{\beta}'_1\mathbf{x}_{1i} + e_i; \qquad y_{1i} = \begin{cases} 1 & y^*_{1i} > 0 \\ 0 & y^*_{1i} \leq 0 \end{cases} \qquad i = 1, 2, ..., N;$$

(4) $$y^*_{2it} = \boldsymbol{\beta}'_2\mathbf{x}_{2it} + u_i + v_{it}; \qquad y_{2it} = \begin{cases} 1 & y^*_{2it} > 0 \\ 0 & y^*_{2it} \leq 0 \end{cases} \qquad i = 1, 2, ..., N;\ t = 1, ..., T;$$

where N represents number of individuals, T represents number of binary choice sets given to producers that answered "yes" to the first question, y^*_{1i} and y^*_{2it} are unobserved latent variables corresponding to y_{1i} and y_{2it}, respectively, e_i and u_i represent the individual specific error terms, and v_{it} is the general error term. The error terms are assumed to have the following distribution:

(5) $$\begin{pmatrix} e_i \\ u_i \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho\sigma_u \\ \rho\sigma_u & \sigma^2_u \end{bmatrix} \right);$$

(6) $$v_{it} \sim N(0, 1).$$

We assume that v_{it} is independent of e_i and u_i; ρ is the correlation coefficient between e_i and u_i.

Unlike Akaichi, Nayga, and Gil (2013) and Vassalos et al. (2016), we explicitly account for the panel nature of the data by using a random effects panel estimator, which gives more efficient estimates. As in a standard probit model, the probability that a respondent joins an alliance is $P(y_{1i} = 1) = \Phi[\boldsymbol{\beta}'_1\mathbf{x}_{1i}]$, while the probability that the respondent does not join an alliance is $P(y_{1i} = 0) = \Phi[-\boldsymbol{\beta}'_1\mathbf{x}_{1i}]$.

The likelihood function for modeling equations (3)–(6) includes two components: The first is for respondents who did not express a willingness to join an alliance ($y_{1i} = 0$), and the second is for respondents who expressed a willingness to join an alliance under certain circumstances ($y_{1i} = 1$). For the latter respondents, we evaluate the joint probability, $P(y_{1i} = 1, Y_{2i1}, Y_{2i2}, Y_{2i3}, Y_{2i4})$. The likelihood for individual i is then given by

$$L_i = [P(y_{1i} = 0)]^{1-y_{1i}} [P(y_{1i} = 1, Y_{2i1}, Y_{2i2}, Y_{2i3}, Y_{2i4})]^{y_{1i}}$$

(7)

$$= [p(y_{1i} = 0)]^{1-y_{1i}} \left[\int_{-\infty}^{\infty} P(y_{1i} = 1|u_i). \left\{ \prod_{t=1}^{4} P(Y_{2it}|u_i) \right\} f(u_i) du_i \right]^{y_{1i}},$$

where $f(u_i)$ is the marginal density function for u_i. The likelihood in equation (7) cannot be evaluated in a closed form solution but can be approximated using Gauss–Hermite Quadrature (GHQ) (Cameron and Trivedi, 2005). Using GHQ, the log-likelihood corresponding to equation (7) can be expressed as

(8)
$$\ln L = \sum_{i=1}^{N} \ln L_i \cong \sum_{i=1}^{N} (1 - y_{1i}) \times \ln \Phi \left[-\boldsymbol{\beta}_1' \boldsymbol{x}_{1i} \right] + \sum_{i=1}^{N} y_{1i} \times \left[\frac{1}{\sqrt{\pi}} \sum_{j=1}^{M} w_j g(a_j) \right],$$

where $g(a_j) = \Phi \left[\frac{\boldsymbol{\beta}_1' \boldsymbol{x}_{1i} + \rho \sqrt{2} a_j}{\sqrt{1-\rho^2}} \right] \times \left\{ \prod_{t=1}^{T} \Phi \left[(2y_{2it} - 1) \times \left(\boldsymbol{\beta}_2' \boldsymbol{x}_{2it} + \sqrt{2} \sigma_u a_j \right) \right] \right\}$, M is the number of GHQ evaluation points, w_j is the weight given to the jth evaluation point, and $a_j$is the jth evaluation point (simply called abscissas). Parameters in equations (3)–(6) are jointly estimated by maximizing the log-likelihood in equation (8).

