Risk Preferences and Contracting In the U.S. Hog Industry

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Abstract

Much of the increase use of vertical coordination in the U.S. swine industry has taken place through contract production. While the incidence of contracting is much higher in non-traditional hog production areas, a growing number of Midwestern producers are being faced with contract options. A variety of contractual arrangements are available through feed companies, integrators, genetics firms, and packers. However, little is known about the profitability and risk characteristics of these alternatives. This research suggests that risk neutral producers in the Midwest would prefer independent production, and risk averse producers would prefer to choose among the various types of coordination arrangements.

Key Words: Risk, Stochastic Dominance, contract production, swine

Pork producers have little experience or data upon which to base sound decisions about the type of production and marketing arrangement they choose. In the past, the choice was simply to produce hogs independently and market on a live weight basis to the highest bidder. Pork producers in the United States are now faced with decisions regarding market coordination methods that differ from traditional independent production. The majority of these alternatives can be broadly categorized as contractual arrangements. A survey of producers and contractors estimated that around 10 percent of the nation's hogs were produced under contract in 1989 (Rhodes).

Market coordination has the potential to increase domestic pork demand by matching quantity and quality produced with consumer wants. Exports of pork may also be enhanced by increased coordination. According to Ueda, only 10 percent of Japan's pork imports come from the U.S. The lack of consistent quantities of high quality pork products at forward prices was cited as the major impediment to the growth of Japanese pork imports from the U.S.[1] In addition, a survey of Japanese consumers by Sapp and Knipe revealed concern about the quality of U.S. pork; only 14 percent of the respondents rated American ham and sausage high in quality. With appropriate contract specifications, processors could improve their ability to provide the volume of forward priced high quality products that the Japanese markets desire.

Williamson (1971, 1979) has suggested that transactions costs and market failures will ultimately lead to integration of successive stages of production. At issue is what types(s) of coordination arrangements will be adopted by producers. Rhodes found that the combination of less market risk and more steady income was the most frequent reason(s) producers entered into contracts. Wilson and Eidman estimated that about

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78 percent of Minnesota swine producers in their sample could be categorized as risk neutral to moderately risk averse. The objective of this paper is to examine alternative contracts of different types. The paper accomplishes the following: 1) a brief overview of contracting in U.S. livestock industries, 2) estimate the first two moments of the distributions of net returns for Midwestern hog producers under different production and working arrangements, and 3) use stochastic dominance with respect to a function to rank the alternatives over ranges of risk aversion.

Contract hog production in the United States initially showed rapid growth in the non-traditional hog producing areas of the southeast and parts of the south and southwest where large scale broiler contracting had previously occurred. Contracting became more prevalent in the Midwest as the effects of the farm financial crisis of the early 1980's were felt by producers. Low profits and financial stress resulted in liquidation of swine herds, leaving behind empty facilities. Later, producers were reluctant or unable to invest the capital necessary to re-establish their herd because of the high level of risk and investment required.

Many of the businesses initiating contract activity in the corn belt were local feed dealerships seeking to secure their feed volume. These firms contracted the use of idle facilities and labor at low cost. More recently, some hog producers in this region have begun building new facilities exclusively for contract production. In addition, hog finishing contracts have provided a mechanism for genetics firms to add value to barrows and nonselected gilts from rather large multiplier herds.

Concerns about producer autonomy and the possibility that contractors may seek to extract appropriable quasi rents from growers have led to proposed legislative restrictions in several states. Iowa was the first state to adopt anti-vertical integration legislation with respect to livestock packing firms. This legislation was amended in 1988 to prohibit contracting by packers.

According to Hamilton and Andrews, the following eight states have enacted anti-corporate farming legislation: Iowa, Kansas, Minnesota, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin. They also point out that Iowa, Kansas, and Minnesota have adopted some form of legislation regulating production contracts in agriculture. In addition, Florida and Indiana have considered legislation which would regulate contracting.

Several factors determine the type of production and marketing scheme that will be adopted/sustained by hog producers. The primary determinants include profitability, variability of profits, risk preference, capital requirements, cash flow, equity building potential, access to technology, and any pre-existing preferences concerning specific types of coordination alternatives.

