Journal of Agricultural and Applied Economics, 30,1(July 1998):175–188

The Effect of Risk and Autonomy on Independent Hog Producers' Contracting Decisions

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ABSTRACT

The introduction of vertical coordination in the hog industry has provided producers with new business arrangements for raising hogs. While some researchers have elicited utility functions for hog producers on the basis of income risk, none have addressed autonomy, a factor which appears to be important in business arrangement selection for independent family hog operations. In this study, a method is developed for eliciting a multi-attribute function with attributes of income and autonomy. Utility functions are elicited for a group of Minnesota farrow-to-finish hog producers. For these producers, autonomy dominated risk as the most important attribute in business arrangement selection.

Key Words: autonomy, contracting, hog industry, risk.

The U.S. pork industry is rapidly undergoing structural changes that are affecting the manner in which hog producers are conducting business. As discussed by Kliebenstein and Lawrence, and by Hurt, one of these changes is an increase in the number of contracts between hog producers and vertical coordinators—which include feed companies and packers. While these contracts differ as to ownership provisions and management responsibilities, it is commonly argued that some independent producers will shift to contract production because it reduces income risk, while others will not do so because of the reduced opportunity to control the operation. This analysis presents a multi-attribute decision framework for estimating the relative importance of risk and other factors in the contracting decision.

In their recent study, Kliebenstein and Lawrence state that the primary reason for contractual arrangements in the hog industry is risk reduction. A number of studies have been conducted predicting hog producers' preferences for contracts on the basis of income risk (e.g., Lawrence and Kaylen; Johnson and Foster). Results of these investigations suggest that some contracts should be attractive to risk-averse producers, depending upon their levels of risk aversion. This is because there is a risk/expected-return tradeoff involved in hog production contracts. While the risk argument partly explains why a producer might accept a contract, it is somewhat unsatisfactory given the resistance that contractors have faced in some of the traditional hog production regions of the U.S. If risk is the primary factor affecting contracting decisions, why have relatively few independent producers in these regions contracted? And why have

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many lobbied for legislation that would outlaw these business practices (Hamilton and Andrews)?

We hypothesize that these producers' value of autonomy is sufficiently large to offset the risk-reducing benefits of contracts and that income risk is not the dominant factor in many producers' contracting decisions. Multi-attribute analysis allows for investigation into the tradeoff between risk and autonomy. Although the presence of attributes other than risk is discussed by Fulton and Gillespie in the context of joint-ownership hog farms, their descriptive model provides no measures of the importance of attributes. Other researchers have quantified agricultural decisions in multi-attribute frameworks (e.g., Foltz et al.; Patrick, Blake, and Whitaker); however, contracts have not been assessed under such a framework.

While income risk is reduced with many contracts, other associated advantages with contract production include the following when comparing independent and contract production units producing approximately the same number of hogs per year: (*a*) less operating capital is required for a contractee than for an independent producer to begin production since, in most cases, the contractor furnishes breeding stock and variable inputs; (*b*) some lending institutions loan money only to contract producers for operating capital or facilities; and (*c*) the producer may prefer sharing management responsibilities with the contractor. The contract producer also faces the following disadvantages: (*a*) moral hazard may result in conflicting incentives of contract provisions, (*b*) the contract may be broken or not renewed by the contractor, (*c*) the producer may not prefer sharing management responsibilities with a contractor, and (*d*) the producer may be concerned about the possibility of future contractor market power.

In this study, the independent producer's preference function for alternative production arrangements is modeled as a multi-attribute decision problem composed of the attributes of income and producer autonomy (autonomy). Autonomy represents the desirability of a business arrangement on the basis of how business structure and lifestyle aspects other than income and variability of income[1] are affected. Attributes other than income are combined into a single attribute, allowing for determination of the relative importance of income risk versus other attributes in producers' contracting decisions.

The objectives of this study are to: (*a*) develop a methodology to estimate a measure of producer autonomy preference for alternative contractual arrangements, (*b*) estimate utility functions for money income and measure how the desire for producer autonomy determines producers' preferences for business arrangements, and (*c*) determine the relative importance of income risk and autonomy in a group of producers' business arrangement preferences.

Methods

The six steps taken to fulfill the study objectives are summarized in table 1. In the following discussion we describe each of these steps in greater detail.

