Appendix III: Modeling the Returns to Contract Production

The net returns of contractors and growers in contract production arrangements were examined by estimating the following empirical model:

$$(1) \qquad W = X_1\beta_1 + \varepsilon_1$$
$$(2) \qquad \Pi_g \equiv W - C_g = X_1\beta_1 + X_2\beta_2 + \varepsilon_2$$
$$(3) \qquad \Pi_c \equiv R_c - W - C_c = X_1\beta_1 + X_3\beta_3 + \varepsilon_3$$

(1) expresses the fees paid by the contractor and received by the grower as a function of X_1, a matrix of variables that influence the contract fee schedule including variables that impact the incentive payment. (2) and (3) describe the returns of the grower and contractor. Π_g is the grower's returns, measured as fees W paid the grower by the contractor net of grower costs C_g. Π_c is the contractor's returns from the hogs sold R_c, net of the fees W paid to the grower and other contractor costs C_c. Both X_2 and X_3 are matrices of exogenous variables that shift such factors as: 1) the contractor's return from the hogs produced R_c; 2) the contractor's and the grower's costs C_c and C_g; and 3) the grower's opportunity wage for contracting.

Model Specification and Estimation

Contract fees were measured as the payment per head made by contractors to growers for hog production services. Since incentive payments are an important determinant of the contract fee, the type of payment scheme used in the contract was included as an explanatory variable in (1). The survey data included an indicator of whether or not each contract had a bonus incentive payment scheme that was specified as a binary variable equal to one if the contract provided an incentive payment, zero otherwise. The data, however, did not specify the type of bonus mechanism used in the contract (e.g., payment tied to death loss, feed conversion, or other factors).

Equations for the grower (2) and contractor (3) were estimated using gross returns net of operating and asset ownership costs as the dependent variable. Since the contractor is the residual claimant to the final product, gross returns of the contractor were defined by the value of the finished hogs.[22] Gross returns of the grower were the fees paid by the contractor, which is a cost to the contractor. Other costs, including feed, other variable inputs, and capital, were charged to each contract participant according to their contribution. The hog costs and returns were expressed on a per hundredweight of gain basis, because gain is an indicator of the product added that results from the inputs used.

Regressors specified in the contract fee (1) and net return (2 and 3) equations included the type of contractor, contract size, years under contract with the current contractor, and characteristics of the grower and the grower's operation. A set of binary variables was used to specify the type of contractor, indicating whether the contractor was an integrator, vertically integrated firm, other farmer, or among all other types of contractors (see Glossary, p. 43, for definitions). Contract size was the number of hogs removed under contract from the operation in 1998.[23] Age of the production facilities was included as an indicator of the point in time when the facilities were constructed and thus the age of the technology used in the production process. Grower experience and education were specified as indicators of the managerial ability of the grower and may also reflect a grower's opportunity cost for contracting. A binary variable that indicated whether or not the grower's major occupation was off-farm employment was also included in the net return equations. Off-farm employment would likely reduce a grower's operational and managerial time available for hog production, and may require the hiring of additional labor.

Another set of binary variables was used to specify the services provided by the contractor. The services were part of the contract arrangement, and included whether the contractor provided facility financing, provided facility specifications, hauled the hogs, delivered the feed, monitored animal health, and/or provided planning and other assistance with manure management. This specification was used to determine what role the provision of common services provided by contractors had in establishing contract fees and in the net returns of contractors and growers. One might expect that more services provided by the contractor would result in lower fees paid to the grower.

[22] Actual market hog prices received by the contractor were not collected in the ARMS, so State average prices were used to value the finished hogs (USDA, NASS, *Agricultural Prices*). This cash market price is likely to be less than what contractors may receive under marketing arrangements with packers. However, this method of valuing the hog production should have a limited impact on the analysis of relative contractor and grower returns since the contractor typically bears all of the price risk in these type of arrangements (Rhodes; Knoeber and Thurman).

[23] This is the size of the grower's operation. Contractor size was not available from the survey data.

Other regressors in the net return equations include the degree to which the grower's operation specialized in hog production and measures of resource use efficiency, including variables for facility capacity utilization and feed efficiency. Specialization may be associated with the operational and managerial time devoted to the hog operation. Capacity utilization is an indicator of the overall management of the operation where unit costs are reduced if facilities are used more intensively, spreading fixed costs over more output. Feed efficiency is also an indicator of the overall management of the operation that is impacted by such factors as the genetic capability of the animals and animal health and husbandry. A variable indicating whether or not the operation was in a Southern State (AL, AR, GA, KY, NC, SC, TN, or VA) was also included. The milder climate in Southern States impacts the type and design of hog housing and manure handling facilities, and thus may affect contract fees, production costs, and returns to contracting. Being in the South may also impact the employment opportunities available to contract growers and thus their opportunity wage for contracting.