The Rhodes survey revealed that 32 percent of contracting producers entered contracts to reduce risk and/or stabilize income. Zering and Beals examined the financial performance of one type of finishing contract and one type of farrow-to-feeder pig contract using North Carolina data. Effects on income of such factors as marginal changes in market hog price, feeder pig price, and feed conversion variables, were noted. Kliebenstein and Hillburn examined three Iowa finishing contracts and three farrow-to-feeder pig contracts under various non-stochastic efficiency levels.

This paper examines the profitability of six coordination alternatives currently used for finishing enterprises in the Midwest. They consist of five different types of contracts and independent production. Profitability is calculated by applying contract provisions and payments to a set of farms with finishing enterprises. Generalized Stochastic Dominance (GSD) is used to rank the six alternatives under a variety of risk preferences. The risk intervals examined were delineated following the identification of Breakeven Risk Aversion Coefficients (McCarl). The ranking of alternatives was examined within a general classification of risk attitudes, drawing on the work by Wilson and Eidman, who ranked risk from neutral to strongly averse.

Contracts, Franchises, and Independent Producers

The types of coordination arrangements observed in the U.S. swine industry span the full spectrum from vertical integration to spot markets. The resource-providing contract generates the most

intense controversy in the debate about the relationship between swine contractors and growers. Under the terms of a resource-providing finishing contract, for example, the contractor usually provides feeder pigs, feed, veterinary care, managerial assistance and all marketing functions. The grower provides buildings, equipment, utilities and labor. Growers are paid a fee per head, plus graduated bonuses for feed conversion efficiency and minimizing death loss.

Why do contracts of this form appear? Schrader's 1986 article, which noted the similarity of swine production contracts and franchises, provides a starting point for the explanation. To understand the significance of this observation, it is useful to consider Ronald Coase's pioneering paper, "The Nature of the Firm," in which he attempts to explain the existence of firms in the economy. Why do some economic actors combine themselves into firms, rather than exchanging their goods and services in the open market? Coase argues that market transactions between independent units are costly, and that the integrated firm can perform repetitive transactions at lower costs. To extend the argument, the franchise contract falls somewhere between the two extremes of the open market and the vertically integrated firm, and may be viewed as a hybrid between the firm and the market. Rubin argues that the franchisor will generally perform functions with costs that fall for a substantial level of output, while the franchisee will perform functions whose average costs generally turn up relatively soon. Just as franchisees are required to pay a substantial fee to participate in the system, hog growers are required to invest in substantial specialized facilities which have few or perhaps even no alternative uses.

To a large extent, franchising is used instead of vertical integration when the franchisee is physically removed from the franchisor so that monitoring the farmer's behavior and performance is difficult. Control mechanisms can be devised that give the franchisee an incentive to avoid shirking and excessive consumption of leisure. If such mechanisms can be devised, it is possible that both the franchisee and the franchisor will gain from an enlargement of the total net returns that they share.

The study of such control mechanisms is the object of the extensive literature on the principal-agent problem. Because it is costly to monitor behavior, the principal uses process outcomes as proxies for input effort. Typically, in hog finishing contracts, these observable proxies consist of things such as feed conversion, death loss, and days to market.

Description of Coordination Alternatives

The measure of profitability calculated for each finishing scenario was designated as returns to labor, management, and overhead (RLMOH). This is a measure of returns minus variable costs, with labor, management, and overhead representing the specific factors of production not included in variable costs. Included in the overhead classification are the cost of facilities and equipment. RLMOH is what is left to compensate for these unpaid factors of production. The value RLMOH was calculated by applying the provisions of each type of contract to farm production data within each enterprise type.[2] This study used production data from a random sample of 17 hog farms participating in the University of Illinois FBFM record system.

Production records were gathered for six consecutive years, 1985-1990. A total of 95[3] observations were identified and the average number of hogs finished annually per farm over the six years was 1,033. Forty of the 95 observations came from farms finishing greater than 1,000 hogs in a given year.

The calculation of RLMOH for each of the 95 observations was made using the data available on each FBFM record. A portion of the cost used in the calculations was estimated from the University of Illinois Livestock Budgets on a per hundred weight basis. The estimates of these nonfeed costs were held at a constant per hundred weight rate for each observation, and were later converted to a per head basis for determining RLMOH.

All of the contracts examined required that the producer provide buildings and equipment[4], labor, management, and nonfeed variable costs. Of the contract scenarios, numbers 1, 2, 3, and 4 all pay a base payment plus bonus payments for high feed efficiency and low death loss. Contract 5 pays a base amount per head, but also stipulates that any

profits or losses earned by the contractor be split equally with the producer. In the contract, contractor profits are defined as gross returns minus variable costs.

