August 2004 Bulletin Number 882

A Conjoint Analysis of Site Selection for the U.S. Broiler Industry:

Implications for Louisiana

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B-882 *(700)* *8/04*

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Implications for Louisiana

The average American consumed 59.1 pounds of beef, 48.6 pounds of pork and 19.2 pounds of chicken in 1960[1]. By 2001, a typical American consumed about 63.1 pounds of beef, 46.9 pounds of pork and 52.4 pounds of chicken. These trends illustrate significant changes in U.S. meat consumption over the last 40 years. Most notably, while beef and pork consumption has remained relatively stable, chicken consumption has increased approximately 173 percent.

This growth can be attributed to two factors. The first is the public's increasing concern about possible negative health effects of red meat consumption; this has led to increased preference for poultry meat. The second is the broiler industry's success in achieving cost efficiency and quality control in broiler production and processing, allowing poultry companies to offer a variety of attractive food products at relatively low cost compared to beef and pork.

Cost efficiencies have been achieved via a vertically integrated production/processing system. Most U.S. broilers are produced and marketed by firms that own or control breeder flocks, hatcheries, broiler flocks, feed mills, slaughter plants, further processing plants, and transportation and distribution centers. In many cases, broilers are grown under resource-providing contracts, where a grower builds and maintains chicken houses and is responsible for the land, labor, litter, equipment, taxes, most of the utilities and insurance associated with growing broilers. The integrator provides the grower with technical assistance, baby chicks, feed and medication, and also catches and transports the birds from the farm to the slaughter plant.

The U.S. poultry industry is the world's largest producer and exporter of poultry meat. In 2001, approximately 200 poultry slaughter plants employed 250,000 workers. There are approximately 43 integrated broiler companies, of which the four largest produce nearly 50 percent of the broiler meat. Broiler production tends to be concentrated in the Southeast, with the top five broiler-producing states located in this region. In 2001, U.S. Census data indicated Arkansas was the top state in terms of poultry establishments with 50 slaughter plants, while Georgia and California ranked second with 38 establishments each.

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[1] Per capita data are reported as boneless, trimmed equivalent, weights (USDA/ERS).

During the same year, Georgia was the leading state in terms of total broiler output, producing approximately 6.24 billion pounds, followed by Arkansas, which produced 5.74 billion pounds. Other states leading in broiler production include Alabama, Mississippi, North Carolina, Texas, Delaware, Virginia and Kentucky. Broiler production remains relatively low in Florida, Louisiana, South Carolina and Oklahoma.

On the other hand, in spite of low production compared to some southeastern states, broiler production is the second largest agricultural industry in Louisiana, second only to forestry (Louisiana Ag. Summary, 2003). The state has eight poultry slaughter/processing plants; about half of these are engaged in the further processing of poultry meat. These plants employ 4,361 employees and produce 978 million pounds of broilers with a gross value of $596 million (Louisiana Ag. Summary, 2003). Slaughter/processing establishments are located in Bienville, Bossier, Claiborne, Natchitoches, St. Landry, St. Martin, Tangipahoa and Union parishes (2001 County Business Patterns). Louisiana's 422 broiler growers produce commercial broilers in 12 parishes, including Bienville, Claiborne, Jackson, Lincoln, Livingston, Natchitoches, Ouachita, Sabine, Union, Vernon, Webster and Winn (Louisiana Ag. Summary, 2003).

The reasons why some states are better suited for broiler production/processing than other states are not well understood. The purpose of this study is to analyze broiler industry executives' decisions on where to locate a broiler complex in the United States. The specific objectives are to: 1) identify factors affecting site locations of broiler complexes in the United States, and 2) measure the effects and relative importance of these factors on the broiler-complex location decision. Identifying these factors will help Louisiana develop strategies to better retain and attract broiler companies, which in turn will boost its economy and provide employment opportunities for rural communities.

Review of Location Theory

Numerous factors are considered when determining a suitable site for a firm. These factors depend on the particularities of an industry, but many factors associated with site selection are tied to finding the least-cost location of procuring raw materials and producing and distributing the final product. Location theories, as developed separately by Von Thünen, Weber and Hoover, are useful for analyzing how these costs affect site selection in the poultry industry. All of these theories use the principle of factor substitution, where an industry selects a site from alternative locations, depending on the relative costs of labor, land, transportation and other primary inputs.

Von Thünen's theory of location is based on evaluating tradeoffs between product-specific transportation costs and location-specific land rents. He

developed a model to predict the type of agricultural product to be grown on geographically dispersed plots of land. Key assumptions of the model include homogeneity of land in all aspects except for its distance to a central market, the urban center. He assumes land is more valuable in the city relative to the country, implying land rents decrease the further away from the city a farm is located. This implies agricultural products grown on plots of land closer to the city are charged higher land rents compared to products grown further away from the city. On the other hand, products grown closer to the city are associated with lower transportation costs than those produced at more distant locations. The type of product grown on a particular site is determined by selecting the type of production that yields the lowest cost, given tradeoffs between product-specific transportation costs and land rents.

In contrast to Von Thünen's model, which assumes resources are given and the type of industry is chosen, Weber's model assumes the type of industry is given and the optimal site is chosen. Weber assumed that input supply and output demand are known, and there is an unlimited supply of labor at fixed locations at a given wage rate. He considered three general factors of location: transportation cost, labor cost and agglomeration forces. When transportation cost is the only factor affecting the location of an industry, the site with lowest transportation cost will be selected. This site may be close to the output market, to the input market or between input and output markets, depending on the product.

Weber argued that the orientation of industries is determined by substitution between transportation and non-transportation cost factors, which include labor costs and agglomeration forces. This substitution involves non-transportation costs exerting a "locational pull," where, in some cases, they attract an industry from the point of minimum transportation cost to a point of higher transportation cost. This change occurs as long as the savings in non-transportation cost factors exceed the additional transportation costs incurred. Though Weber's location model is a general theory of location for all industries, his assumption of constant demand and omission of institutional factors, such as interest rate, insurance, taxes and others, leaves gaps in the theory (Greenhut).

Hoover's theory of industry location bridges this gap by focusing on demand determinants as well as transportation and production factors. Hoover's inclusion of institutional factors provides a more comprehensive theory of firm location than either Von Thünen or Weber. Hoover argued that local property taxes were an important element of land cost, thereby influencing the location decision. A distinguishing feature of Hoover's theory is the introduction of fuel and raw material costs, agglomeration forces and the costs generated by factors such as taxes and climate on the location decision. Like previous theories of location, however, the optimal site depends on the relative tradeoffs among institutional factors and costs of production and transportation.

Literature Review

Several studies have addressed factors affecting broiler firm location decisions. Easterling, Braschler and Kuehn used a transportation linear programming model to determine optimal locations for the broiler industry. Results showed that energy cost was relatively unimportant in determining the location of broiler growing and slaughter. They also found that the southern states, especially Georgia and Alabama, had substantial cost advantages with respect to labor and utilities, and that the relative cost of imported versus locally produced feed was significant to broiler production in the South.

Lopez and Henderson examined determinants of location choices of new food processing plants in the Mid-Atlantic region. They performed 56 telephone interviews, of which four were related to poultry processing. The sample also included fruit and vegetable, egg and seafood processors. Of the 41 factors surveyed, variables considered most important for poultry processors were the cost of water, waste disposal, availability of a waste treatment/disposal facility, water pollution regulations, availability of an existing plant facility, stringency of enforcement of environmental regulations and capital expenditure for pollution abatement. The results also showed that labor factors, and state and local policies, were relatively less important in the location decision of a poultry processor (Lopez and Henderson).

Aho conducted a descriptive analysis of regional trends in broiler production. During the period, 1996-1998, seven new complexes were established in the United States. Three were established in Kentucky, and one each in Tennessee, Texas, Oklahoma, and Alabama (Aho). High feed cost was the main disadvantage for broiler production in the North; high cost of production (especially transportation cost) was the main disadvantage for production in the West. Though the Midwest has the advantage of low feed cost, it has relatively high land and labor costs. He attributed inexpensive land and labor, favorable business climate, and low transportation cost (cheap rail rates) as the main advantages for broiler industry location in the South.

Berry analyzed factors involved in site selection for new and modified poultry facilities in Oklahoma. His analysis showed that availability of utilities (water, electricity and natural gas) was the most important factor considered in site selection.

This study differs from previous studies in two respects. First, top executives within the broiler industry were surveyed, and a comprehensive set of location factors was analyzed. These include costs of raw materials, transportation costs and institutional factors. Second, a conjoint methodology was used to estimate tradeoffs among the location factors and relative importance coefficients for each location attribute calculated.