The parameters of equations 1, 2, and 3 were estimated using the seemingly unrelated regression (SUR) procedure proposed by Zellner. Because the equations are closely related, it is likely that some unmeasurable or omitted factors could have similar effects on the disturbances in all three equations; thus, the errors may be correlated. When a system of equations has correlated error terms, SUR provides estimators which are asymptotically more efficient than those obtained by applying ordinary least squares to each equation. The set of equations was estimated using SUR with the ARMS survey weights to account for the complex sample design (Dubman).

Model Results

SUR parameter estimates for the equations used to describe the factors affecting contract fees per head and the returns to hog finishing arrangements are shown in Appendix tables III-1 and 2. The model explained 42 percent of the variation in these variables as indicated by the system-weighted R-squared. A negative parameter estimate in the contract fee equation (Appendix table III-1) implies that an increase in the explanatory variable results in lower payments per head to growers from contractors, while positive estimates indicate variables associated with higher contract payments. Parameter estimates for the net return equations (Appendix table III-2) indicate the impact that each explanatory variable had on the net returns of growers and of contractors.

Contractor type was specified in the contract fee equation with the variable indicating that the contractor was an integrator as the base for comparison. The results indicate that whether the contractor was an integrator, vertically integrated firm, or other farmer did not have a statistically significantly effect on the level of contract fee paid (Appendix table III-1). Among the contract characteristics, the coefficient on length of time with the contractor was significant and had a negative effect on contract fees. Contract fees also declined with the age of the production facilities. A possible reason for these results is that more recent contracts compensated growers for inflated facility costs in recent years relative to facility investments made under older contracts. Also, technologies used in older facilities may be less efficient and contract fees could reflect the lower productivity from these facilities.

The variable indicating that an incentive payment was a part of the fee schedule had a positive and statistically significant impact on contract fees. The coefficient indicates that contract growers earned about 83 cents per head from bonus incentives. Among contractor services, the monitoring of herd health by contractors was the only service that had a statistically significant impact on contract fees. Counter to prior expectations, providing this service had a positive impact on contract fees that was substantial at $1.83 per head. The positive impact may indicate that more attention was given to animal health when contractors monitored herd health, reducing death and disease and raising contract payments tied to animal performance. The provision of other services, such as facility specifications and assistance with manure management, did not significantly impact the level of contract payments.

Both grower experience and education had a positive and statistically significant effect on the level of contract fees. These characteristics may indicate a willingness of contractors to pay more to growers who likely bring a higher level of management skill to the operation, and/or indicate growers who have a higher opportunity wage for contracting. Experience and education may also be indicative of growers that had more skill in contract selection and negotiation. Also, growers in Southern States were paid significantly lower contract fees. This could reflect the lower investment requirement of contract growers for production facilities in Southern States due to the milder climate. It could also reflect a lower opportunity wage among growers in the South due to fewer alternative employment options.

Contractor type was also specified in the net return equations with the variable indicating that the contractor was

Appendix table III-1—SUR results for contract fees in contract hog finishing arrangements, 1998

Variable	Estimated coefficient	Standard error
Intercept	8.5360**	2.1612
Contractor type 1: Vertically integrated[1]	-0.7037	0.8188
Contractor type 2: Other farmer[1]	0.2392	0.7943
Contractor type 3: All others[1]	-1.8749*	1.0082
Contract size (1,000 head removed)	-0.0700	0.0450
Contract years (years with contractor)	-0.2108**	0.0610
Incentive payment (fixed plus bonus)	0.8295*	0.4695
Contractor service 1: Facility financing	-1.2960	0.9385
Contractor service 2: Facility specifications	-0.8688	0.7075
Contractor service 3: Animal hauling	0.7874	1.6779
Contractor service 4: Feed delivery	1.4159	1.7814
Contractor service 5: Monitoring herd health	1.8260**	0.6449
Contractor service 6: Manure management	0.5634	0.6163
Facility age (years)	-0.2444**	0.0328
Grower experience (years producing hogs)	0.0512**	0.0244
Grower education (years of schooling)	0.2024*	0.1158
Location (Southern State)	-1.7611**	0.8620
Sample size	227	
System-weighted R-squared	0.42	

Notes: Contract fees were the per head compensation paid by contractors to growers for services provided in contract hog finishing arrangements; single (*) and double asterisks (**) denote significance at the 10-percent and 5-percent levels, respectively.
[1]Coefficients interpreted relative to the deleted group, integrators.