Contract 1 stipulates that the contractor pay the producer a base payment of $4.00 per head on arrival (payment in) and $4.50 per head after marketing (payment out). In addition, producers are paid bonuses based on death loss and feed efficiency. The bonus schedule for this contract is listed in table 1.

Contract 2 has a base payment of $7 per head sold, paid when the hogs are marketed, and the bonus schedule is in table 2.

Contract 3 is another traditional base payment plus feed efficiency and death loss bonus contract. The base payment is $7 per head sold, paid when the hogs are marketed, and the bonus schedule for feed efficiency and death loss is identical to that of Contract 1 (table 1).

Contract 4 also pays producers both a base amount and a bonus amount according to feed efficiency and death loss. The base payment is $7.50 per head sold, which is paid when the hogs are marketed (table 3).

The base payment for Contract 5 is divided into two parts. The first part is $2.50 per head upon arrival and the second payment is $2.50 per head at marketing. However, Contract 5 differs from Contracts 1 through 4 in that the bonus payment consists of profit sharing between the producer and the contractor. Therefore, the estimates of RLMOH for Contract 5 reflect overall profitability in the hog finishing business, not just differences in feed efficiency and mortality rates among producers. The shared net return is calculated by subtracting variable costs (feeder pig cost, feed cost, veterinary and medicine, interest on production inventory, and marketing expense) from the gross receipts and the profits (or losses) are shared equally between the producer and the contractor.

Several managerial assumptions were needed to make comparisons across contracts. First, hog quality was assumed to be the same across all alternatives. Specifically, the genetic variation within the sample (actual records) was assumed for all contracting scenarios. This is probably a reasonable assumption. Our experience with a number of contractors in the Midwest suggests that they use the same or similar genetics as independent producers of that region. It also appears that the production and marketing techniques used by contractors in the Midwest are not as sophisticated as those of their counterparts in the Southeast. Consequently, the second assumption is that independent management as reflected in the Illinois data is representative of contract management. The third important assumption involves the health of feeder pigs as they enter the contract growing unit. Some independent finishers co-mingle pigs from multiple sources. This practice increases the likelihood of contracting swine health problems. Again, our experience suggests that the local feed companies writing contracts sometimes co-mingle hogs in order to fill their contracts.

Table 4 lists the calculated values of RLMOH per head for each finishing coordination alternative examined. For the six-year period studied (1985-1990), the mean RLMOH per head sold was highest for the independent scenario at $14.45. The mean RLMOH for independent finishing operations is more than twice that of Contracts 1, 2, 3 and 4. The maximum value of RLMOH for independent production reveals the potential for large profits. However, the minimum values observed for the independent alternative suggests that producers could experience losses in bad years that could potentially drive the producer out of business.

The variability of returns for the independent producer (standard deviation = 10.95) is larger than for the contract alternatives. The standard deviation reveals the tremendous profit variability of independent finishing compared to contract production. Another measure used to compare the variability of prospects with differing means and standard deviations is the coefficient of variation (CV) which is the standard deviation divided by the mean. The CV is an indication of variability per average unit of return. The independent scenario has six times greater variability per unit of return than Contract 1.

Table 1. Bonus Payment Schedule for Contract 1

Feed Efficiency (lbs feed/lbs gain)	Dollars per Head Sold	Death Loss (percent)	Dollars per Head Sold
0.00-2.79	2.00	0.00-.749	1.50
2.80-2.89	1.75	0.75-0.99	1.25
2.90-2.99	1.50	1.00-1.249	1.00
3.00-3.09	1.25	1.25-1.99	0.70
3.10-3.19	1.00	2.00-2.99	0.30
3.20-3.29	0.75	3.00 or above	0.00
3.30-3.39	0.50		
3.40 or above	0.00		

Table 2. Bonus Payment Schedule for Contract 2

Feed Efficiency (lbs feed/lbs gain)	Dollars per Head Sold	Death Loss (percent)	Dollars per Head Sold
0.00-2.59	1.50	0.00-0.99	1.50
2.60-2.79	1.00	1.00-1.99	1.00
2.80-2.99	0.50	2.00-2.99	0.50
3.00 or above	0.00	3.00 or above	0.00