Methodology

Conjoint analysis (CA) is a technique used to measure a respondent's preferences ("part-worth" utilities) for selected attribute levels given his/her evaluation of hypothetical products or services (Green and Srinivasan). Principal applications of CA pertain to new product/concept evaluation, product repositioning, competitive analysis, pricing and market segmentation (Wittink and Cattin). The CA may also be used to study location decisions. Hopman et al. used CA to elicit growers' preferences for locating horticultural enterprises in the Netherlands. Similarly, this study uses conjoint analysis to examine broiler executives' preferences for alternative broiler complex locations in the United States. CA is useful in analyzing location problems since site selection is a multidimensional decision-making process that almost always requires the evaluation of tradeoffs among numerous location attributes.

Selection of Attributes and Levels

The selection of attributes for the location problem of a broiler complex was based on a review of the previously cited studies and personal interviews with broiler industry experts. The experts interviewed during questionnaire development and pre-testing included a retired chief executive officer (CEO) of a U.S. poultry company, a top executive with the Chicken Council and various extension personnel working in the poultry industry. The process revealed approximately 30 attributes affecting site selection for a broiler complex (table 1). The attributes are categorized as those pertaining to costs of purchased inputs, such as feed, utilities and land; infrastructure, such as proximity to rail, availability of municipal utilities, availability of local lenders, etc.; environmental regulations, such as stringency of water pollution regulations; labor, such as unemployment rate, hourly wages, availability of catchers and availability of skilled labor; and, state and local policies, such as state development incentives, property taxes, etc.

The relatively large number of attributes creates a methodological challenge for conjoint analysis, since CA requires subjects to rate hypothetical location profiles. More specifically, the more attributes selected for evaluation, the greater the potential for information overload by respondents. Therefore, we needed to reduce the number of attributes to a more manageable level. We do this by pre-testing the 30 attributes through personal interviews with poultry industry experts. This narrowed the list to 12 attributes that were selected as the most pertinent factors affecting the location decision. Twelve attributes is still a relatively large number for conjoint analysis, so the analysis was divided into separate designs for the three key enterprises of the broiler complex. These include broiler growing, feed mill operations and broiler slaughter. Each of these enterprises is associated with a subset of factors that influences the industry

Table 1. List of Attributes Analyzed in Broiler Complex Location Decision.

Attributes
Costs of Purchased Inputs
Electricity cost
Feed cost
Heating cost
Land cost
Sewer cost
Water cost
Infrastructure
Availability of local grain supply
Availability of a municipal facility for wastewater treatment and solid waste disposal
Availability of local lenders for broiler growers (mortgage, operating loans)
Availability of local contacts to assist in analysis of community attitude
Broiler industry already established in the region
Distance between feed mill and grower
Number of growers and potential growers available
Proximity of railroads to feed mill
Proximity to major metropolitan markets
Proximity to farmland or other sources for litter disposal
Quality of roads from feed mill to growers
Quality of life in the region for employees
Labor
Availability of catchers
Availability of skilled labor (electricians, general mechanics and refrigeration mechanics)
Average hourly wage in the region
Growers attitude toward contract production
Unemployment rate in the region
Environmental Regulations
Community attitude toward broiler industry
Stringency of water pollution regulations
Stringency of dead bird and litter disposal regulations
State and Local Policies
Local property tax
State development incentives (income tax credit, job training, direct loans, etc.)
State fuel tax
State property tax

executive's decision regarding his respective location. Some of the attributes affecting each enterprise are mutually exclusive across enterprises, and others are common across the entire broiler complex. Therefore, the decision on the best location for a broiler complex depends on decisions about the best locations of the three separate enterprises.

To model the interdependency across enterprises, a technique that allows for the "bridging" of part-worth estimates across the three conjoint designs is applied. The technique involves dividing the total number of attributes into three sets and developing separate experimental designs with at least one common attribute across each design (Green and Srinivasan, 1990). Respondents are then asked to evaluate each design, and part-worth models are estimated and analyzed independently. The next step requires use of common attributes to rescale the part worths from each enterprise into an overall set of part-worth estimates for the entire broiler complex.

Table 2 lists the attributes and levels for the three conjoint designs. The levels for respective attributes were selected based on a survey of utility, feed and labor costs in the mid-South and southern regions of the United States. The levels for number of growers available, distance between feed mill and grower, and proximity to metropolitan markets were selected based on personal interviews with the previously described industry experts. For two-level attributes, we selected highest and lowest values observed in these regions, and for the three-level attribute (feed cost) we used the highest, average and lowest values for the region.

The broiler growing enterprise includes six attributes with two levels per attribute. The feed mill enterprise includes three attributes, one attribute with three levels and two attributes with two levels each. Finally, the broiler slaughter enterprise includes seven attributes, each with two levels. All three enterprises have one attribute in common (community attitude), with the broiler growing and slaughter enterprises having three attributes in common. Since only two enterprises can be bridged at a time, this study uses a two-stage bridging technique similar to that applied by Francois and MacLachlan. Details of the bridging technique will be discussed later.

Table 2. Attributes Involved in Conjoint Analysis of Broiler Complex Enterprises.

Attributes	Levels
Broiler Growing Enterprise	
Community attitude toward broiler industry	1) Favorable 2) Not favorable
Water cost	1) High cost, $2.50 per thousand gallons 2) Low cost, $1.00 per thousand gallons
Electricity cost	1) High cost, 6.50 cents per kWh 2) Low cost, 4.00 cents per kWh
Heating cost	1) High cost, LP gas $1.00 per gallon 2) Low cost, LP gas $0.90 per gallon
Number of growers and potential growers available	1) 75-100 2) 250-300
Distance between feed mill and grower	1) 30 miles 2) 100 miles
Feed Mill Enterprise	
Community attitude toward broiler industry	1) Favorable 2) Not favorable
Cost of feed ingredients	1) $160 per ton 2) $260 per ton 3) $310 per ton
Quality of roads from feed mill to growers	1) Poor 2) Good
Broiler Slaughter Enterprise	
Community attitude toward broiler industry	1) Not favorable 2) Favorable
Water cost	1) High cost, $2.50 per thousand gallons 2) Low cost, $1.00 per thousand gallons
Electricity cost	1) High cost, 6.50 cents per kWh 2) Low cost, 4.00 cents per kWh
Proximity to major metropolitan markets	1) 400 miles 2) 800 miles
Unemployment rate in the region	1) High 2) Low
Average hourly wage in the region	1) Low wage, $7.50 per hour 2) High wage, $8.50 per hour
Sewer cost	1) Low cost, $1 per thousand gallons 2) High cost, $3 per thousand gallons

The Conjoint Designs and Questionnaire

The experimental design uses a full-profile approach that allows respondents to evaluate hypothetical site locations based on the complete set of attribute-levels. A disadvantage of the full-profile approach is the possibility of information overload on the part of the respondent, since a full factorial design may require a large number of hypothetical locations to be evaluated (Green and Srinivasan, 1978). For instance, since there are six attributes with two levels each in the broiler growing conjoint design, there are 2x2x2x2x2x2= 64 possible broiler growing locations. Similarly, there are 3x2x2=12 possible locations for the feed mill, and 2x2x2x2x2x2x2= 128 possible sites for the broiler slaughter enterprise.

Researchers commonly use a fractional factorial design to overcome the information overload problem. The primary advantage of a fractional factorial design is the number of hypothetical products a subject must evaluate is greatly reduced, while enough information is retained to estimate all part-worth main effects. A disadvantage of the fractional design is that interaction part-worth effects are not usually recoverable. This may not be a significant restriction, however, because previous research has found attribute interactions to have negligible effects on total utility (Harrison et al., 1998). The Bretton-Clark Designer (1988) program was used to select the fractional factorial designs for this study. This program produces a subset of hypothetical products based on the attribute levels provided by the researcher. More specifically, the program minimizes the confounding of attribute main effects by selecting a sub-sample of orthogonal product combinations.

The conjoint portion of the questionnaire consisted of three sections. The first section deals with the broiler growing enterprise. It contains eight hypothetical location profiles as prescribed by the Britton-Clarke software. Similarly, the second and third sections contain the feed mill and broiler slaughter conjoint designs, each of which also consists of eight hypothetical location profiles, as described by the fractional design. The survey was mailed to the CEOs of 43 U.S. broiler companies using Dillman's Total Design Method (Dillman, 1978). The survey was conducted from September to December 2002. Responses were received from 13 CEOs. Three questionnaires were incomplete, leaving 10 usable questionnaires for a response rate of 23.3 percent. These 10 companies accounted for about 55 percent of total U.S. broiler output. The CEOs reported that their companies are operating 73 broiler complexes.

The general characteristics of respondents' broiler operations are presented in table 3. Forty percent of the respondents indicated their oldest broiler complex was constructed more than 40 years ago. Forty percent of the respondents indicated that they expanded their poultry operations by building a new broiler complex in the last five years. Thirty percent of the respondents employed more than 10,000 workers in their broiler operations and had sales of more than $1

Table 3. Results of Questions Related to Respondents' Broiler Operations.