The specific empirical equations used for estimating equations (3) and (4) are

(9)
$$y_{1i}^* = \beta_{11} + \beta_{12} Costinfo_i + \beta_{13} Herd_i + \beta_{14} Age_i + \beta_{15} Educ_i + \beta_{16} BQA_i + e_i;$$

(10)
$$\begin{aligned} y_{2it}^* = \beta_{21} &+ \beta_{22}(Retainown_{Ait} - Retainown_{Bit}) + \beta_{23}(Profitshare_{Ait} - Profitshare_{Bit}) \\ &+ \beta_{24}(Liveperf_{Ait} - Liveperf_{Bit}) + \beta_{25}(Inddata_{Ait} - Inddata_{Bit}) \\ &+ \beta_{26}(Restrictprot_{Ait} - Restrictprot_{Bit}) + \beta_{27}(Animalreq_{Ait} - Animalreq_{Bit}) \\ &+ \beta_{28}(Animalreq_{Ait} - Animalreq_{Bit}) \times Herd_i + \beta_{29}(Fee_{Ait} - Fee_{Bit}) \\ &+ \beta_{30}(Fee_{Ait} - Fee_{Bit}) \times Costinfo_i + u_i + v_{it}. \end{aligned}$$

Table 2 reports variable definitions and summary statistics.

Empirical Results

Results (Table 3) show that producers who collect at least one piece of cost information for their beef operation are more likely to join an alliance than those who do not collect any cost information. The coefficient estimate of age is negative, suggesting that younger producers are more inclined to join an alliance under certain conditions. This result is in line with the findings of Steiner et al. (2012) in analyzing Canadian beef producers' willingness to join an alliance. Unlike Steiner et al., we also consider BQA producers, and our results indicate that they are much more willing to join an alliance compared to those that are not BQA producers.

Overall, producers are less inclined to choose an alliance with live versus carcass performance data as a type of data sharing. Our coefficient estimates for production protocol attributes are highly significant (at the 1% level), indicating that these requirements significantly influence producers'

Table 2. Variable Descriptions and Sample Statistics

Variable Names	Variable Descriptions	*N*	Min.	Max.	Mean
y_{1i}	Binary variable = 1 if *i*th producer is willing to join an alliance under certain circumstances; 0 otherwise.	187	0	1	0.572
y_{2it}	Binary variable = 1 if the *i*th producer prefers alliance A over alliance B in the *t*th choice (where $t = 1, \ldots, 4$); 0 otherwise.	109	0	1	0.550
Costinfo	Binary variable = 1 if producer collects at least one piece of cost information on either feed, grazing, operating, cash, fixed or per pound cost of gain; 0 otherwise.	187	0	1	0.877
Herd	Binary variable = 1 if >150 cows (i.e., 151–300 or >300); 0 otherwise.	187	0	1	0.283
Age	Producer age (1 = $\leq$30, 2 = 31–40, 3 = 41–50, 4 = 51–60, 5 = $\geq$61).	187	1	5	4.166
Educ	Producer education (1 = high school graduate or less, 2 = some college, 3 = 4-year degree or more).	187	1	3	2.187
BQA	Binary variable = 1 if producer is certified through the state's Beef Quality Assurance program; 0 otherwise.	187	0	1	0.439
$Retainown_A$	Binary variable = 1 if alliance A allows producer to retain ownership, 0 otherwise.	109	0	1	0.649
$Retainown_B$	Binary variable = 1 if alliance B allows producer to retain ownership, 0 otherwise.	109	0	1	0.571
$Retainown_A - Retainown_B$	*Retainown* value for alliance choice A minus choice B.	109	−1	1	0.078
$Profitshare_A$	Binary variable = 1 if alliance A includes profit sharing; 0 otherwise.	109	0	1	0.342
$Profitshare_B$	Binary variable = 1 if alliance B includes profit sharing; 0 otherwise.	109	0	1	0.287
$Profitshare_A - Profitshare_B$	*Profitshare* value for alliance choice A minus choice B.	109	−1	1	0.055
$Liveperf_A$	Binary variable = 1 if alliance A uses live performance data for pricing; 0 if alliance A uses carcass data for pricing.	109	0	1	0.688
$Liveperf_B$	Binary variable = 1 if alliance B uses live performance data for pricing; 0 if alliance B uses carcass data for pricing.	109	0	1	0.367
$Liveperf_A - Liveperf_B$	*Liveperf* value for alliance choice A minus choice B.	109	−1	1	0.321
$Inddata_A$	Binary variable = 1 if alliance A uses individual data; 0 if group/pen data.	109	0	1	0.431
$Inddata_B$	Binary variable = 1 if alliance B uses individual data; 0 if group/pen data.	109	0	1	0.103
$Inddata_A Inddata_B$	*Inddata* value for alliance choice A minus choice B.	109	−1	1	0.328
$Restrictprot_A$	Binary variable = 1 if alliance A restricts vaccination and antibiotics use; 0 otherwise.	109	0	1	0.667
$Restrictprot_B$	Binary variable = 1 if alliance B restricts vaccination and antibiotics use; 0 otherwise.	109	0	1	0.507
$Restrictprot_A - Restrictprot_B$	*Restricprot* value for alliance choice A minus choice B.	109	−1	1	0.161
$Animalreq_A$	Binary variable = 1 if alliance A requires a minimum number of animals; 0 otherwise.	109	0	1	0.406
$Animalreq_B$	Binary variable = 1 if alliance B requires a minimum number of animals; 0 otherwise.	109	0	1	0.553
$Animalreq_A - Animalreq_B$	*Animalreq* value for alliance choice A minus choice B.	109	−1	1	−0.147
Fee_A	Participation fee value for alliance choice A.	109	0	20	9.300
Fee_B	Participation fee value for alliance choice B.	109	0	20	9.037
$Fee_A - Fee_B$	Participation fee value for alliance choice A minus choice B.	109	−20	20	0.264