Methodology: Generalized Stochastic Dominance

Meyer demonstrated a methodology to extend first and second degree stochastic dominance (GSD) techniques to order risky prospects while considering a distinct set of risk attitudes. This Generalized Stochastic Dominance (GSD) concept (also known as Stochastic Dominance with Respect to a Function (SDRF)) does not impose the assumption of normality on the distributions being compared as does mean-variance analysis, and does not assume a specific risk preference as do first and second degree Stochastic Dominance. Thus, GSD is more flexible in regard to the scenarios that can be compared. Stochastic Dominance has been used in a variety of agricultural settings. Dornbush and Boehlje used second order stochastic dominance to evaluate turkey production contracts in Minnesota. Other agricultural applications of Stochastic Dominance to agricultural problems include but are not limited to: Klemme; Anderson; Lee, Brown, and Lovejoy; Hardaker and Tanago; Williams; and Kramer and Pope.

For this study, GSD was used to rank market coordination alternatives based on the distribution of RLMOH across various risk attitude intervals. The class of decision makers considered in any GSD problem is designated by defining an upper and lower bound of the Arrow-Pratt function ($r(x)$) or risk aversion coefficients (RAC). An individual's RAC is a measure of risk preference based on a negative exponential utility function. Generally speaking, a positive RAC implies risk

Table 3. Bonus Payment Schedule for Contract 4

Feed Efficiency (lbs feed/lbs gain)	Dollars per Head Sold	Death Loss (percent)	Dollars per Head Sold
0.00-2.29	7.00	0.00-0.99	1.50
2.30-2.39	6.50	1.00-1.99	1.00
2.40-2.49	6.00	2.00-2.99	0.50
2.50-2.59	5.50	3.00 or above	0.00
2.60-2.69	5.00		
2.70-2.79	4.50		
2.80-2.89	4.00		
2.90-2.99	3.50		
3.00-3.09	3.00		
3.10-3.19	2.50		
3.20-3.29	2.00		
3.30-3.39	1.50		
3.40-3.49	1.00		
3.50-3.59	0.50		
3.60 or above	0.00		

Table 4. Estimated Statistics for Returns to Management, Labor, and Overhead

Coordination Method	*N*	Return to Labor, Management and Overhead				Coeff. of Variation
		Mean[a]	S & D	Max	Min	
Independent	95	$14.45	10.95	40.07	-14.36	.758
Contract 1	95	$5.46	.66	7.69	4.49	.121
Contract 2	95	$3.72	.69	5.91	2.66	.185
Contract 3	95	$3.79	.73	6.16	2.66	.193
Contract 4	95	$4.95	1.60	11.91	3.16	.323
Contract 5	95	$10.35	5.46	23.36	-4.11	.528

[a]All values are computed on a dollars per head basis.

averse preference, an *RAC* of zero implies risk neutrality, and an *RAC* that is negative implies risk seeking behavior. That is,

$$RAC > 0 \Rightarrow \text{risk averse behavior}$$
$$RAC = 0 \Rightarrow \text{risk neutral behavior}$$
$$RAC < 0 \Rightarrow \text{risk seeking behavior}$$

$$RAC = U''(x)/U'(x)$$
$$\textit{where}$$
$$U(x) = -e^{-rx}$$

GSD ranks risky prospects from most preferred to least preferred through sequential pair wise comparisons of each prospect's expected utility. The expected utility is a product of a prospect's cumulative distribution curve and the marginal utility of a particular class of decision makers. For example, consider two prospects with probability density functions $f(x)$ and $g(x)$ representing cumulative distribution functions $F(x)$ and $G(x)$, with x defined in the range of [0, 1]. The prospect $F(x)$ is preferred to or indifferent to prospect $G(x)$ by a decision maker with utility function $U(x)$ if and only if:

$$\int_0^1 U(x)f(x)dx \geq \int_0^1 U(x)g(x)dx$$

In other words, distribution F is preferred to distribution G if the expected utility of F exceeds that of G. Equivalently, integrating the above expression by parts yields the condition by which prospect F is preferred to G:

$$\int_0^1 [G(x)-F(x)]U'(x)dx \geq 0$$

The class of decision makers specified or preference interval is defined as:

$$r1(x) < U''(x)/U'(x) < r2(x)$$

where r1 and r2 represent lower and upper bounds on the *RAC*, and can range from strongly risk averse to strongly risk seeking (see Meyer).[5]

Raskin and Cochran summarize several SDRF studies and corresponding estimates of r1 and r2 used in previous research. There is not a clear methodology for choosing the values of $r1$ and $r2$ due to differing outcome variables and varying risk aversion coefficient estimates. (Robison and Cochran outline how transformation effect estimates of $r1$ and $r2$ when ranking alternatives different scales to transform from whole farm to per unit values of the upper and lower bounds, it is necessary to multiply the estimated bounds by the whole farm scale factor. In this case we multiplied by 1,000, the average number of hogs produced annually).