Broiler Operation questions and their categories	Percentage[1]
Age of the oldest broiler complex	
• 5-10 years	10.00
• 11-20 years	10.00
• 21-30 years	40.00
• 31-40 years	0.0
• More than 40 years	40.00
Age of the newest broiler complex	
• 1-5 years	40.00
• 6-10 years	30.00
• 11-20 years	20.00
• More than 20 years	0.0
Planning to expand in the next 5 years	
• Yes	60
• No	40
Ways of expanding[2, 3]	
• Build a new complex plant	0.0
• Expand an existing complex (adding growers feed mills and broiler processing plant)	83.33
• Build a further processing facility that adds value to ready-to-cook products	50
• Other	16.67
Primary forces driving the expansion[2,3]	
• Growth in domestic market	33.33
• Growth in export market	0.0
• Expansion of market share	50.00
• Other	0.0
Total number of employees working in broiler operation	
• 100-999	20.00
• 1,000-2,499	30.00
• 2,500-4,999	0.0
• 5,000-9,999	20.00
• More than 10,000	30.00
Total sales of the company in last fiscal year	
• Less than $250 million	40.00
• $250 million -$500 million	10.00
• $500 million-$1 billion	20.00
• More than $1 billion	30.00

Note: [1]The percentage is calculated for the nine respondents.
[2] The percentage is calculated for the six respondents who showed willingness to expand in next 5 years.
[3] The respondents were allowed to choose more than one category.

billion in the last fiscal year. Sixty percent of the respondents were planning to expand their broiler operations in the next five years. Most planning to expand preferred to expand an existing complex (adding growers, feed mills and slaughter plants) and/or build processing facilities that add value to ready-to-cook products. Growth of domestic markets and expansion of market share were the primary forces driving the expansion of these broiler operations.

Model Specification

The two most commonly used methods for coding preferences in the CA literature are rank order (RO) and interval rating (IR) scales. The primary difference between these methods is associated with the restriction each places on the metric and nonmetric properties of the subject's utility function. The RO method requires subjects to unambiguously rank all hypothetical product choices, which provides a nonmetric ordering of respondent preferences. The IR method allows subjects to express order, indifference and intensity across product choices, a feature that allows for both metric and nonmetric properties of utility to be elicited. Since RO scaling provides no provision for subjects to express indifference or intensity across product attributes, information is lost if respondents wish to express cardinal properties in their preference orderings. Moreover, IR scales tend to be easier for respondents to use since they do not require a unique ordering. In this study, respondents were asked to rate the previously described profiles using an IR scale from 0 to 10, where 0 represents the least preferred combination of location features, and 10 represents the most preferred combination of location feature.

The method used to scale preferences has implications on the selection of an appropriate model for estimating part-worth values. If RO scaling is used, then the dependent variable (the RO scale) is clearly ordinal, and ordered regression models such as ordered probit or logit are best suited for estimating conjoint parameters. Model selection becomes less clear, however, if the IR method is used. For instance, a number of studies have used the two-limit Tobit model to estimate part-worth parameters (Roe et al.; Stevens et al.; and Harrison et al.). These studies implicitly assume that utility is cardinal (the IR scale is continuous) between upper and lower bounds of the scale. Other researchers argue that ordered probit or logit (OLP) models are best suited for conjoint estimation, since IR scales are measured as a discrete variable (Mackenzie, 1990 and 1993; Sy et al., 1997). A disadvantage of OLP models is they assume preferences are ordinal, which fails to account for cardinal information if respondents express intensity in their responses. Another disadvantage of OLP models is they require more degrees of freedom to estimate part-worth parameters.

Both two-limit Tobit (TLT) and ordered probit (OP) models were estimated in this study. The TLT and OP part-worth estimates were found to be of the same sign and were quite close in terms of magnitude. This is consistent with previous literature, which found little difference between TLT and OLP estimates in conjoint analysis (Boyle et al.; Harrison et al.). Since the TLT model provides additional degrees of freedom, and therefore greater efficiency, only TLT results are presented in the paper.[2]

Once part-worth utilities are estimated, relative importance (RI) values are calculated for each attribute in the respective models. Relative importance weights for each attribute are calculated using a method described in Halbrendt, Wirth and Vaughn (1991). The first step is to determine the highest and lowest part-worth values for each attribute. The differences between the highest and lowest values represent the utility range for that attribute. Once the utility range for each attribute is determined, the RI for the *i*th attribute is calculated as follows:

$$RI_i = \frac{R_i}{\Sigma R_i \forall Attributes} \times 100,$$

where R_i is the range of part-worth values for the *i*th attribute, and RI_i is the relative importance for the *i*th attribute.

Results

The part-worth estimates and RI coefficients for the broiler-growing, feed mill and broiler slaughter enterprises are presented in tables 4, 5 and 6, respectively. The log-likelihood ratio tests show that all three models are significant at the $\alpha = .01$ level.

The Broiler Growing Analysis

The broiler growing coefficient associated with a favorable community attitude is positive (1.048) and significant at the $\alpha = .01$ level, indicating that a favorable community attitude toward the broiler industry increases the average respondent's preference for a potential location. In contrast, the negative sign on the unfavorable community attitude part-worth (-1.048) indicates that CEO

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[2] Readers interested in additional details regarding the ordered probit and two limit Tobit models used in the analysis should contact the authors.

preferences for a potential site decrease when local residents express reservations about the broiler industry. Moreover, the RI coefficients indicate that community attitude was the most important factor in CEOs' decisions regarding broiler-growing location. That is, 29.04 percent of the variation in the total preference scores was attributed to community attitude (table 4).

The importance of community attitude may reflect the CEOs' knowledge that state and local environmental regulations are likely to be more severe in regions where the public's concern regarding the negative aspects of broiler growing is high. The odor associated with waste products, the discharge of large amounts of broiler litter and the need for dead bird disposal are all negative aspects of broiler growing. Though factors affecting a community's attitude toward the broiler industry are complex, communities where the residents are less sensitive to (or aware of) the negative aspects of broiler growing are likely to be more attractive to broiler companies.

The part-worth values indicating distance between the feed mill and growers is significant at the α =.01 level. The coefficient associated with the 30-mile distance is positive (.903), indicating that as driving distances between the feed mill and growers decrease, the average respondent's preference for a potential production area increases. This result is consistent with previously discussed location theories, which predict that transportation cost is an important determinant of site location. The result is also consistent with the findings of Vest et al., who concluded that companies specify a maximum allowable distance between a broiler farm and the feed mill or slaughter plant to lower the cost of transportation. The distance between feed mill and growers is the second most important factor, contributing approximately 25 percent to the variation in total preference rating.

The coefficients representing water, heating and electricity costs are not significant, which may be attributed to the fact that integrators are not responsible for utility costs under the terms of the typical broiler production contract. As mentioned earlier, the grower is responsible for utilities associated with growing broilers.

The Feed Mill

All coefficients associated with the feed mill attributes are found to be significant at the α = .01 level, except for the quality of roads between the feed mill and growers, which is significant at the α = .05 level. The coefficient associated with low feed cost is positive (4.632), indicating that, as the cost of feed decreases, the preference for a particular site location increases. Conversely, higher feed costs reduce the preference for a particular site location. This is shown by the negative coefficient on the intermediate (-1.830) and high feed cost levels (-2.802). Thus, in accordance with theory, to lower cost of production, firms locate at sites with relatively lower feed costs.

Table 4. Two-Limit Tobit Part-worth Estimates and Relative Importance of Attributes for the Broiler Growing Enterprise.

Variable	Coefficient	b/S.E.
Constant	3.685***	11.325
Community attitude toward broiler industry:		
(P_1^1)[1] Favorable (29.04)[2]	1.048***	3.221
(P_2^1) Not Favorable (29.04)[3]	-1.048***	-3.221
Water cost:		
(P_3^1) High cost, $2.50 per thousand gallons (7.79)	-0.279	-0.859
(P_4^1) Low cost, $1.00 per thousand gallons (7.79)	0.279	0.859
Electricity cost:		
(P_5^1) High cost, 6.50 cents per kWh (16.08)	-0.576*	-1.774
(P_6^1) Low cost, 4.00 cents per kWh (16.08)	0.576*	1.774
Heating cost:		
(P_7^1) High cost, LP gas $1.00 per gallon (10.89)	0.390	1.200
(P_8^1) Low cost, LP gas $0.90 per gallon (10.89)	-0.390	-1.200
Number of growers and potential growers available:		
(P_9^1) 250-300 (10.97)	0.393	1.210
(P_{10}^1) 75-100 (10.97)	-0.393	-1.210
Distance between feed mill and grower:		
(P_{11}^1) 30 miles (25.22)	0.903***	2.775
(P_{12}^1) 100 miles (25.22)	-0.903***	-2.775
χ^2 LogL: 21.56***		

Note: (*) indicates significance at the α = 0.1 level, (**) indicates significance at the α = 0.05 level, (***) indicates significance at the α = 0.01 level.