Notes: N represents number of individuals. Actual number of observations for y_{2it} is $109 \times 4 = 436$.

Table 3. Maximum Likelihood Estimates of Model Parameters

	Parameter Estimates		Marginal Effects	
Variable	**Estimate**	**Std. Err.**	**Estimate**	**Std. Err.**
Alliance participation willingness equation				
Intercept	−0.315	0.646		
Costinfo	0.569*	0.321	0.194**	0.098
Herd	0.102	0.236	0.040	0.093
Age	−0.198*	0.105	−0.078*	0.041
Educ	0.159	0.116	0.060	0.045
BQA	1.137***	0.213	0.412***	0.070
Alliance choice preference equation				
Intercept	0.023	0.238		
$Retainown_A - Retainown_B$	−0.277*	0.158		
$Profitshare_A - Profitshare_B$	0.150	0.183		
$Liveperf_A - Liveperf_B$	−0.315*	0.191		
$Inddata_A - Inddata_B$	0.273	0.203	See Table 4	
$Restrictprot_A - Restrictprot_B$	0.464***	0.113		
$Animalreq_A - Animalreq_B$	−0.354**	0.164		
$(Animalreq_A - Animalreq_B) \times Herd$	0.205	0.292		
$Fee_A - Fee_B$	−0.087***	0.032		
$(Fee_A - Fee_B) \times Costinfo$	0.050	0.032		
ρ	0.025	0.427		
σ_u	0.791***	0.146		

Notes: Single, double, and triple asterisks (*,**,***) indicate statistical significance at the 10%, 5%, and 1% level. When calculating marginal effects for a variable we held all other variables at their modal value. Marginal effects for age are from 51–60 to >61 and education are from some college to a 4-year degree or more.

alliance choices. Producers are less inclined to join an alliance when a minimum number of animals are required and when an alliance does not restrict the use of vaccinations and antibiotics compared to one that restricts their usage. This result differs from Steiner et al. (2012), who found that production protocol requirements did not significantly influence producers' beef alliance choices.

Marginal Effects

Table 4 reports the marginal effects of changes in explanatory variables on the probability of a producer choosing alliance A over alliance B. For discrete explanatory variables, marginal effects are calculated as differences in the probabilities of choosing A over B under different scenarios. For example, the marginal effect of the presence of retained ownership on the probability of choosing A over B is calculated as

$$\begin{aligned} & P(y_{2i}=1|Retainown_{Ait}-Retainown_{Bit}=1)-P(y_{2i}=1|Retainown_{Ait}-Retainown_{Bit}=0) \\ (11) \quad & = \Phi[\beta_{21}+\beta_{22}+\beta_{29}(Fee_{Ait}-Fee_{Bit})+\beta_{30}(Fee_{Ait}-Fee_{Bit})\times Costinfo_i] \\ & \quad -\Phi[\beta_{21}+\beta_{29}(Fee_{Ait}-Fee_{Bit})+\beta_{30}(Fee_{Ait}-Fee_{Bit})\times Costinfo_i]. \end{aligned}$$

Table 4. Estimated Marginal Effects of Alliance Attributes and Different Fee Levels