In theory, the coordination system which eventually prevails will be that which provides the desired commodity at the lowest cost. Successful contract production depends on the availability of independently owned physical and human capital. While feed costs and feeding pig costs are the largest single costs in hog production, fixed costs are still a significant percentage of total production costs. Thus, it is reasonable to expect that current producers will have some control over the costs associated with various systems via an implicit rental market. An important aspect of this study is determining how acceptable the contract alternatives are for producers with various degrees of risk aversion.

The location of the RAC where the ranking of the prospects switch, named breakeven risk aversion coefficients (BRAC) by McCarl, is of interest in order to identify discrete risk preference intervals in which the ranking of contracts remains unchanged. Attempts to rank prospects using an interval that spans a BRAC (i.e., the BRAC lies between r1 and r2) will result in an inability to rank at least one pair of prospects. The goal supporting the use of this approach was to identify the largest preference intervals in which all prospects could still be ranked.

Beginning with the 95 data points from the finishing enterprise coordination alternatives, McCarl's computer algorithm was used to identify the breakeven risk aversion coefficients where a shift of preference between two alternatives occurred. The search technique locates the particular risk preference denoted by the Arrow-Pratt co-efficient, for which the difference in expected utility between some pair of prospects is zero. The procedure makes sequential comparisons

between pairs of prospects until all possible pairwise combinations have been considered.

For the hog finishing contracts, nine BRACs were identified. The positive BRACs identified were 0.5332, 0.5269, 0.4475, 0.3802, 0.2081, 0.2060, 0.1860, 0.1725 and 0.1034.

Generalized Stochastic Dominance Rankings of Selected Swine Production Contracts

After identifying the BRACs, the Cochran and Raskin GSD program was used to identify the actual ranking of each production alternative within the intervals defined by the BRACs. This minimizes the probability of Type I error (accidentally excluding the preferred option), but at the same time weakening the discrimination among prospects, Type II error (see Goh, Shih, Cochran, and Raskin).

The GSD program identified the coordination alternative with the highest expected utility for a specific range of risk preference. This prospect dominated all other prospects in pairwise comparisons. The prospect with the second highest expected utility dominated all but one prospect, and so on, down to the prospect that dominated no others but instead is dominated by all others. Consecutive risk preference intervals were ranked for each enterprise type until a wide range of risk preferences spanning from extremely risk averse to risk neutral was considered.

In this study, GSD techniques are implemented and discussed in the context of both general classifications of risk preferences (risk neutral, slightly risk averse, moderately risk averse, and strongly risk averse) and within the ranges defined by the breakeven risk aversion coefficients. Most previous research has implemented only rough approximations of producer risk preferences when ranking risky prospects. Utilization of both sources of information in this study allows a broader understanding of rankings of alternative market coordination methods in the pork industry.

Table 5 presents a summary of rankings of coordination alternatives in swine finishing enterprises for successive levels of risk preference defined by the breakeven risk coefficients. Beginning at the top of the table with the most risk averse group of decision makers, Contract 1, which averages $5.47 RLMOH per head, is the most preferred alternative. The level of profitability coupled with the low variability of returns with Contract 1 make it the dominant distribution over the entire range of RACs greater than .2082. With regards to Contracts 1, 2, 3, and 4, which all pay the producer a base payment plus feed efficiency/death loss bonuses, Contract 1 is most often the dominant distribution among the group, even over lower values of r1 and r2 or risk neutral preferences. Contract 1 has the highest mean RLMOH of the rigid contract group, due mostly to having the highest base payment among all contracts at $8.50 per head, and these contracts all have small standard deviations.