[1] The item in parentheses is the symbol representing the part worths. For example, P_{12}^1 represents 12th level in broiler growing enterprise, which is represented as 1.

[2] the value in parentheses represents the relative importance of the attribute in the location decision of a broiler growing enterprise.

[3] As the relative importance is calculated for the attribute, its value will be the same for all the levels of that attribute.

The quality of roads between the feed mill and growers, and community attitude toward the broiler industry, are also significant. Good roads and a favorable community attitude have a positive effect (1.023, table 5) on site selection. Perhaps more important, the results show that poor quality roads in regions where integrators transport feed from mill to growers will affect the preference for a particular location negatively (note the -1.023 coefficient in table 5). Moreover, the RI coefficients show that feed costs are the most important attribute for the feed mill enterprise of the complex, accounting for 55.5 percent of the variation in preference rating. Therefore, the feed cost component of the broiler complex plays a prominent role in the location decision.

After feed costs, community attitude toward the broiler industry is the second most important factor, accounting for 29.23 percent of the variation in the preference rating. Though road quality is the least important attribute, it is significant and accounts for 15.24 percent of the variation in preference rating.

Broiler Slaughter

Most of the coefficients for the broiler slaughter enterprise are significant at the $\alpha = .01$ level. Exceptions include electricity and sewer costs, which are significant at the $\alpha = .05$ level. The coefficients for water cost and proximity to major metropolitan markets have the expected sign, but are not significantly different from zero (table 6).

The coefficient associated with a favorable community attitude is positive (1.436), indicating that broiler company executives are sensitive to community attitudes associated with broiler slaughter. Conversely, unfavorable community attitudes reduce the preference for a particular site location. This is shown by the negative coefficient on the unfavorable community attitude (-1.436). The coefficient associated with higher unemployment rates is positive (0.931), indicating that broiler companies prefer regions with surplus labor. Conversely, low unemployment rates reduce the preference for a particular site location, shown by the negative coefficient on the low unemployment rate (-0.931). This result is consistent with economic theory, which predicts that firms relying on low skilled labor would prefer locations where low-skilled workers are more available.

Average hourly wage in the region is also significant. The coefficient is negative (-0.837), indicating that higher wage rates decrease the average respondent's preference for a particular site. This result is consistent with economic theory, which predicts that firms prefer locations where labor costs are low, to lower the total cost of production. The result is also consistent with the findings of Easterling et al., and Aho, who concluded that low labor costs are among the critical factors for broiler industry concentration in the South. The coefficients associated with electricity, sewer and water costs all have negative signs, indicating that high utility costs have negative effects on site selection.

Table 5. Two-Limit Tobit Part-worth Estimates and Relative Importance of Attributes for the Feed Mill Enterprise.

Variable	Coefficient	b/S.E.
Constant	3.896***	8.923
Community attitude toward broiler industry:		
(P_1^2)[1] Favorable (29.23)[2]	1.956***	4.659
(P_2^2) Not Favorable (29.23)[3]	-1.956***	-4.659
Cost of Feed Ingredients:		
(P_3^2) $160 per ton (55.52)	4.632***	6.656
(P_4^2) $260 per ton (55.52)	-1.830***	-2.855
(P_5^2) $310 per ton (55.52)	-2.802***	-5.014
Quality of roads from feed mill to growers:		
(P_6^2) Good (15.24)	1.023**	2.465
(P_7^2) Poor (15.24)	-1.023**	-2.465
χ^2 LogL: 58.46***		

Note: (**) indicates significance at the α = 0.05 level, (***) indicates significance at the α = 0.01 level.

[1] The item in parentheses is the symbol representing the part worths. For example, P_7^2 represents 7th level in feed mill enterprise, which is represented as 2.

[2] the value in parentheses represents the relative importance of the attribute in the location decision of a feed mill enterprise.

[3] As the relative importance is calculated for the attribute, its value will be the same for all the levels of that attribute.

The RI coefficients show that community attitude is the most important attribute for the slaughter aspect of the broiler complex, accounting for about 30 percent of the variation in the preference rating. The prominence of community attitude in the slaughter model may be caused by the large amounts of solid and liquid wastes associated with this activity, which places greater demand on the community's sewage system and may create environmental concerns for local residents. The slaughter enterprise may also be the most visible aspect of the broiler complex, because slaughter tends to locate closer to urban centers, whereas broiler growing and feed mills are more geographically dispersed in rural areas.

Following community attitude, the unemployment rate (19.11 percent) and average hourly wage in the region (17.18 percent) are the second and third most important attributes, respectively. Proximity to major metropolitan markets was found to be the least preferred attribute, accounting for only 5.75 percent of variation in the preference rating.

Table 6. Two-Limit Tobit Part-worth Estimates and Relative Importance of Attributes for the Broiler Slaughter Enterprise.

Variable	Coefficient	b/S.E.
Constant	4.632***	18.291
Community attitude toward broiler industry:		
(P_1^3)[1] Favorable (29.48)[2]	1.436***	5.652
(P_2^3) Not Favorable (29.48)[3]	-1.436***	-5.652
Water cost:		
(P_3^3) High cost, $2.50 per thousand gallons (6.57)	-0.320	-1.265
(P_4^3) Low cost, $1.00 per thousand gallons (6.57)	0.320	1.265
Electricity cost:		
(P_5^3) High cost, 6.50 cents per kWh (10.94)	-0.533**	-2.105
(P_6^3) Low cost, 4.00 cents per kWh (10.94)	0.533**	2.105
Proximity to major metropolitan markets:		
(P_7^3) 400 miles (5.75)	0.286	1.129
(P_8^3) 800 miles (5.75)	-0.286	-1.129
Unemployment rate in the region:		
(P_9^3) High (19.11)	0.931***	3.674
(P_{10}^3) Low (19.11)	-0.931***	-3.674
Average hourly wage in the region:		
(P_{11}^3) High wage, $8.50 per hour (17.18)	-0.837***	-3.301
(P_{12}^3) Low wage, $7.50 per hour (17.18)	0.837***	3.301
Sewer cost:		
(P_{13}^3) High cost, $3 per thousand gallons (10.96)	-0.534**	-2.108
(P_{14}^3) High cost, $3 per thousand gallons (10.96)	0.534**	2.108
χ^2 LogL: 49.67***		

Note: (*) indicates significance at the α = 0.1 level, (**) indicates significance at the α = 0.05 level, (***) indicates significance at the α = 0.01 level.

[1] The item in parentheses is the symbol representing the part worths. For example, P_{14}^3 represents 14th level in broiler slaughter enterprise, which is represented as 3.

[2] the value in parentheses represents the relative importance of the attribute in the location decision of a broiler slaughter enterprise.

[3] As the relative importance is calculated for the attribute, its value will be the same for all the levels of that attribute.

Overall Attribute Effects

To estimate overall RI coefficients for each attribute affecting the broiler complex location decision, a "bridging" technique is applied that uses the results from the three separate conjoint models. The technique assumes that a common attribute (or attributes) provide common bases (denominators) for measuring the relative importance across all attributes in the three models.

The procedure used in this study is similar to the technique described by Francois and MacLachlan. Since the bridging of part-worth values is possible for only two models at a time, the broiler growing and broiler slaughter enterprises are bridged initially (stage one). After stage one is complete, the resulting estimates are bridged with the feed mill enterprise to calculate the final relative importance values. The scaling factor used to bridge the broiler growing and slaughter designs is calculated as follows:

$$B = \frac{(R_1^1 + R_2^1 + R_3^1)}{(R_1^3 + R_2^3 + R_3^3)}$$

where B is the stage-one bridging scalar, R_1^1= the range of part-worth estimates for the community attitude attribute in the broiler-growing model; R_1^2 = the range of part-worth estimates for the water cost attribute in the broiler-growing model; and, R_1^3= the range of part-worth estimates for the electricity cost attribute in broiler growing model. Similarly, R_1^3= the range of part-worth estimates for the community attitude attribute in the broiler slaughter model; R_2^3= the range of part-worth estimates for the water cost attribute in the broiler slaughter enterprise; and, R_3^3= the range of part-worth estimates for the electricity cost attribute in the broiler slaughter enterprise. Note the bridging algorithm uses the ratio of common part-worth ranges across the two enterprises.