Variables	$0/Head	$5/Head	$10/Head	$15/Head	$20/Head
$Retainown_A - Retainown_B$	−0.068*	−0.112***	−0.154***	−0.195***	−0.234***
	(0.039)	(0.039)	(0.040)	(0.042)	(0.045)
$Profitshare_A - Profitshare_B$	0.037	−0.008	−0.053	−0.097*	−0.141**
	(0.044)	(0.046)	(0.049)	(0.053)	(0.057)
$Liveperf_A - Liveperf_B$	−0.077	−0.121**	−0.163***	−0.204***	−0.242***
	(0.047)	(0.048)	(0.049)	(0.051)	(0.053)
$Inddata_A - Inddata_B$	0.067	0.022	−0.023	−0.068	−0.112*
	(0.051)	(0.052)	(0.054)	(0.058)	(0.061)
$Restrictprot_A - Restrictprot_B$	0.112***	0.068**	0.024	−0.021	−0.066
	(0.032)	(0.032)	(0.034)	(0.039)	(0.044)
$(Animalreq_A - Animalreq_B)\times$	−0.086**	−0.130***	−0.172***	−0.212***	−0.250***
$(Herd\ size \leq 150\ cows)$	(0.038)	(0.041)	(0.045)	(0.049)	(0.052)
$(Animalreq_A - Animalreq_B)\times$	−0.037	−0.081	−0.125**	−0.167***	−0.207***
$Herd\ size > 150\ cows$	(0.059)	(0.061)	(0.062)	(0.064)	(0.065)
Costinfo		0.105***	0.203***	0.289***	0.359***
		(0.040)	(0.073)	(0.092)	(0.096)
$Fee_A - Fee_B$		−0.016***	−0.018***	−0.020***	−0.023***
		(0.004)	(0.005)	(0.006)	(0.007)

Notes: Numbers in parentheses are estimated standard errors. Single, double, and triple asterisks (*,**,***) indicate statistical significance at the 10%, 5%, and 1% level. Negative differences generally have an opposite sign with similar magnitude and significance, but not identical, because the mean of difference in participation fees is not centered on 0.

Similarly, the marginal effect of the presence of minimum number of animals required on the probability of choosing A over B is calculated as

$$\begin{aligned} & P(y_{2i}=1|Animalreq_{Ait}-Animalreq_{Bit}=1)-P(y_{2i}=1|Animalreq_{Ait}-Animalreq_{Bit}=0) \\ (12) \quad & =\Phi[\beta_{21}+\beta_{27}+\beta_{28}Herd_i+\beta_{29}(Fee_{Ait}-Fee_{Bit})+\beta_{30}(Fee_{Ait}-Fee_{Bit})\times Costinfo_i] \\ & -\Phi[\beta_{21}+\beta_{29}(Fee_{Ait}-Fee_{Bit})+\beta_{30}(Fee_{Ait}-Fee_{Bit})\times Costinfo_i]. \end{aligned}$$

These marginal effects are evaluated for different values of $(Fee_{Ait} - Fee_{Bit})$, from \$0 to \$20, in increments of \$5. Marginal effects for other discrete variables are calculated in a similar manner. The marginal effect of the continuous variable, $(Fee_{Ait} - Fee_{Bit})$, is calculated as

$$\begin{aligned} \frac{\partial P(y_{2i}=1)}{\partial(Fee_{Ait}-Fee_{Bit})} &= \phi\,[\beta_{21}+\beta_{22}(Retainown_{Ait}-Retainown_{Bit}) \\ &+\beta_{23}(Profitshare_{Ait}-Profitshare_{Bit})+\beta_{24}(Liveperf_{Ait}-Liveperf_{Bit}) \\ (13) \quad &+\beta_{25}(Inddata_{Ait}-Inddata_{Bit})+\beta_{26}(Restrictprot_{Ait}-Restrictprot_{Bit}) \\ &+\beta_{27}(Animalreq_{Ait}-Animalreq_{Bit}) \\ &+\beta_{28}(Animalreq_{Ait}-Animalreq_{Bit})\times Herd_i+\beta_{29}(Fee_{Ait}-Fee_{Bit}) \\ &+\beta_{30}(Fee_{Ait}-Fee_{Bit})\times Costinfo_i]\times(\beta_{29}+\beta_{30}\times Costinfo_i). \end{aligned}$$

Equation (13) gives the marginal effect with respect to a fee difference for the two options (i.e., option A versus B) under consideration.