At the opposite end of the coordination spectrum, independent operation is the least preferred alternative among strongly risk averse producers. Any attractiveness of high profitability levels is outweighed by the dislike for substantial variability. However, as a move is made toward risk neutrality, independence is preferred as a result of its higher average profit potential.

Contract 5, which is a mix of base payments and profit sharing, lies somewhere between the extremes of resource providing contracts and independence. In the range of slightly to moderately risk averse levels of preference, Contract 5 is preferred or dominates, but becomes dominated by the rigid contracts in intervals of very strong risk aversion. Movement towards lower risk aversion leads to domination of Contract 5 over Contract 1 and independence. The profit sharing aspect of this contract contributes to the higher mean RLMOH relative to other contracts, and the steady base payment of $5.00 per head reduces some variability relative to independent production.

Contract 4 is never ranked worse than fourth and is always preferred to Contracts 2 or 3. This alternative averages $4.95 dollars RLMOH per head, which is close to the $5.46 figure of Contract 1. The base payment with this contract is $7.50 per head, a dollar less than Contract 1 but the bonus schedule of Contract 5 is more lucrative than Contract 1. Contract 4 has a higher Standard Deviation because more of the payment to the

Table 5. Ranking of Finishing Coordination Alternatives Between Breakeven Risk Aversion Coefficients (BRAC) Using GSD

Preference Interval ($r1$ to $r2$)	BRAC	Ranking of Coordination Alternatives (Most Preferred to Least Preferred)
0.5333 to 15.00		1, 4, 3, 2, 5, Ind[a]
	0.5332	
0.5270 to 0.5331		1, 4, 3, 5, 2, Ind
	0.5269	
0.4476 to 0.5268		1, 4, 5, 3, 2, Ind
	0.4475	
0.3803 to 0.4474		1, 5, 4, 3, 2, Ind
	0.3802	
0.2082 to 0.3801		5, 1, 4, 3, 2, Ind
	0.2081	
0.2067 to 0.2080		5, 1, 4, 3, Ind, 2
	0.206	
0.1861 to 0.2065		5, 1, 4, Ind, 3, 2
	0.186	
0.1726 to 0.1859		5, 1, Ind, 4, 3, 2
	0.1725	
0.1035 to 0.1724		5, Ind, 1, 4, 3, 2
	0.1034	
-0.3122 to 0.1033		Ind, 5, 1, 4, 3, 2

[a]Ind refers to independent production and the numbers denote the number of the corresponding contract.

producer is based on bonus incentives versus the base payment. The variability of Contract 4 causes it to be less preferred than Contract 1 in intervals of strong risk aversion.

A look at table 5 reveals that as risk attitudes change from risk neutral to slightly risk averse the ranking of independence, Contract 5 and Contract 1 reverses. The range of *RAC* from 0.5333 to 15 is an area of very strong risk aversion, where Contract 1 is most preferred, independence is least preferred, and Contract 5 with its profit sharing attributes, is between the two. The range 0.1034 to 0.3801 approximates slight to moderate risk aversion and Contract 5 (profit sharing) is the preferred alternative. The risk aversion coefficients range from -0.3122 to 0.1033, approximating risk neutral preferences, and independence is the preferred choice.

The risk preference intervals estimated by Wilson and Eidman for Minnesota hog farmers provide another basis for evaluating the ranking of alternative coordination schemes with SDRF. After transforming for scale, the corresponding intervals are -0.10 to 0.10, 0.10 to 0.20, 0.20 to 1.0 and 1.0

Table 6. Stochastic Dominance Results Using Risk Intervals for Minnesota Hog Producers[a]

	Secondary Distribution																			
	Contract 1				Contract 2				Contract 3				Contract 4				Contract 5			
Primary Distribution	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
independent	1[b]	0	-1	-1	1	1	0	-1	1	1	0	-1	1	0	-1	-1	1	0	-1	-1
Contract 1					1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	1
Contract 2									-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1
Contract 3													-1	-1	-1	-1	-1	-1	0	1
Contract 4																	-1	-1	0	1

[a]The risk intervals in the table are the scale adjusted counterparts for Minnesota hog farmers developed by Wilson and Eidman. Risk intervals are denoted as follows: *A* is -0.1 to 0.1, *B* is 0.1 to 0.2, *C* is 0.2 to 1.0, and *D* is >1.0.