The bridging scalar (B) is used to rescale the broiler slaughter part worths, and B^{-1} is used to rescale the broiler-growing part worths. The calculations and part-worth estimates for the first stage bridging of the broiler growing and slaughter models are presented in table 7. Note we use the notation P_k^j to represent part-worth estimates for the k^{th} part-worth level in the jth enterprise. For example, P_{12}^1 represents the 12^{th} level (100 miles distance between feed mill and grower) in the broiler-growing enterprise (i.e., j=1). Similarly, P_{12}^3 represents the 12^{th} level ($7.50 per hour average hourly wage) in the broiler slaughter enterprise (j=3). The first stage part-worth values are denoted as W_m, where m = 1, 2, 3, … 20 (table 7).

Once broiler-growing and slaughter models are bridged, the final step is to bridge the stage one part-worths (W_m) with the feed mill model. In this step, there is only one common attribute between the two designs (community attitude toward the broiler industry). The bridging scalar is calculated as

Table 7. First Stage Bridging Part-worth Estimates.

Attributes	BA[1]	PW[2]	Rank
Community attitude			1
Favorable	$W_1 = (P_1^{1*}B^{-1}) + (P_1^{3*}B) = 2.454$		
Not favorable	$W_2 = (P_2^{1*}B^{-1}) + (P_2^{3*}B) = -2.454$		
Distance between feed mill and grower			2
30 miles	$W_{11} = (P_{11}^{1*}B^{-1}) + (P_{11}^{1}) = 1.989$		
100 miles	$W_{12} = (P_{12}^{1*}B^{-1}) + (P_{12}^{1}) = -1.989$		
Unemployment rate in the region			3
High	$W_{15} = (P_9^3) + (P_9^{3*}B) = 1.705$		
Low	$W_{16} = (P_{10}^3) + (P_{10}^{3*}B) = -1.705$		
Average hourly wage in the region			4
High wage, $8.50 per hour	$W_{17} = (P_{11}^3) + (P_{11}^{3*}B) = -1.533$		
Low wage, $7.50 per hour	$W_{18} = (P_{12}^3) + (P_{12}^{3*}B) = 1.533$		
Electricity cost			5
High Cost, 6.50 cents per kWh	$W_5 = (P_5^{1*}B^{-1}) + (P_5^{3*}B) = -1.136$		
Low Cost, 4.00 cents per kWh	$W_6 = (P_6^{1*}B^{-1}) + (P_6^{3*}B) = 1.136$		
Sewer cost			6
High cost, $3 per thousand gallons	$W_{19} = (P_{13}^3) + (P_{13}^{3*}B) = -0.978$		
Low cost, $1 per thousand gallons	$W_{20} = (P_{14}^3) + (P_{14}^{3*}B) = 0.978$		
Number of growers			7
250-300	$W_9 = (P_9^{1*}B^{-1}) + (P_9^{1}) = 0.866$		
75-100	$W_{10} = (P_{10}^{1*}B^{-1}) + (P_{10}^{1}) = -0.866$		
Heating cost			8
High cost, LP gas $1.00 per gallon	$W_7 = (P_7^{1*}B^{-1}) + (P_7^{1}) = 0.859$		
Low cost, LP gas $0.90 per gallon	$W_8 = (P_8^{1*}B^{-1}) + (P_8^{1}) = -0.859$		
Water cost			9
High cost, $2.50 per thousand gallons	$W_3 = (P_3^{1*}B^{-1}) + (P_3^{3*}B) = -0.602$		
Low cost, $1.00 per thousand gallons	$W_4 = (P_4^{1*}B^{-1}) + (P_4^{3*}B) = 0.602$		
Proximity to major metropolitan markets			10
400 miles	$W_{13} = (P_7^3) + (P_7^{3*}B) = 0.524$		
800 miles	$W_{14} = (P_8^3) + (P_8^{3*}B) = -0.524$		

Note: [1] indicates the algorithm used to bridge the broiler growing and slaughter enterprise in order to estimate the new set of part worths ($W_1, W_2 \ldots W_{20}$).
[2] indicates the new set of part worths estimated by bridging broiler growing and slaughter enterprise. For example, the new part worth estimated for favorable community attitude (W_1) is equal to 2.454.

follows:

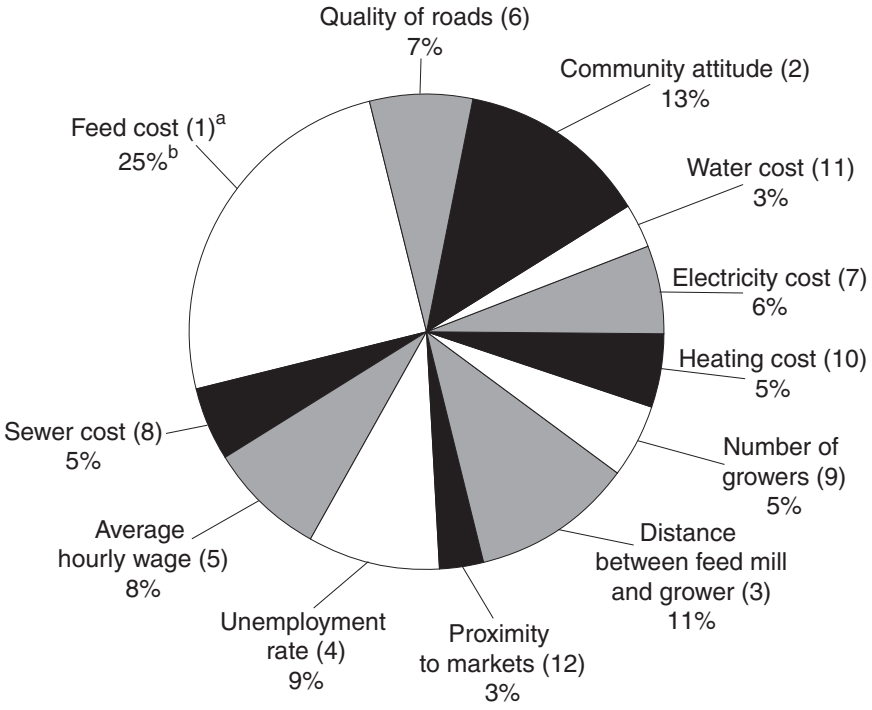
$$FB = \frac{R_1^w}{R_1^2}$$

where FB represents the final bridging scalar, R_1^w equals the range of stage-one part-worth estimates for the community attitude attribute ($W_1 - W_2$), and R_1^2

equals the range of part-worth estimates for community attitude in the feed mill model. Similar to the stage-one calculation, the bridging scalar (FB) is used to rescale the feed mill part worths, and FB^{-1} is used to rescale the stage-one part worths.

The overall part-worth and RI coefficients for a broiler complex are presented in table 8. The cost of feed is the most important factor affecting the location of a broiler complex, accounting for about 25 percent of the variation in the preference for broiler complex locations. The relative importance of factors affecting the overall broiler complex location decision is illustrated in figure 1. As the cost of feed increases, the preference for a particular location decreases, as indicated by overall part-worth estimates of 10.43 for $160 per ton, -4.12 for $260 per ton and -6.31 for $310 per ton, respectively. This result is consistent with the fact that feed costs account for about 60 percent of the total cost of producing a pound of live broilers (Bastien and Goan).

Figure 1. Relative Importance and Rank of Factors Affecting Broiler Complex Location Decision.



Note: [a] indicates the rank of attribute in broiler complex location division
[b] indicates the relative importance (RI) of the attribute in the location decision of a broiler complex

Easterling, Braschler and Kuehn report that cost of importing feed is the most critical variable in the location decision of a broiler complex. Feed costs include the costs associated with transporting the feed ingredients from the source to the feed mill. The Midwest Corn Belt, where corn and soybean are produced in large quantities, is a primary source for feed ingredients. Thus, feed costs alone suggest broiler companies would prefer this region of the country.

However, tradeoffs among low-cost feed and other factors are important to the location decision. For example, community attitude toward the broiler industry was the second most important factor in the broiler complex location decision, accounting for 13.2 percent of the variation in preference rating. Community attitude captures the broiler executive's perception of the receptiveness of a particular community to the broiler industry. This attribute is difficult to measure but may include factors such as wastewater discharge and solid waste disposal regulations, as well as other environmental regulations that may be more stringent in regions where communities are sensitive to the negative aspects of the broiler industry. It may also include the executive's perception of the farming community's attitude toward broiler production, including farmer preferences for contract production.

Other factors include the distance between the feed mill and growers, and the availability of growers in the region, which ranked third and ninth in order of importance, respectively (table 8). This suggests broiler companies prefer locations where they can contract with a geographically concentrated, relatively large number of potential growers. Growers located in close proximity to the feed mill lower the cost associated with transporting feed to the broiler houses. Vest and Lacy report that companies specify a maximum allowable distance between a broiler farm and the feed mill or slaughter plant to lower the cost of transportation.