Sale Type (Marketing Methods)

Results in Table 4 show that when retained ownership is present in an alliance, producers are less likely to choose this alliance as the difference in participation fees ($Fee_{Ait} - Fee_{Bit}$) increases.[1] For example, if the participation fee in one alliance is $20 greater than the fee for another alliance, producers are 23.40% less likely to choose the first alliance when retained ownership is present. Producers are only less likely to choose a profit-sharing alliance when the fee difference is above $15/head or relatively high. As shown is Table 4, producers are 9.74% and 14.06% less likely to join an alliance with profit sharing when the alliance participation fees are $15/head and $20/head greater, respectively, than an otherwise equal competing alliance. However, producers prefer market strategies that allow them to sell their animals to the alliance over a retained-ownership type of alliance. Producers may face issues meeting all cash production costs until slaughter and possibly higher alliance transaction costs (Gillespie et al., 2006; Steiner et al., 2012). Our fee result appears to be consistent with Steiner et al., who suggest that producers' preferences for selling their animals within the alliance could be motivated by the timing of cash flow availability with retained ownership. Producers are also more likely to join an alliance with compensation schemes that do not share their profit with other members of the alliance.

Type of Data Sharing

When considering data-sharing information preferences, the results (as shown in Table 4) suggest that producers are less likely to select an alliance with live performance compared to carcass data when live performance data sharing is combined with a higher alliance participation fee ($5 or more). Marginal effects become relatively larger and highly significant for higher fees. This indicates that producers are not motivated to join an alliance that has live performance as opposed to carcass data sharing, and the likelihood of joining such an alliance decreases as the fee differential increases. The likelihood of not choosing an alliance where live performance is present increases with fee differences. For example, if the difference in alliance participation is $5, $10, $15, or $20 per head, the probability of choosing an alliance in which live performance is present decreases by 12.08%, 16.32%, 20.36%, and 24.18%, respectively.

Results from data sharing suggest that producers are most interested in sharing carcass data. Our results indicate that producers' preferences are not influenced by the presence of individual data, individual and yield data, or group and/or pen data unless the participation fee is $20 or more. When individual data or individual and yield data are combined with a participation fee of at least $20, producers are 11.19% more likely to join the alliance that shares group and/or pen data information and has a lower participation fee.

Production Protocols

The highly significant and negative estimate for the production protocol requiring a minimum number of animals suggests that—with or without a difference in alliance participation fees—producers are highly motivated not to join an alliance with this requirement. Their probability of not joining this alliance increases when the difference in the alliance participation fees increases concurrently in favor of that alliance. When the participation fee for one alliance is $5, $10, $15, or $20 per head greater than the other alliance, producers with a herd of less than 151 cows are 12.99%, 17.19%, 21.19%, and 24.95% less likely, respectively, to choose the alliance that requires the producer to sell a minimum number of animals and that has a greater participation fee (Table 4).

Producers are 11.21% more likely to choose an alliance that restricts vaccinations and enforces antibiotic use when two alliances have the same participation fees. Given a difference in alliance participation fee of $5/head, producers are 6.84% more likely to join an alliance that restricts vaccinations and enforces antibiotic use. Results are statistically significant at the 1% level, suggesting that producers are highly motivated to join an alliance that restricts vaccination and

[1] $Fee_{Ait} - Fee_{Bit}$ = participation fee of alliance A minus the participation fee of alliance B.

Table 5. Estimated Attribute(s) Value and Statistical Significance

Attribute Descriptions	Perceived Attribute Values ($/head)	Std. Err.
Individual		
Retained ownership	−7.550*	4.304
Profit sharing	4.095	4.997
Live performance	−8.595*	5.203
Individual data	7.434	5.537
Restrictions on vaccination and use of antibiotics	12.640***	3.089
Minimum number of animals required (producers w/ ≤150 cows)	−9.653**	4.476
Minimum number of animals required (producers w/ >150 cows)	−4.079	6.430
Producers who collected a least one piece of cost information	1.358	0.884
Joint		
Live performance, restrictions on vaccination and use of antibiotics	4.045	4.999
Retain ownership, profit sharing	−3.455	5.054
Live performance, individual data	−1.161	7.098
Carcass, individual data	16.029**	8.067
Restrictions on vaccination and use of antibiotics, minimum number of animals required (producers with ≤ 150 cows)	2.987	5.874
Restrictions on vaccination and use of antibiotics, minimum number of animals required (producers with > 150 cows)	8.561	7.233
Restrictions on vaccination and use of antibiotics, no minimum number of animals required (producers with ≤150 cows)	22.293***	4.963
Restrictions on vaccination and use of antibiotics, no minimum number of animals required (producers with >150 cows)	16.719**	2.377

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

antibiotic use even if they have to pay up to $5/head more in participation fees. However, the marginal effect is insignificant when the difference in participation fees is $10/head or more. Steiner et al. (2012) found that production protocols do not significantly affect producers' preferences for an alliance. Even though we use similar questions, we compare restricted and nonrestricted production protocols by jointly analyzing the effects of fee participation and the presence of a specific attribute, which was not the case in Steiner et al.