Business Arrangements and Net Returns Distributions

Six business arrangements represent the array currently offered to farrow-to-finish producers. Table 2 presents these arrangements in order of the highest level of autonomy and income risk (independent production) to the lowest level (vertical integration).

Net returns distributions were computed for arrangements from actual efficiency factors, costs, and returns of representative farrow-to-finish producers in the Southwestern Minnesota Farm Business Management Association (SMFBMA). Farms with a consistent number of sows per year represented the three size classes of 60-, 130-, and 300-sow operations. Criteria suggesting farms were well managed included sow productivity, feed efficiency, weans per litter, and death loss. Five years of production and price data (1986–90)

[1] In this study, "income" is defined as net returns and is the return to labor and management when it is discussed in relation to the decision maker's utility.

Table 1. Summary of Methods Used in Eliciting Hog Producer's Preference Functions

Steps to Be Taken	Brief Summary of Method
1. Identify business arrangements.	Discussion with industry leaders and vertical coordinating firms; review industry magazines.
2. Calculate net returns distributions.	Distributions computed for arrangements from efficiency factors, costs, and returns of actual farms. Returns include price and production risk.
3. Determine whether income and autonomy are mutually additive independent.	Personal producer interview developed to determine whether income is additive independent of autonomy, and whether autonomy is additive independent of income. Methods developed according to Keeney and Raiffa.
4. Elicit producer's preferences for income. Estimate utility functions.	Ramsey method used to elicit income preferences via personal interview. SCAR functional form and error-in-response model used to estimate utility functions.
5. Elicit producers' preferences for autonomy and its subattributes.	Decision tree approach used to compare net returns distributions for alternative business arrangements and independent production via personal interview. Contract premium is determined. Autonomy premium is calculated from contract premium and risk premium. Subattributes of autonomy are assessed.
6. Determine the relative importance of risk versus autonomy.	Size of autonomy premium and size of risk premium are compared between independent production and all other business arrangements.

were used to calculate annual net returns to labor and management for business arrangements in each size class, allowing for incorporation of price and production risk (table 3). Returns were calculated using contract formulas and prices received by the top 20% of SMFBMA producers. Price risk is assumed to be reduced by the alternative arrangements. Fixed capital requirements are assumed to be equal for all arrangements except for vertical integration. With contracts, hogs, feed, and other variable inputs are owned by the contractor. The 1986–90 time frame represents a hog cycle period representative of prices that producers expected to receive when preferences were elicited (i.e., during winter 1992–93).

Assessing the Assumption of Mutual Additive Independence

Investigation of additive independence allows for the determination of the appropriate form of a multi-attribute function. Keeney and Raiffa describe additive independence as holding when "the paired preference comparison of any two lotteries, defined by two joint probability distributions on $Y \times Z$, depends only on their marginal probability distributions" (p. 230). Thus, with additive independence, (1) holds:

$$u(y, z) = k_Y u_Y(y) + k_Z u_Z(z), \tag{1}$$

where $u(y, z)$ represents the multi-attribute utility function with attributes Y and Z and weights k_j. With additive independence, autonomy and income risk preferences are elicited separately, reducing the hypothetical nature of subsequent elicitation questioning.

A personal producer interview was used to test whether income preference was independent of autonomy preference. For each of four business arrangements, certainty equivalents were elicited assuming three different net returns distributions. A decision tree method was employed. For each distribution, if the certainty equivalents were equal for all ar-

Table 2. Business Arrangements Examined in the Analysis, Listed from Highest to Lowest Levels of Risk and Autonomy

Business Arrangement	Provisions
Independent Production	The producer owns all inputs and determines when and where to market hogs (traditional production arrangement).
Cost-Plus Marketing Agreement	Independent producers contract for a risk-reducing price ahead of time. The producer uses a contractor-designed feed program and purchases the non-feedgrain portion of feed from the contractor. The producer may purchase breeding stock from the contractor.
Contract w/Incentive Payments	The contractor provides variable inputs, breeding stock, feed, other services such as vet and medicine, technical expertise, and transportation, and manages the operation. Producer provides facilities, utilities and fuel, and labor. Producer receives payment per cwt plus feed efficiency, sow productivity, and market weight incentive payment.
Contract w/No Incentive Payments	Same as the contract with incentive payments, except no incentive payments for feed efficiency, sow productivity, and market weight.
Contract w/Neighbor	This is a contract with no incentive payments, except that the contract is with another local producer instead of a large corporation.
Vertical Integration	Used in Quebec, this is an arrangement where integrators own all operations from production to processing. In this study the producer is assumed to sell facilities and manage the unit for a predetermined salary.