The fourth and fifth ranked location attributes were the unemployment rate and hourly wage in the region. These accounted for 9.19 percent and 8.26 percent of the variation in the preference rating, respectively. Electricity, heat, water and sewage costs individually are less important to the location decision, as compared to the aforementioned. Their combined effect, however, accounted for 19.2 percent (electricity + heating + water + sewage costs) of variation in the preference rating. Electricity cost was most important among the utility costs; it accounted for 6.10 percent of variation in preference rating. Proximity to major metropolitan markets was the least important factor, accounting for just 2.81 percent of variation in preference rating.

Table 8. Final Bridged Part-worth Estimates for Broiler Complex.

Attributes	BA[1]		PW[2]	RI[3]	Rank
Cost of feed Ingredients				25.05	1
$160 per ton	$(P_3^2) + (P_3^{2*} FB)$	=	10.43		
$260 per ton	$(P_4^2) + (P_4^{2*} FB)$	=	-4.12		
$360 per ton	$(P_5^2) + (P_5^{2*} FB)$	=	-6.31		
Community attitude toward broiler industry				13.20	2
Favorable	$(W_1^* FB^{-1}) + (P_1^{2*} FB)$	=	4.41		
Not favorable	$(W_2^* FB^{-1}) + (P_2^{2*} FB)$	=	-4.41		
Distance between feed mill and grower				10.71	3
30 miles	$(W_{11}^* FB^{-1}) + (W_{11})$	=	3.58		
100 miles	$(W_{12}^* FB^{-1}) + (W_{12})$	=	-3.58		
Unemployment rate in the region				9.19	4
High	$(W_{15}^* FB^{-1}) + (W_{15})$	=	3.07		
Low	$(W_{16}^* FB^{-1}) + (W_{16})$	=	-3.07		
Average hourly wage in the region				8.26	5
High wage, $8.50 per hour	$(W_{17}^* FB^{-1}) + (W_{17})$	=	-2.76		
Low wage, $7.50 per hour	$(W_{18}^* FB^{-1}) + (W_{18})$	=	2.76		
Quality of roads between feed mill and grower				6.88	6
Good	$(P_6^2) + (P_6^{2*} FB)$	=	2.30		
Poor	$(P_7^2) + (P_7^{2*} FB)$	=	-2.30		
Electricity cost				6.10	7
High Cost, 6.50 cents per kWh	$(W_5^* FB^{-1}) + (W_5)$	=	-2.04		
Low Cost, 4.00 cents per kWh	$(W_6^* FB^{-1}) + (W_6)$	=	2.04		
Sewer cost				5.27	8
High cost, $3 per thousand gallons	$(W_{19}^* FB^{-1}) + (W_{19})$	=	-1.76		
Low cost, $1 per thousand gallons	$(W_{20}^* FB^{-1}) + (W_{20})$	=	1.76		
Number of growers				4.67	9
250-300	$(W_9^* FB^{-1}) + (W_9)$	=	1.56		
75-100	$(W_{10}^* FB^{-1}) + (W_{10})$	=	-1.56		
Heating cost				4.61	10
High cost, LP gas $1.00 per gallon	$(W_7^* FB^{-1}) + (W_7)$	=	1.54		
Low cost, LP gas $0.90 per gallon	$(W_8^* FB^{-1}) + (W_8)$	=	-1.54		
Water cost				3.23	11
High cost, $2.50 per thousand gallons	$(W_3^* FB^{-1}) + (W_3)$	=	-1.08		
Low cost, $1.00 per thousand gallons	$(W_4^* FB^{-1}) + (W_4)$	=	1.08		
Proximity to major metropolitan markets				2.81	12
400 miles	$(W_{13}^* FB^{-1}) + (W_{13})$	=	0.94		
800 miles	$(W_{14}^* FB^{-1}) + (W_{14})$	=	-0.94		

Note: [1] indicates the algorithm used to bridge the new design (broiler growing + broiler slaughter enterprise) and feed mill enterprise to estimate the final overall set of part worths.

[2] indicates the final overall set of part worths. For example, the final part worth estimated for favorable community attitude is equal to 4.41.

[3] indicates the relative importance (RI) of the attribute in the location decision of a broiler complex.

Analysis of Additional Factors

As mentioned, because of potential information overload on the part of the respondents, only 12 attributes were considered in the conjoint analysis; however, 30 attributes were initially identified during personal interviews with industry executives. The remaining 18 attributes not involved in the conjoint study were included in the questionnaire. A series of questions was posed that required respondents to rate the importance of these attributes on a scale from 1 to 7, where 1 indicated the factor was not important and 7 indicated the factor was very important. The additional attributes and the frequency distribution of respondents' ratings for these factors are given in table 9. The additional factors are grouped under four categories: infrastructure, environmental regulations, labor and state and local policies.

Infrastructure

Nine additional factors related to infrastructure were analyzed. The percentage importance of these factors in the broiler complex location is illustrated in figure 2 in ascending order of importance. The percentages were calculated by grouping ratings 1 and 2 as less important; 3, 4 and 5 as moderately important; and 6 and 7 as very important. Figure 2 shows that proximity to a railroad is the most important and having a broiler firm already established in the region is the least important infrastructure factor affecting the broiler complex location decision. Eighty percent of the respondents considered proximity of railroads to the feed mill to be very important by giving it a rating of 7. This result complements the conjoint analysis, which found feed costs to be the most important factor in the broiler complex location decision. The closer the feed mill to railroads, the lower the transportation costs, which in turn reflect lower feed costs. Therefore, poultry companies tend to locate broiler complexes as close to railroads as possible to lower their feed costs.

The availability of local lenders to finance broiler growers was very important. Sixty percent of the respondents gave this factor a rating of 7. In the vertically integrated system of broiler production, it is the responsibility of the grower to provide broiler houses and grow out equipment, such as feeders, waterers and brooders. Generally the cost of providing these facilities exceeds $120,000 for each broiler house (Cunningham). Therefore, growers interested in broiler production would look for locally available lenders to secure loans for this capital investment.

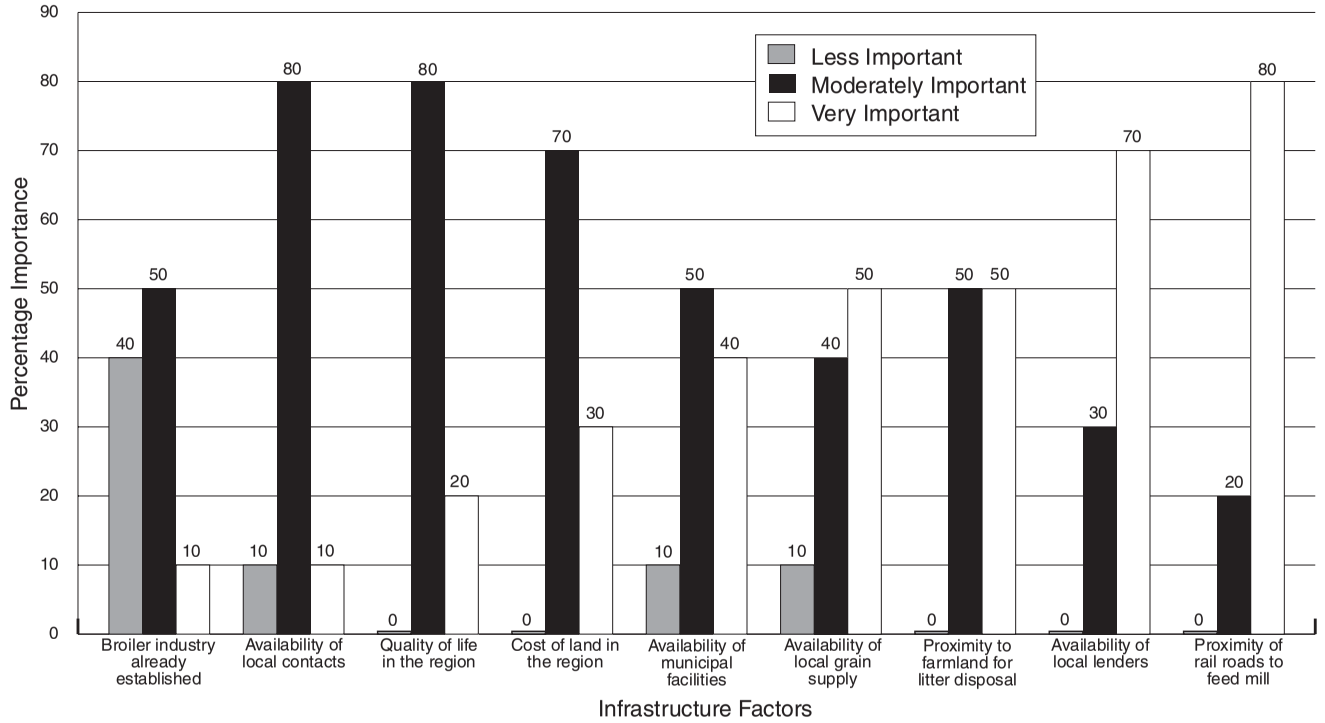
The availability of a municipal facility for wastewater treatment and solid waste disposal also was important for the broiler complex location decision. Twenty percent of the respondents gave a rating of 7, and 30 percent gave a rating of 6 for availability of municipal facilities. This result is consistent with the findings of Lopez and Henderson, who report that availability of waste treatment/disposal facilities are among the most important factors in their study.