[b]A value of 1 indicates that the primary distribution second degree stochastically dominates the secondary distribution over the associated risk interval for that cell of the table. A value of 0 indicates that it is not possible to rank the two alternatives over the associated risk interval. A value of -1 indicates that the secondary distribution second degree stochastically dominates primary distribution over the associated risk interval

to 00. Table 6 contains the rankings of the coordination alternatives within this set of risk aversion intervals. Roughly, these intervals would correspond to the risk neutral, slight risk averse, moderately risk averse, and very risk averse producer. Notice, from tables 5 and 6, that the ranking of alternatives is the same for both risk intervals that surround zero. Furthermore, for the interval 0.1 to 0.2, Contract 5 stochastically dominates all other contracts. Contract 1 stochastically dominates 2, 3, and 4 over all examined risk intervals in table 6, and dominates Contract 5 over the interval >1.0. These results lead to the generalization that slightly risk averse producers will prefer Contract 5, but more risk averse producers will tend to prefer Contract 1.

Concluding Remarks

If the adoption of coordination alternatives is dependent only on mean profitability, the results of this study indicate that independent production would consistently be the most preferred. However, the growing interest in contract production among producers indicates that average annual returns are not the only means by which coordination alternatives are measured. The frequency and magnitude of variability of returns, therefore, must also be important.

Contracts 1, 2, 3 and 4 fit into the resource-providing category of contracts and offer fairly steady levels of mean RLMOH. The most risk averse group of producers, those who are strongly opposed to profit swings or who are financially unstable, will most likely prefer such alternatives. New entrants into hog production lacking substantial capital may also fall into this category. Among these resource providing contracts, Contract 2 is most often stochastically dominated over the various risk intervals, and Contract 1 most often dominates. The combination of a low base payment and small bonuses hinder the acceptance of Contract 2. Contract 1 offers the largest base payment and the bonuses are such that variability is limited.

Contract 5 shares net returns between the contractor and producer, but the producer maintains ownership of the hogs and a large stake in production management. Contract 5 falls somewhere nearer the spot market end of the coordination spectrum. Of the contracts studied, this one appears most apt to be preferred by slightly

risk averse producers. In addition, some of the risk inherent in independent production is passed to the contractor at a relatively low cost to the producer in terms of only slightly lower mean returns.[6]

It would appear that alternative coordination efforts will continue to evolve in the U.S. pork industry. However, because Wilson and Eidman found that 78 percent of Minnesota hog farmers were risk neutral or slightly risk averse, the results in tables 5 and 6 support continued independent farmer ownership of production facilities and hogs either through traditional means or less restrictive contracts such as profit sharing or marketing arrangements with packers. In response to the demand for greater coordination along the pork marketing chain, the incidence of grade and yield marketing has already increased substantially.[7]

Regardless of which mechanism is used to produce and market pork in the future, a failure to meet the demands of the domestic and export markets will be devastating to the industry. At home, consumers with unmet expectations will shift consumption from pork to other sources of protein. Abroad, other pork producing countries have been quick to meet the demands of overseas markets. However, if a consistent quantity of quality products were in greater supply, the U.S. might be more competitive due to lower production and transportation costs.

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Endnotes

1. Denmark has been the primary supplier of pork to Japan. The production, slaughter, processing, and marketing stages are highly coordinated by cooperatively owned slaughterhouses. Rasmussen describes this coordinated system.

2. Regarding the source of the contracts used in this study, two were obtained from the Iowa State University extension paper by Kliebenstein and Hillburn titled *Evaluation of Contract Provisions and Performance.* The remaining contracts were acquired from various sources in the eastern corn belt.

3. Only 95 observations were used (instead of the expected 102) because missing data were found in seven cases.

4. Facilities are deemed acceptable subject to the approval of the contractor (owner of the hogs).

5. For this study, risk seeking intervals are not of interest since it is not likely that any pork producers could be viewed as risk seekers. There are likely to be other more risky prospects with higher expected payoffs than producing pork that would attract pure risk seekers. The classes examined in this study range from strongly risk averse to risk neutral.

6. Packers may also be interested in these arrangements assuming that the same benefits of "harmonizing" adjacent production stages can be achieved under the profit sharing contracts as under the other contracts. Grade and yield marketing alternatives offered by most packers fill a similar coordination niche.

7. In 1988, Kauffman, et al., estimated that 28% of U.S. hogs were sold on a grade and yield system versus 36% in 1992 as estimated by Jekanowski.