Perceived Attribute(s) Value

Using the estimated model, we calculate perceived attribute values (PAV) using producers' preferences for beef alliance choices. PAV is calculated using the fee difference needed to make the producer indifferent between alliances with and without that particular attribute. For example, the PAV for an alliance that allows retained ownership over an alliance that does not allow retained ownership is calculated as

$$-\frac{\beta_{22}}{\beta_{29} + \beta_{30} \times Costinfo_i}. \tag{14}$$

Table 5 reports PAV for other attributes, which are calculated similarly. Producers have a PAV of $12.64/head to join an alliance that restricts members' vaccination and antibiotic use. That is, producers see a market value less any costs associated with not being able to use vaccinations and antibiotics of $12.64/head. Producers do not prefer an alliance that allows membership only to certain large producers. This is evident by a significant PAV of −$9.65. Similarly, when a producer compares an alliance that uses live performance data for pricing of cattle and one that uses carcass data, the producer prefers the latter and is willing to pay up to $8.60 for receiving carcass data back from the slaughterhouse in an alliance. These PAV results indicate that a successful design of alliances for better vertical coordination in the beef industry should consider restrictions on vaccinations and antibiotics, use carcass weight for cattle pricing, and open membership to smaller producers.

Conclusions and Implications

We build on studies of producer preferences for alliances in the U.S. pork and vegetable industries by quantifying Arizona producers' demographics and preferences for joining a beef alliance. We implemented a nested bivariate panel probit model to account for the two-stage and panel survey structure, which reduces the cognitive burden placed on participants compared to the more traditional, exhaustive combination of choices used in a multivariate analysis (Akaichi, Nayga, and Gil, 2013). Our bivariate approach is nested because the panel probit (attribute choice model) is within or nested by the binary probit (participation model). We simultaneously estimate these two equations to provide more insights into producers' attribute choice preferences and demographics.

The study addresses a cow–calf producer's decision to join an alliance and quantifies producers' attribute choice preferences by jointly analyzing the effects of fee participation and the presence of specific attributes. We implemented an unlabeled choice experiment design (i.e., choice alternatives labeled as "Alliance A" and "Alliance B") so that no information was conveyed beyond that provided by the attributes. Consistent with Steiner et al. (2012), our results suggest that producers' willingness to join a beef alliance is significantly influenced by their age. We also present results that are unique to our data and analysis: We find that BQA producers are significantly more willing to join an alliance than non–BQA producers. Also, ranchers who collect at least one piece of cost information (e.g., on feed, grazing, operating, cash, fixed or per pound cost of gain) are more willing to join an alliance that those who do not.

Similar to willingness-to-pay calculations, we compare differences in beef alliance participation fees to quantify the monetary value (i.e., perceived attribute value, PAV) that producers place on individual alliance attributes. Estimates from our bivariate nested panel probit indicate that participation fees play a critical role in producers' preferences for selecting an alliance. For any difference in the participation fee for an alliance, producers are less likely to choose an alliance that allows retained ownership compared to selling to an alliance. Cow–calf producers desire alliances that do not require retained ownership ($-\$7.55/head$) or pay on live performance ($-\$8.60/head$). This suggests ranchers want individual data back on their cattle but don't want to be billed for the costs associated with feeding and slaughter, which they may feel are out of their control. Producers with fewer than 151 cows are not likely to join an alliance that requires a minimum number of animals be sold to the alliance (PAV of \$9.65/animal to avoid this feature in an alliance). However, producers are 11.21% more likely to join an alliance that enforces restrictions on vaccination and antibiotic use when there is no difference in alliance participation fees (PAV of \$12.64/animal for this requirement). Restrictions on vaccination and antibiotic use are very important if producers are targeting high-quality products that meet consumers' growing concerns about the health implications of what they eat (Ibanez and Grolleau, 2008; Thilmany McFadden, 2013) and demand for products without antibiotics (Bowman et al., 2016).

In conclusion, we use a nested bivariate panel probit model to quantify producers' willingness to join an alliance with various attributes. Results indicate that cow–calf producers have strong preferences for certain alliance attributes. These preferences need to be considered when forming an alliance. Alliances should target younger producers who participate in BQA certification. Cow–calf producers want individual carcass data, but they do not necessarily want to take on the risks and costs associated with feeding and slaughter. Given the limited ability of beef certification programs to reverse the trend in consumers' declining share of meat expenditures on beef, alliances that target individuals who desire and value more coordinated market signals, production protocols, and data sharing should help move the beef industry to a more competitive position relative to the pork and poultry sectors.