Table 9. Percentage Importance of Additional Attributes in the Broiler Complex Location Decision.

Additional Factors	Ratings Percentage						
	Not Imp.						Very Imp.
	1	2	3	4	5	6	7
Infrastructure[a]							
• Availability of local grain supply	0.0	10.0	0.0	20.0	20.0	40.0	10.0
• Proximity of railroads to feed mill	0.0	0.0	10.0	0.0	10.0	0.0	80.0
• Cost of land in the region	0.0	0.0	10.0	20.0	40.0	30.0	0.0
• Broiler industry already established in the region	20.0	20.0	10.0	0.0	40.0	10.0	0.0
• Availability of a municipal facility for wastewater treatment and solid waste disposal	0.0	10.0	10.0	20.0	10.0	30.0	20.0
• Proximity to farmland or other sources for litter disposal	0.0	0.0	10.0	20.0	20.0	30.0	20.0
• Availability of local lenders for broiler growers (mortgage, operating loans).	0.0	0.0	0.0	30.0	0.0	10.0	60.0
• Availability of local contacts to assist in analysis of community attitude	0.0	10.0	10.0	30.0	40.0	10.0	0.0
• Quality of life in the region for employees	0.0	0.0	20.0	10.0	50.0	20.0	0.0
Regulations[b]							
• Stringency of water pollution regulations	0.0	0.0	10.0	10.0	10.0	30.0	40.0
• Stringency of dead bird and litter disposal regulations	0.0	0.0	20.0	30.0	20.0	20.0	10.0
Labor[c]							
• Growers attitude toward contract production	0.0	0.0	10.0	0.0	0.0	60.0	30.0
• Availability of catchers	0.0	0.0	10.0	0.0	30.0	40.0	20.0
• Availability of skilled labor (electricians, general mechanics and refrigeration mechanics)	0.0	0.0	0.0	10.0	30.0	40.0	20.0
State and Local Policies[d]							
• State development incentives (income tax credit, job training, direct loans etc.)	0.0	0.0	0.0	10.0	20.0	60.0	10.0
• State property tax	0.0	0.0	0.0	0.0	30.0	70.0	0.0
• Local property tax	0.0	0.0	0.0	0.0	30.0	60.0	10.0
• State fuel tax	0.0	0.0	0.0	0.0	40.0	60.0	0.0

Note: [a] includes local factors that are not included in the conjoint portion of the questionnaire.
[b] includes factors related to environmental regulations imposed on the broiler industry.
[c] includes factors related to broiler labor that are not included in the conjoint portion of the questionnaire.
[d] includes factors related to incentives and taxes.

Figure 2. Percentage Importance of Infrastructure Factors in the Broiler Complex Location Decision.



Note: less important includes ratings 1 and 2, moderately important includes rating 3, 4 and 5, and very important includes ratings 6 and 7.

A broiler slaughter plant generally disposes of large amounts of wastewater and solid waste. The wastewater is discharged to publicly owned treatment plants that remove most of the pollutants before the water is discharged.

The proximity to farmland and other places for litter disposal was nearly as important as the availability of municipal facilities in the location decision. Twenty percent of the respondents gave a rating of 7 and 30 percent gave a rating of 6 for proximity to farmland or other sources for litter disposal. A typical broiler house produces between 125 and 150 tons of litter material every year. Broiler litter is generally used as fertilizer and, in some cases, is fed to beef cattle. When used as a fertilizer, generally four tons of litter is applied per acre; thus, 35 to 50 acres of land are required per broiler house to dispose of litter appropriately (Cunningham).

The respondents rated availability of local grain supply between moderately to very important in the location decision. Generally, broiler complexes in the South import feed from the Midwest and prefer to reserve locally available grain as a backup.

The respondents' preference for a region with an already established broiler industry had mixed responses. Twenty percent considered it as unimportant, while some considered it to be moderately important to the broiler complex location decision. Regions where broiler complexes are already established may be associated with positive agglomeration economies, where the new integrator will have a clear picture of availability of growers, community attitude toward broiler industry, costs of production and access to input and output markets. Conversely, there may be disadvantages associated with establishing a new broiler complex in a region where a broiler industry is already established. The main disadvantages may be associated with greater demand for dead bird and litter disposal from broiler houses and disposal of wastewater and solid waste from the slaughter plant. There may not be enough land available (in close proximity) for litter disposal if a broiler complex is already established in the region.

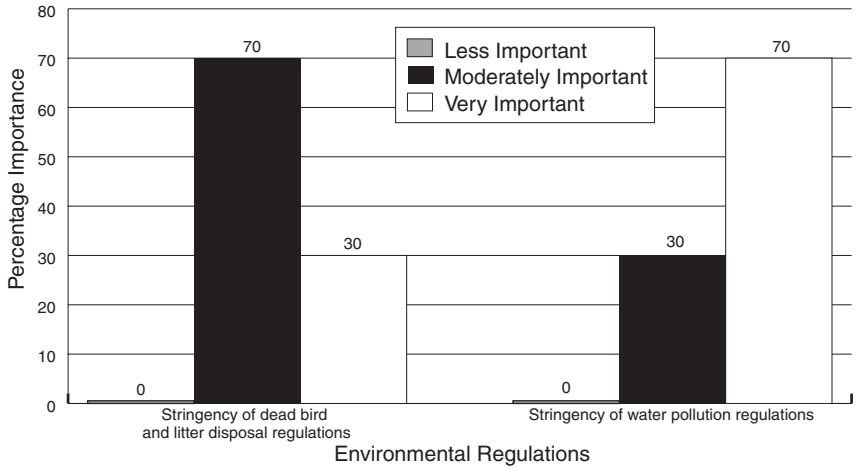
The cost of land was moderately important in the broiler complex location decision. This factor was hypothesized to be one of the most important reasons for concentration of the broiler industry in the South. However, within the South, relative differences in land costs may be less significant, and, as a result, other factors discussed in the conjoint portion of this study may play a key role in the broiler location decision. The other infrastructure factors (availability of local contacts to assist in the analysis of community attitude and quality of life in the region for the employees) were moderately important in the broiler complex location decision. Availability of local contacts may moderately benefit the integrator in assessing community attitude, but that itself is not sufficient for completely assessing the communities' preference for the broiler industry. The reason for quality of life in the region not being significantly important may be

attributed to the fact that the broiler industry is mainly associated with low skilled workers.

Environmental Regulations

The stringency of water pollution regulations and stringency of dead bird and litter disposal regulations are two additional environmental regulation factors analyzed. The importance of these two factors in the broiler complex location decision is illustrated in figure 3. Of the two, stringency of water pollution regulation was very important in the location decision of a broiler complex. Forty percent of the respondents gave a rating of 7, and 30 percent gave a rating of 6 for this attribute. This is consistent with the findings of the conjoint analysis, which indicated that community attitude toward the broiler industry is one of the most important factors. In general, broiler companies may face stringent water pollution regulations enforced by state and local agencies where the local community is not in favor of having a broiler complex in its region. This result is consistent with the findings of Lopez and Henderson, who report that factors related to environmental regulations play a key role in broiler location decisions.

Figure 3. Percentage Importance of Environmental Regulation Factors in the Broiler Complex Location Decision.



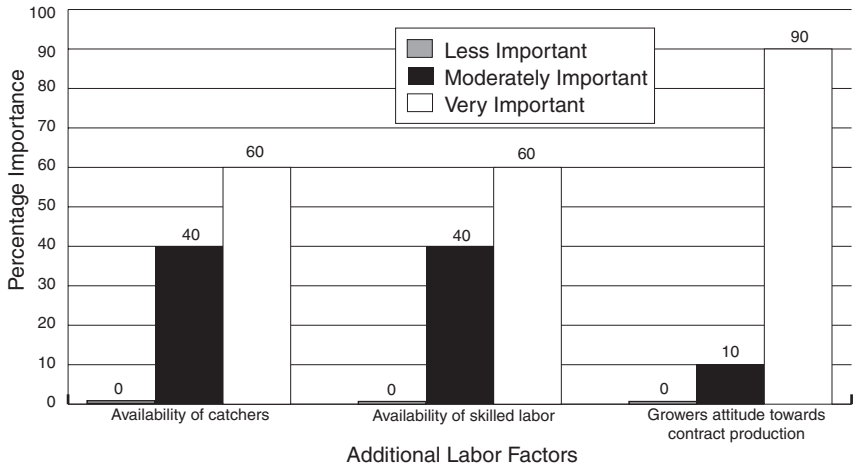
Note: less important includes ratings 1 and 2, moderately important includes rating 3, 4 and 5, and very important includes ratings 6 and 7.