Appendix table III-2—SUR results for the net returns of contractors and growers in contract hog finishing arrangements, 1998

	Grower		Contractor	
Variable	Coefficient	Std. error	Coefficient	Std. error
Intercept	-12.4046**	2.5792	38.1958**	8.2030
Contractor type 1: Vertically integrated[1]	2.4371**	0.8788	-8.7032**	2.7920
Contractor type 2: Other farmer[1]	1.7468**	0.8681	-9.3367**	2.7587
Contractor type 3: All others[1]	1.4498	1.0688	-3.9380	3.3953
Contract size (1,000 head removed)	0.0322	0.0470	-0.0866	0.1492
Contract years (years with contractor)	0.0950	0.0625	0.2596	0.1985
Incentive payment (fixed plus bonus)	-0.2053	0.4957	-2.3397	1.5745
Contractor service 1: Facility financing	-1.9926**	0.9586	-5.0156	3.0437
Contractor service 2: Facility specifications	0.5040	0.7164	-2.1478	2.2746
Contractor service 3: Animal hauling	2.4973	1.6809	-6.1497	5.3361
Contractor service 4: Feed delivery	0.6539	1.7862	-1.3552	5.6704
Contractor service 5: Monitoring herd health	0.9886	0.6533	-3.2451	2.0742
Contractor service 6: Manure management	0.7631	0.6222	-5.0135**	1.9752
Facility age (years)	-0.1154**	0.0344	-0.6832**	0.1092
Grower experience (years producing hogs)	0.0099	0.0260	0.0653	0.0825
Grower education (years of schooling)	0.0982	0.1314	-1.0566**	0.4173
Location (Southern State)	-0.0042	0.8764	-1.1157	2.7827
Grower occupation (off-farm)	-0.6781	0.6119	-1.3487	1.9549
Grower specialize (farm value from hogs)	0.0409**	0.0108	-0.0453	0.0344
Capacity utilized (head removed/head space)	0.3878**	0.1030	1.4335**	0.3291
Feed conversion (lbs. Fed/lb. gained)	-0.1861**	0.1052	-1.3916**	0.3362

Notes: Net returns were defined as returns above the operating and ownership costs per hundredweight of gain for each contract participant; single (*) and double asterisks (**) denote significance at the 10-percent and 5-percent levels, respectively.
[1]Coefficients interpreted relative to the deleted group, integrators.

an integrator as the base for comparison. Statistically significant coefficients on the contractor type variables indicate that growers who contracted with integrators had lower net returns than growers who contracted with vertically integrated firms or other farmers (Appendix table III-2). Contractors who were integrators had significantly higher net returns than contractors who were vertically integrated firms or other farmers. Integrators have generally been in the business of hog contracting longer than the other contractor types and are the most specialized type of hog contractor. This experience and specialization in hog production may have enhanced their ability to produce hogs more efficiently than the other types of contractors. Also, integrators may have been larger hog producers than other contractor types, allowing them to achieve greater economies of scale. It is also possible that integrators were better at designing contracts that extract more of the economic surplus from these business arrangements.

The coefficient on contract size was not statistically significant in either the grower or contractor equations. This result suggests that contractors did not offer more or less favorable terms to operations with larger contracts relative to those with smaller contracts. Facility capacity utilization was significant and positively associated with net returns in both equations. Since growers bear the facility ownership costs, using facilities more intensely allows these fixed costs to be spread over more units of production. The fact that capacity utilization was also positive and significant for contractor returns may be indicative of the overall better management of these operations. Improved feed conversion (i.e., less feed per pound of gain) is also an indicator of more efficient production that resulted in significantly greater returns for both growers and contractors.

Only a few of the services provided by contractors impacted either grower or contractor returns. Despite having a positive impact on contract fees, bonus incentives and herd health monitoring were not statistically significant in the net return equations. Contractor financing of the production facilities was associated with lower returns for contract growers, but this practice was included in only 6 percent of contracts. Likewise, providing plans or assistance for manure management was associated with lower contractor returns. Manure management assistance was most likely provided to operations with limited land for manure disposal and/or operations facing a more stringent regulatory environment. Issuing contracts to growers in these situations would likely require that contractors assist with manure handling, increasing contractor costs. Facility age was highly significant and had a negative impact on contractor and on grower returns, a possible result of lower animal performance in older facilities relative to those using a more recent technology.

Among grower characteristics, grower specialization had a significant positive impact on grower returns while grower education had a negative relationship with the net returns of contractors. Operations more specialized in hog production may spend more time and effort in hog production, and the added labor and management input may have been reflected in higher grower returns. As indicated in the estimated contract wage equation, more educated growers commanded higher contract payments possibly because they have more employment options, resulting in higher costs for contractors.