Table 3. Descriptive Statistics for Distributions of Net Returns to Land, Labor, Management, and Risk

	Business Arrangement			
Measures (by operation size)	Independent Production	Cost-Plus Marketing Agreement	Contract w/Incent. Payments	Contract w/No Incent. Payments; Contract w/ Neighbor
60-Sow (initial mean[a] = $10,722)				
Std. Dev.	13,350	7,467	6,124	2,130
Skewness[b]	0.406	−0.223	0.827	−0.577
130-Sow (initial mean[a] = $33,811)				
Std. Dev.	52,327	33,315	15,671	8,841
Skewness[b]	1.184	2.028	0.467	1.291
300-Sow (initial mean[a] = $46,238)				
Std. Dev.	71,846	33,826	20,605	20,931
Skewness[b]	−0.441	1.474	−0.548	−0.562

[a] Denotes initial mean used in CP elicitation.

[b] Denotes Pearson measure of skewness.

rangements, then income was judged to be additive independent of autonomy.[2]

The respondent was then asked to rank four business arrangements from most to least preferred, assuming all shared the same net returns distribution. The process was repeated using two other distributions. If business arrangements were ranked the same under each distribution, autonomy was judged to be additive independent of income.

Assuming that additive independence holds, relationship (2) will hold:[3]

$$CP = CRP + AP, \tag{2}$$

where *CP* is the contract premium, *CRP* is the comparative risk premium, and *AP* is the autonomy premium. The CP is the amount of money the producer is willing to pay or accept to remain as an independent producer, as opposed to accepting an alternative business arrangement (ABA). The CRP is the difference between the certainty equivalent of independent production and the certainty equivalent of an ABA. The AP is the amount of money the producer is willing to pay or accept to retain his or her autonomy level.

Elicitation of Preferences for Income and Estimation of Utility of Income

The CRP may be determined through elicitation of preferences and estimation of utility of income, which assumes the expected utility hypothesis holds.[4] For this analysis, individuals' risk preferences were elicited using the Ramsey approach because it has been found to be relatively easy for producers to understand and thus yields consistent choices (Officer and Halter; Knowles). Using the Ramsey approach, there are two lotteries, both with two equally probable outcomes—the first lottery with incomes x_{1i} and x_{2i}, and the second with income x_{3i} and a non-prespecified income ω_i. In a series of n lottery iterations, ω_i are elicited that render the decision maker indifferent among the various sets of lotteries. The ranges of incomes elicited here using the Ramsey approach were \$0 to \$40,000 for 60- and 130-sow producers, and \$0 to \$80,000 for 300-sow producers.

The functional form selected for utility of income $U(I)$ is the sum of constant absolute risk aversion (SCAR) function, specified in (3):

$$U(I) = -e^{\lambda_1 I} - \beta e^{\lambda_2 I}, \tag{3}$$

where λ_1 is the upper bound on absolute risk aversion, λ_2 is the lower bound, and β is a weighting parameter. SCAR allows for constant or decreasing absolute risk aversion. Previous comparisons of functional forms reveal that SCAR results in the best fit of several alternative functional forms (Keeney and Raiffa; Knowles).[5] (See the appendix for a discussion of estimation combining the SCAR function with the error-in-response model.)

Derivation of the Autonomy Premium and Assessing the Subattributes of Autonomy

Business arrangements may be ordered according to autonomy level, but no prescribed

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[2] This is a method that may be used to test for utility independence, as discussed by Keeney and Raiffa. However, in our case, autonomy is assumed to be deterministic. Since autonomy is deterministic, utility independence is necessary and sufficient for additive independence. Thus, we use this technique to test for additive independence. (See Keeney and Raiffa for further details.)

[3] Assuming that additive independence holds, a proposition by Varian allows (2) to be mapped to (1): "Suppose preferences are complete, reflexive, transitive, continuous, and strongly monotonic. Then there exists a continuous utility function, u: $\mathfrak{R}^k_+ \rightarrow \mathfrak{R}$, which represents those preferences" (p. 112). We assume preferences for income (leading to the calculation of the CRP) and preferences for autonomy (leading to the calculation of the AP) meet these assumptions. Therefore, utility functions exist for both, and can be represented as (1).