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References

Akaichi, F., R. M. Nayga, and J. M. Gil. "Are Results from Non-Hypothetical Choice-Based Conjoint Analyses and Non-Hypothetical Recoded-Ranking Conjoint Analyses Similar?" *American Journal of Agricultural Economics* 95(2013):949–963. doi: 10.1093/ajae/aat013.

Bowman, M., K. K. Marshall, F. Kuchler, and L. Lynch. "Raised without Antibiotics: Lessons from Voluntary Labeling of Antibiotic Use Practices in The Broiler Industry." *American Journal of Agricultural Economics* 98(2016):622–642. doi: 10.1093/ajae/aaw008.

Brocklebank, A., and J. E. Hobbs. "Building Brands: Supply Chain Alliances in the Canadian Beef Industry." Tech. rep., University of Saskatchewan, Saskatoon, SK, 2004. Available online at https://www.agrireseau.net/bovinsboucherie/documents/BrandedBeef%20p.pdf.

Cameron, A. C., and P. K. Trivedi. *Microeconometrics: Methods and Applications*. Cambridge, UK: Cambridge University Press, 2005.

Child, J., and D. Faulkner. *Strategies of Cooperation: Managing Alliances, Networks and Joint Ventures*. Oxford, UK: Oxford University Press, 1998.

Gillespie, J., A. Basarir, and A. Schupp. "Beef Producer Choice in Cattle Marketing." *Journal of Agribusiness* 22(2004):149–161.

Gillespie, J., A. Bu, R. W. Boucher, and W.-J. Choi. "Case Studies of Strategic Alliances in U.S. Beef Production." *Journal of Agribusiness* 24(2006):197–220.

Hensher, D. A., J. M. Rose, and W. H. Greene. *Applied Choice Analysis: A Primer*. Cambridge, UK: Cambridge University Press, 2005.

Hobbs, J. E. "Measuring the Importance of Transaction Costs in Cattle Marketing." *American Journal of Agricultural Economics* 79(1997):1083–1095. doi: 10.2307/1244266.

Ibanez, L., and G. Grolleau. "Can Ecolabeling Schemes Preserve the Environment?" *Environmental and Resource Economics* 40(2008):233–249. doi: 10.1007/s10640-007-9150-3.

Lajili, K., P. J. Barry, S. T. Sonka, and J. T. Mahoney. "Farmers' Preferences for Crop Contracts." *Journal of Agricultural and Resource Economics* 22(1997):264–280.

Lamb, R. L., and M. Beshear. "From the Plains to the Plate: Can the Beef Industry Regain Market Share?" *Economic Review* 83(1998):49–66.

Lan, X. *Formal Beef Alliance and Alignment Problems in Canadian Beef Industry*. Master's thesis, University of Alberta, Edmonton, AB, 2007.

Livestock Marketing Information Center. *Expend.xls, Sumq.xls and Wkly463ComprehensiveBoxed BeefCutout.xls [spreadsheets]*. Lakewood, CO: Livestock Marketing Information Center, 2017. Available online at http://www.lmic.info/.

Louviere, J. J., D. A. Hensher, and J. D. Swait. *Stated Choice Methods: Analysis and Applications*. Cambridge, UK: Cambridge University Press, 2000.

Macho-Stadler, I., J. D. Pérez-Castrillo, and R. Watt. *An Introduction to the Economics of Information: Incentives and Contracts*. Oxford, UK: Oxford University Press, 2001, 2nd ed.

Mohr, J., and R. Spekman. "Characteristics of Partnership Success: Partnership Attributes, Communication Behavior, and Conflict Resolution Techniques." *Strategic Management Journal* 15(1994):135–152.

Mulrony, B. R., and F. R. Chaddad. "Strategic Alliances in the U.S. Beef Supply Chain." *Journal of Food Distribution Research* 36(2005):1–15.

Peterson, H., A. Wysocki, and S. Harsh. "Strategic Choice along the Vertical Coordination Continuum." *International Food and Agribusiness Management Review* 4(2001):149–166. doi: 10.1016/S1096-7508(01)00079-9.

Purcell, W. D. "Measures of Changes in Demand for Beef, Pork, and Chicken, 1975-2000." Research Bulletin 4-2000, Virginia Tech, Research Institute on Livestock Pricing, Blacksburg, VA, 2000. Available online at http://purl.umn.edu/232384.