Stringency of dead bird and litter disposal regulations was another environmental regulation included in the questionnaire. This factor is only moderately important in the location decision, as compared to other environmental regulatory factors. The reason for this may be attributed to the fact, that in a vertically integrated system, it is the responsibility of growers to dispose of dead birds and litter. Since this survey was directed to the integrators, stringency of dead bird and litter disposal regulations was not considered to be important.

Labor

Grower attitudes toward contract production, availability of catchers and availability of skilled workers are additional labor factors studied. The importance of these three labor factors is illustrated in figure 4. The broiler companies consider grower attitudes toward contract production as a very important factor in the location decision. Thirty percent of the respondents gave ratings of 7, and 60 percent gave ratings of 6 for importance of grower attitude in their location decision. This result is consistent with the conjoint analysis, which found community attitude toward the broiler industry to be the second most important factor in the location decision. Broiler growers are also local residents of the community, and their willingness to work under contractual agreements with integrators may reflect favorable community attitudes toward the broiler industry.

Figure 4. Percentage Importance of Additional Labor Factors in the Broiler Complex Location Decision.



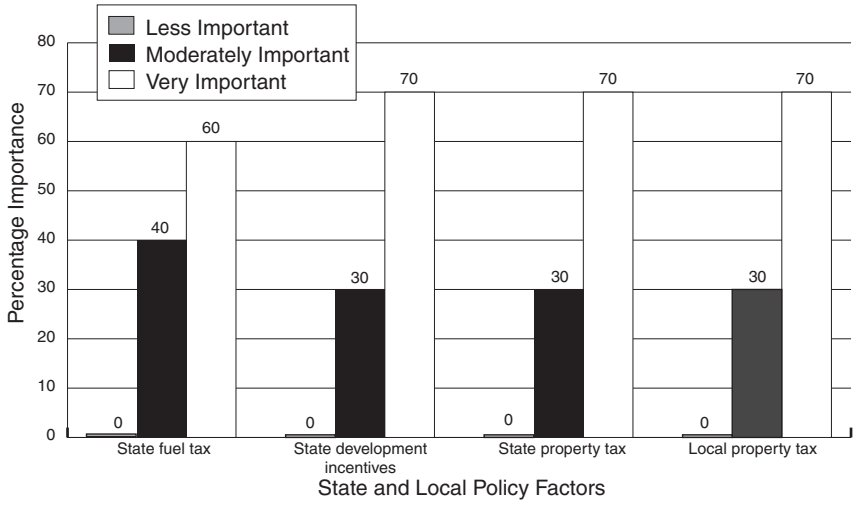
Note: less important includes ratings 1 and 2, moderately important includes rating 3, 4 and 5, and very important includes ratings 6 and 7.

The availability of catchers and skilled labor were very important in the location decision. For both of the factors, 20 percent of the respondents gave ratings of 7, and 40 percent gave ratings of 6. These results complement the conjoint results, which found unemployment rate in the region as the fourth most important factor in the broiler complex location decision.

State and Local Policies

State development incentives, state property, local property and state fuel taxes are the additional factors related to state and local policies that are included in the study. Figure 5 presents the ratings of these four attributes. These four factors were only moderately important, because most of the respondents gave ratings of 5 and 6. This result is consistent with Lopez and Henderson, who also found that factors related to state and local policies are not key in broiler complex location decisions when compared to other factors.

Figure 5. Percentage Importance of Factors Related to State and Local Policies in the Broiler Complex Location Decision.



Note: less important includes ratings 1 and 2; moderately important includes rating 3, 4 and 5; and very important includes ratings 6 and 7.

Conclusions

The U.S. broiler industry is concentrated primarily in the South, which accounts for 85 percent of the domestic broiler supply. The top producing states are Georgia, Arkansas, Alabama, Mississippi and North Carolina, which account for more than 60 percent of the total U.S. broiler supply. Conversely, other southeastern states such as Florida, Kentucky, Louisiana, South Carolina, Oklahoma and Tennessee produce relatively few broilers compared to leading southern states. The reason some regions are better suited for broiler production than other states is not well understood. The purpose of this study was to analyze broiler industry decisions regarding where to locate a broiler complex. The specific objectives were to: 1) identify factors affecting the site locations of broiler complexes in the United States and 2) measure the effects and relative importance of these factors on the broiler complex location decision.

The study applied conjoint analysis (CA) to the industry location problem. Forty-three chief executive officers within the broiler industry were surveyed, of which 10 responded, yielding a response rate of 23.3 percent. The 10 responding to the survey account for approximately 55 percent of total U.S. broiler output. Separate models were estimated for broiler growing, feed milling and slaughter, and conjoint bridging techniques were used to measure the relative importance of all attributes affecting the location decision of a total broiler complex.

Relative importance estimates showed that low feed costs, a favorable community attitude toward the broiler industry, availability of geographically concentrated growers, high unemployment rates and low wage rates are the top five attributes affecting broiler company location decisions. Sixty-six percent of the variation in site preference was attributed to these five attributes. Other factors, by order of importance, include: the quality of roads between the feed mill and growers, the cost of electricity, the cost of sewage disposal, the number of potential growers in the region, heating costs, water costs and proximity to metropolitan areas. In addition to the factors involved in conjoint analysis, the broiler companies' consideration of additional factors indicates that proximity of railroads to feed mill, availability of local lenders for financing, grower attitude toward broiler production and stringency of water pollution regulations are the most important additional factors in the location decision.

Since optimal site selection almost always involves evaluating tradeoffs among location attributes (low feed costs may be offset by unfavorable community attitudes, the lack of growers and/or high unemployment rates in a particular region), estimating the order of importance for location attributes is an important contribution of this study. Results also provide an explanation for the

concentration of broiler complexes in the South. Though feed costs are higher in the South than in the Midwest, the combination of favorable community attitudes in rural areas of the South, greater availability of growers relative to the Midwest, and higher unemployment, and lower wage rates in the South creates a "locational pull" away from low-cost feeds to areas with relatively low-cost rural labor. This conclusion is consistent with location theory and consistent with the findings of Easterling, Braschler and Kuehn, and Aho, who also concluded broiler companies prefer regions with low labor costs.

Our findings should help community development strategists understand relative tradeoffs among broiler complex location attributes. This could lead to better decisions regarding policies aimed at attracting the broiler industry to rural communities. Some factors that play a role in the location decision can be influenced by government policy. For instance, educational programs and/or loan guarantees that encourage rural entrepreneurs to consider poultry growing as an alternative enterprise could influence the growth of Louisiana's poultry industry. Policies aimed at educating community leaders and farmers about benefits and costs of broiler production to economic development, and/or identifying rural communities more favorably disposed to broiler production, could also be useful. Once suitable communities are identified, state and local agencies may more actively promote Louisiana to poultry companies seeking expansion. On the other hand, we should note that some important attributes are difficult for government and community planners to control. Local feed costs, for example, are largely determined by availability of local grain supplies and the cost of transporting grain from surplus producing regions of the United States. Factors affecting feed costs are difficult for state agencies to influence.

Another important finding is that none of the respondents planned to build a new broiler complex in the next five years. Most preferred to expand their existing broiler complexes (adding growers, feed mills and broiler slaughter plants) or build a further processing plant that would add value to ready-to-cook products. Therefore, for the next five years, Louisiana should develop strategies that will aid existing companies in expanding their broiler complexes.

Since feed cost was the most important attribute, future research could focus on analyzing ways to lower feed costs in the state, perhaps through new seed varieties that lower costs of production or raise yields for corn and soybean. Another direction of future research could focus on analyzing factors that can lower costs of importing feed. Future research could also focus on disentangling the specifics associated with community attitude. Analyzing the factors important to the community, which leads to a favorable attitudes toward the broiler industry, would aid in attracting broiler operations.

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A Conjoint Analysis of Site Selection for the U.S. Broiler Industry:

Implications for Louisiana

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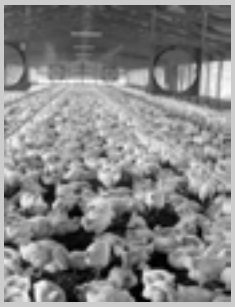

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