[4] Though its axioms have been challenged (Machina), expected utility arguably remains the best available tool for analyzing risk preferences (Robison and Barry, p. 20). Elicitation and econometrics methods have been developed and refined which reduce axiom violations and bias (e.g., Spetzler and Stael von Holstein; Knowles).

[5] The SCAR function has not been compared to Saha's flexible expo-power function.

cardinal measure is associated with autonomy. Thus, utility indexing is not useful for autonomy. As a composite attribute, three subattribute categories for autonomy are those which (*a*) include moral hazard between contractor and contractee, such as the risk of contract default; (*b*) affect management style; and (*c*) affect input quality and usage. In this study, subattributes are aggregated into one attribute—autonomy.

Elicitation of the CP allows for calculation of the AP through equation (2). The CP is estimated using contingent valuation techniques. The producer is presented with two business arrangements—independent production and an ABA. Both arrangements are assumed to have equal expected net returns to labor and management.[6] The producer then examines provisions and net returns distributions of the ABA and independent production, and determines which to accept at the given expected net returns level. Provisions include specifications for input use, including labor, and pricing. By adding or subtracting constants to each element of the ABA distribution and utilizing a decision tree approach (Anderson, Dillon, and Hardaker), a distribution is discovered that makes the producer indifferent between the ABA and independent production. Thus, assuming $U[E(I_{ABA})] = U[E(I_{IP})]$, where $E(I_1)$ is the expected income indifference level for arrangement 1, the CP are determined using (4):

$$(4) \qquad CP = E(I_{ABA}) - E(I_{IP}).$$

The corresponding AP are acquired through (2). The decision tree approach is used to avoid asking the abstract question, "How much would I have to offer you to accept the alternative arrangement?" Information bias is minimized by carefully describing each arrangement. Hypothetical bias is not considered problematic since most producers are familiar with the provisions and have considered contracts.

Elicitation of preferences was conducted during winter 1992–93, a period when prices were at the lower bound of the previous 10-year period, but consistent with hog cycle expectations. Thus, we do not believe that contracts would be significantly more or less attractive to producers due to economic conditions during this period.

A follow-up mail survey was utilized to determine the importance of the subattributes of autonomy. Subattributes (listed in table 4) were identified from the literature (e.g., Zering and Beals; Kliebenstein and Hillburn), and included those which contained moral hazard, affected input usage, and affected management style. In the mail survey, statements were made about contracts. Using a scale from 1–7 (see table 4 footnote), the producer was asked to rank his or her reaction to each statement.

Results

Results of the Additive Independence Interview

Fourteen farrow-to-finish producers whose operations ranged in size from 50 to 250 sows were interviewed to determine whether independence properties held. Twelve of the 14 producers provided certainty equivalents consistent with the assumption that income was additive independent of autonomy. Equal certainty equivalents were chosen by eight producers, while four chose certainty equivalents that were within $2,000 of one another. In these "close" cases, income was judged to be weakly additive independent of autonomy.[7] Income was not additive independent of autonomy for two producers.

In determining whether autonomy was additive independent of income, eight of 11 producers chose the same rankings of business arrangements when expected income was increased from $21,917 to $75,833. Six of the 14 did not rank business arrangements the same when two distributions of equal expected

[6] Expected net returns are generally lower for contracts; however, constants are added to the net returns distributions of contracts so that expected net returns are equal for each arrangement at the onset. This is necessary for elicitation of contract premia.

[7] Final limbs of the decision tree are set at $2,000 increments. It is assumed that a subject could easily respond with an error in response of $2,000.

Table 4. Subattributes of Autonomy and Their Rankings by Producers

Statement	Producer Reaction (by avg. ranking)[a]
The contract may be broken with a three-month notice by either party.	3.18
I can receive a loan from the contractor to build new facilities.	5.00
I share management responsibilities with the contractor.	4.00
The contractor determines the type of feed to be used.	3.41
The contractor determines quality and usage of variable inputs (feed, veterinary and medical supplies).	3.12
The contractor determines when to place and remove hogs.	3.00
The contractor determines how many hogs will be in the facilities.	2.94
Some local hog buyers may close if area farmers begin contracting.	2.24
The contractor provides and maintains ownership of breeding stock.	2.88
A fieldman visits the farm weekly to monitor the operation and advise the farmer.	4.47