Purcell, W. D., and W. T. Hudson. "Risk Sharing and Compensation Guides for Managers and Members of Vertical Beef Alliances." *Applied Economic Perspectives and Policy* 25(2003):44–65. doi: 10.1111/1467-9353.00045.

Purfeerst, J. "Capturing Value in Your 2017 Beef Calves." *Beef Magazine* (2017):33–35. Available online at https://www.beefmagazine.com/marketing/capturing-value-your-2017-beef-calves.

Raper, K. C., J. R. Black, and J. H. Hilker. "Perceptions of Vertical Marketing Arrangement Performance: Cow/calf Producers versus Multiple Production Level Producers." 2008. Paper presented at the annual meeting of the American Agricultural Economics Association, Orlando, Florida, July 27–29.

Raper, K. C., J. R. Black, M. Hogberg, and J. H. Hilker. "Assessing Bottlenecks in Vertically Organized Beef Systems." *Journal of Food Distribution Research* 36(2005):151–155.

Roe, B., T. L. Sporleder, and B. Belleville. "Hog Producer Preferences for Marketing Contract Attributes." *American Journal of Agricultural Economics* 86(2004):115–123. doi: 10.1111/j.0092-5853.2004.00566.x.

Schroeder, T. C., and J. Kovanda. "Beef Alliances: Motivations, Extent, and Future Prospects." *Veterinary Clinics of North America: Food Animal Practice* 19(2003):397–417. doi: 10.1016/S0749-0720(03)00031-8.

Schroeder, T. C., and D. R. Mark. "How Can the Beef Industry Recapture Lost Consumer Demand?" *Journal of Animal Science* 77(2000):1. doi: 10.2527/jas2000.77E-Suppl1r.

Schroeder, T. C., T. L. Marsh, and J. Mintert. "Beef Demand Determinants." Tech. rep., Kansas State University, Department of Agricultural Economics, Manhattan, KS, 2000. Report prepared for the Beef Board Joint Evaluation Advisory Committee.

Siebert, J. W., and C. Jones. "A Case Study on Building the Certified Angus Beef® Brand." *International Food and Agribusiness Management Review* 16(2013):195–208.

Steiner, B. E., K. Lan, J. R. Unterschultz, P. C. Boxall, E. Laate, and D. Yang. "Producer Preferences towards Vertical Coordination: The Case of Canadian Beef Alliances." 2012. Paper presented at the 123rd seminar of the European Association of Agricultural Economists, Dublin, Ireland, February 23–24.

Thilmany McFadden, D. "Local Food, Organics, and Sustainability." In W. J. Armbruster and R. D. Knutson, eds., *U.S. Programs Affecting Food and Agricultural Marketing,* New York, NY: Springer New York, 2013, 419–442.

Thompson, N. M., B. W. Brorsen, E. A. DeVuyst, and J. L. Lusk. "Genetic Testing to Signal Quality in Beef Cattle: Bayesian Methods for Optimal Sample Size." *American Journal of Agricultural Economics* 99(2017):1287–1306. doi: 10.1093/ajae/aax039.

Tronstad, R., and J. Unterschultz. "Looking beyond Value-Based Pricing of Beef in North America." *Supply Chain Management: An International Journal* 10(2005):214–222. doi: 10.1108/13598540510606278.

U.S. Department of Agriculture. *Certified Beef Programs*. Washington, DC: U.S. Department of Agriculture, Agricultural Marketing Service, 2018. Available online at https://www.ams.usda.gov/services/auditing/certified-beef-programs.

van Eenennaam, A. L., and D. J. Drake. "Where in the Beef-Cattle Supply Chain Might DNA Tests Generate Value?" *Animal Production Science* 52(2012):185–196. doi: 10.1071/AN11060.

Vassalos, M., W. Hu, T. Woods, J. Schieffer, and C. Dillon. "Risk Preferences, Transaction Costs, and Choice of Marketing Contracts: Evidence from a Choice Experiment with Fresh Vegetable Producers." *Agribusiness* 32(2016):379–396. doi: 10.1002/agr.21450.

Ward, C., and K. Raper. "Update on Beef Industry Alliances." OSU Fact Sheet AGEC-614, Oklahoma State University, Oklahoma Cooperative Extension Service, Stillwater, OK, 2009.

Ward, C. E. "Beef Industry Alliances and Vertical Arrangements." Fact Sheet F-563, Oklahoma State University, Oklahoma Cooperative Extension Service, Stillwater, OK, 2004.