Note: Based on follow-up mail survey responses provided by 17 of the 20 producers comprising the study sample.
[a] The 1–7 ranking scale is defined as follows: 1 = this factor would prevent me from contracting, 2 = this factor would be a very negative aspect of contracting, 3 = this factor would be a slightly negative aspect of contracting, 4 = this factor would not affect my decision whether or not to contract, 5 = this factor would be a slightly positive aspect of contracting, 6 = this factor would be a very positive aspect of contracting, and 7 = this factor would cause me to contract.

income but different variance were compared. However, of the six, three believed they could increase the probability of attaining the upper income levels in the widely dispersed distribution, indicating they misunderstood the questioning. Consequently, these results were judged "not applicable." The three remaining producers stated if they were going to make a stable income, they would work in a factory. They selected a contract as first choice with the narrowly dispersed distribution, and IP as first choice with the widely dispersed distribution. For those producers, autonomy preference depended upon income.

While most multi-attribute utility analyses assume additive independence without testing, these results lead us to assume that additive independence will hold in the majority of cases and be a limiting assumption in a few cases, thus allowing for the elicitation of the CRP and AP separately.

Risk Preference Elicitation Results

Table 5 presents results of the SCAR with error-in-response model estimations derived from responses by six 60-sow, twelve 130-sow, and two 300-sow operators.[8] Monetary outcomes are divided by 1,000 in preparing estimates, facilitating estimation of the small parameter values for λ_1 and λ_2. Results shown in table 5 indicate that all of the surveyed producers are risk averse. An observation was made that some producers' certainty equivalents for independent production were negative using the SCAR model. In the sensitivity analysis, we examine results of the constant absolute risk aversion (CAR) function, which is estimated as SCAR but assumes that $\beta = 0$. Negative certainty equivalents for independent production were not found using CAR.

[8] This distribution of hog farm sizes is consistent with the distribution of hog farm sizes in Minnesota in the early 1990s. The relatively small producers could remain the same size and enter into cost-plus marketing agreements and contracts with neighboring producers. In order to contract with a vertical integrator, most of the small operators would require expansion. However, questions for the CP interview for contracts with vertical integrators assumed the producer could remain the same size. This allowed for determination of the attractiveness of these types of business arrangements to small producers and conclusions that could be drawn as to the attractiveness of contracts to existing producers.

Table 5. Estimates of the SCAR Function (λ_1 and λ_2 divided by 1,000)

Farm No.	λ_1	λ_2	β
60-Sow Operation			
1	0.0785	1.84E-5	327.1
	(0.0508)	(4.03E-10)	(0.0364)
4	0.0963	4.70E-6	1,889.3
	(0.0560)	(2.63E-11)	(0.0607)
6	0.1284	8.69E-6	4,706.1
	(0.0733)	(1.67E-9)	(2.4277)
9	0.2064	8.66E-6	6,620.0
	(0.0854)	(1.90E-9)	(3.3177)
13	0.3921	1.21E-5	867.6
	(0.3085)	(2.67E-11)	(0.0210)
16	0.4353	0.0270	1.981
	(0.1391)	(0.0063)	(0.7942)
130-Sow Operation			
2	0.0099	−2.34E-7	24,130.8
	(0.2814)	(7.63E-10)	(23.7832)
3	0.0394	1.26E-7	3,928.6
	(0.0232)	(2.45E-22)	(2.25E-10)
8	0.1309	7.05E-5	29.00
	(0.0595)	(1.01E-13)	(8.25E-7)
10	0.0336	1.00E-5	149.1
	(0.0277)	(4.75E-9)	(0.0780)
11	0.5271	8.73E-5	227.6
	(0.1524)	(5.05E-10)	(0.0089)
12	0.1947	1.46E-5	458.6
	(0.0577)	(1.12E-12)	(0.0004)
14	0.1870	9.24E-5	72.4
	(0.0695)	(1.12E-10)	(0.0008)
15	0.4990	8.06E-6	8,793.3
	(0.2589)	(7.24E-10)	(2.0352)
17	0.1320	1.20E-5	494.3
	(0.0540)	(2.45E-12)	(0.0009)
18	0.4395	2.21E-5	316.1
	(0.2236)	(3.70E-8)	(1.4025)
19	0.1820	3.74E-5	153.7
	(0.0538)	(1.83E-12)	(9.80E-5)
20	0.2387	1.67E-5	2,104.4
	(0.1827)	(4.58E-9)	(1.8753)
300-Sow Operation			
5	0.0231	9.97E-6	331.4
	(0.0139)	(9.59E-10)	(0.1224)
7	0.0209	1.10E-6	526.8
	(0.0061)	(1.97E-9)	(0.0524)

Note: Numbers in parentheses are standard errors.

Contract Premium Elicitation Results

The contingent valuation CP elicitation posed surprisingly little difficulty for producers. We believe the reason for this is twofold. First, producers are familiar with independent production and its associated net returns distribution, and they accepted as a reasonable representation the provided distribution; and second, most producers are familiar with provisions of many of the ABAs. The realistic nature of the choices allowed most producers to examine provisions and give careful thought to their answers. Results of the CP elicitation are summarized in table 6. We report the average CP for each ABA. A negative CP indicates that the producer prefers the ABA over independent production, whereas a positive CP signifies that the producer prefers independent production over the ABA. Since neither of the two 300-sow producers in the study chose contracts, this producer group is not shown in table 6.

As indicated by the "CP % Increase" row in table 6, the six 60-sow producers report they would require more than double their current expected income from hog production in order to accept ABAs; each alternative arrangement shows an increase of over 100%. The cost-plus marketing arrangement and the contract with a neighbor would require 139% and 120% higher net returns, respectively. However, because there were only six 60-sow operators in the study, the averages are dramatically influenced by one individual whose CPs were much higher than the others. Without this producer's results, the percentage increase for the three arrangements with the lowest CPs would drop to 70%.

The highest CP average for the twelve 130-sow producers is associated with vertical integration (table 6). Relinquishing all independence through vertical integration is unattractive to the producers since they are becoming employees of the company. The CPs for the remaining arrangements are very close, ranging from $5,417 to $6,146. These results suggest that, on average, producers would require an expected net return increase of 16–19% to enter into an alternative contractual ar-

Table 6. Contract Premia (CP) and Autonomy Premia (AP) for Alternative Business Arrangements

Measures (by operation size)	Alternative Business Arrangements				
	Contract w/ No Incent. Payments	Contract w/ Incent. Payments	Cost-Plus Marketing Agreement	Vertically Integrate	Contract w/ Neighbor
60-Sow (6 producers)					
CP Average ($)	23,106	25,606	15,000	25,250	12,917
	(21,042)	(20,056)	(19,321)	(6,910)	(10,043)
CP Median ($)	10,000	21,250	15,000	25,000	10,000
CP % Increase	215	238	139	234	120
CP No. (−) / (∞)	0 / 1	0 / 1	0 / 1	0 / 1	0 / 0
AP Average ($)	29,952	31,427	19,698	33,597	20,546
	(20,010)	(19,645)	(8,117)	(8,566)	(9,081)
AP Median ($)	21,678	25,809	18,698	35,177	16,546
AP No. (−) / (∞)	0 / 1	0 / 1	0 / 1	0 / 1	0 / 0
130-Sow (12 producers)					
CP Average ($)	6,146	6,042	5,938	15,375	5,417
	(16,898)	(16,392)	(15,131)	(13,538)	(16,067)
CP Median ($)	7,500	6,250	1,875	16,875	3,750
CP % Increase	19	18	18	46	16
CP No. (−) / (∞)	5 / 0	5 / 0	5 / 0	1 / 2	5 / 0
AP Average ($)	50,172	47,725	42,759	59,120	49,442
	(21,951)	(21,052)	(19,932)	(22,049)	(20,804)
AP Median ($)	55,678	51,444	50,510	57,065	53,037
AP No. (−) / (∞)	0 / 0	0 / 0	0 / 0	0 / 2	0 / 0
Average, All Sizes (20 producers)					
CP Average ($)	11,134	11,796	8,681	18,667	10,658

Note: Numbers in parentheses are standard errors.

rangement, or 46% to vertically integrate. Not surprisingly, most 130-sow producers report similar CPs across the board because arrangements with lower autonomy levels also have less associated income risk. This tradeoff partially explains why the cost-plus marketing agreement does not have a lower associated CP. Also, most producers agree that the requirement of the cost-plus marketing agreement to buy breeding stock and feed from the integrator and sell hogs to the integrator's specifications is only slightly more attractive than other contracts.

Over all size categories, five of the 20 producers (all of whom are 130-sow operators) provide negative CPs. These producers would accept contracts if the expected income were equal to independent production. The unwillingness of the 60-sow operators to accept ABAs is not surprising for three reasons. First, most realize they would have to expand their operation sizes in order to enter into a contract. Second, they are typically more diversified than the larger operations; thus these producers realize they would have to reduce labor in another enterprise in order to contract with a larger herd. Third, because the SMFBMA 60-sow operators' production efficiencies are not as high as those of larger producers in the association, the change to a contract would require greater managerial attention.

Table 7. Autonomy Shares for Alternative Business Arrangements

	Alternative Business Arrangements				
Autonomy Share (by operation size)	Contract w/ No Incent. Payments	Contract w/ Incent. Payments	Cost-Plus Marketing Agreement	Vertically Integrate	Contract w/ Neighbor
	(%)				
60-Sow (6 producers)					
Average	78	81	79	80	71
Highest	93	94	91	87	89
Lowest	65	73	57	76	59
130-sow (12 producers)					
Average	57	51	52	56	51
Highest	64	65	68	64	64
Lowest	38	38	39	45	36
All Sizes (20 producers)					
Average	58	60	59	64	58
Sensitivity Analysis					
Low Risk Aversion	64	62	64	68	63
High Risk Aversion	58	59	59	63	58
CAR Results	65	65	64	70	64

Autonomy Premium Analysis

The AP quantifies the attractiveness of the independent production autonomy level as compared to the ABA. For 60-sow operators, the average AP is highest for vertically integrating, at $33,597 (table 6). The contract with incentive payments is slightly lower ($31,427), followed by the contract with no incentive payments ($29,952). The lowest average APs are for the cost-plus marketing agreement and the contract with a neighbor, which are 63% and 65% the size of the average AP for the contract with incentive payments, respectively. The cost-plus marketing agreement provides managerial flexibility, while a contract with a neighbor is more acceptable since reputation in the community is an important factor which may encourage contract compliance.

The cost-plus marketing agreement also has the lowest average AP for 130-sow operators, at $42,759, while the AP for vertically integrating is highest, at $59,120 (table 6). Contracting with a neighbor is slightly more attractive to producers than the contract with no incentive payments, even though both share the same income distribution.

Across all farm sizes, no producers provide results indicating negative AP. While results of the CP elicitation show that five producers would accept an ABA, without the advantages of risk reduction, none would consider this option due to other provision arrangements.

Autonomy Share

The autonomy share indicates the relative influence of the two attributes on the producers' decisions (table 7). It is calculated as shown by equation (5):

$$(5)\quad \textit{Autonomy Share} = Abs(AP) \div [Abs(AP) + Abs(CRP)],$$

where $Abs(\cdot)$ denotes absolute value, which is used to determine the magnitude of both AP and CRP since they are opposite in sign for risk-averse individuals.

Results for 60-sow producers indicate that autonomy is the dominant attribute in the contracting decision. On average, the autonomy share is 71% to 81% across arrangements for 60-sow producers. However, for 130-sow producers, the autonomy share is lower, with averages ranging from 51% to 56%. When av-

Table 8. Business Arrangement Choice Under Utility of Income versus Choice Under Utility of Income Plus Autonomy Premium

	Chosen Arrangement		
Farm No.	Utility Income Maximization	Utility Income Maximization + Autonomy	The Same?
60-Sow Operation			
1	Cost-Plus Mktg.	Indep. Prodn.	N
4	Indep. Prodn.	Indep. Prodn.	Y
6	Indep. Prodn.	Indep. Prodn.	Y
9	Indep. Prodn.	Indep. Prodn.	Y
13	Cost-Plus Mktg.	Indep. Prodn.	N
16	Cost-Plus Mktg.	Indep. Prodn.	N
130-Sow Operation			
2	Cost-Plus Mktg.	Cost-Plus Mktg.	Y
3	Cost-Plus Mktg.	Cost-Plus Mktg.	Y
8	Cost-Plus Mktg.	Indep. Prodn.	N
10	Cost-Plus Mktg.	Cost-Plus Mktg.	Y
11	Cost-Plus Mktg.	Indep. Prodn.	N
12	Cost-Plus Mktg.	Cost-Plus Mktg.	Y
14	Cost-Plus Mktg.	Indep. Prodn.	N
15	Cost-Plus Mktg.	Cost-Plus Mktg.	Y
17	Cost-Plus Mktg.	Indep. Prodn.	N
18	Cost-Plus Mktg.	Indep. Prodn.	N
19	Cost-Plus Mktg.	Indep. Prodn.	N
20	Cost-Plus Mktg.	Indep. Prodn.	N
300-Sow Operation			
5	Contract w/Incent.	Indep. Prodn.	N
7	Contract w/Incent.	Indep. Prodn.	N

eraging across all farm sizes, the autonomy share ranges from 58% to 64%.

Contract Choice with Utility of Income versus Utility of Income Plus Autonomy

Maximization of utility of money income is the rule typically used to assess the effect of income risk on producers' decisions among risky alternatives. How does inclusion of autonomy affect results regarding contract choice? Table 8 presents a listing of the producers' business arrangement choice that maximizes utility of money income and the choice that maximizes utility of money income and autonomy. Results indicate that business arrangement selection differs greatly between the two decision rules. With maximization of utility of income, 17 of the 20 producers chose an ABA. However, with autonomy included, only five of the 20 accepted an ABA. Of the 12 producers whose arrangement selection changed when autonomy was considered, all switched from independent production to either the cost-plus marketing agreement or the contract with incentive payments. Their APs were positive and large enough to offset risk-reduction advantages of ABAs. Inclusion of autonomy altered arrangement selection for 12 of the 20 producers.

Sensitivity of Results

A sensitivity analysis on risk preference is conducted by (*a*) varying the estimated parameters (λ_1 and λ_2) by their standard errors, and (*b*) estimating utility functions using the CAR form. As shown at the bottom of table 7, results of the high risk-aversion scenario (λ_1 and λ_2 plus their standard errors) indicate the average autonomy share ranges from 58% to 63%, while results of the low risk-aversion scenario reflect a range from 62% to 68%. These findings show that autonomy dominates income risk under both scenarios. Using the CAR function, autonomy share ranges from 64% to 70%. Only positive certainty equivalents result when using the CAR function and the low risk-aversion scenario.

Subattributes of Autonomy

Which subattributes of autonomy were most important to the surveyed producers? Follow-up mail survey forms were returned by 17 of the 20 producers whose preferences were elicited. (Results of the survey are shown in table 4.) Of those who responded, five were 60-sow, 10 were 130-sow, and two were 300-sow producers. The subattribute statement receiving the highest average ranking by producers was "I can receive a loan from the contractor to build new facilities." This statement was ranked at 5 on the 1–7 scale, denoting that producers considered this to be a slightly positive factor of contracting. Producers' contracting decisions were not influenced by two subattribute statements, both of which offered management expertise: "I share management responsibilities with the contractor," and "a fieldman visits the farm weekly to monitor the operation and advise the farmer."

Subattributes containing moral hazard and affecting input usage were perceived as slightly negative aspects of contracting. These included: "the contract may be broken with a three-month notice by either party," "the contractor determines the type of feed to be used," "the contractor determines quality and usage of variable inputs," "the contractor determines when to place and remove hogs," "the contractor determines how many hogs will be in the facilities," and "the contractor provides and maintains ownership of breeding stock." The subattribute ranked by producers as a very negative aspect of contracting was "some local hog buyers may close if area farmers begin contracting." This perhaps reflects a fear of contracting becoming the dominant business arrangement and the discontinuance of independent production.

Conclusions and Implications

Although economists have long recognized the importance of risk in producers' selections of business arrangements, little information has been uncovered about the importance of risk versus other attributes that enter into the decision. An important finding in this study is that, while risk is an important factor in a producer's contracting decision, autonomy is a very significant attribute and thus is an important consideration when predicting the success of a business arrangement. If income were the only attribute used to model the producers' contracting decisions, our results suggest that attractiveness of ABAs would be overestimated and the price required to attract independent producers would be underestimated. The producers surveyed in this study indicate that autonomy preference dominates risk preference in their selections of ABAs.

These results are preliminary in nature due to the small number of producers comprising the study sample. Nevertheless, our findings do indicate a lack of interest in contracting by some Upper Midwestern independent producers. At first, this appears to conflict with the trend toward contracting in the hog industry. However, it is expected that new entrants' preferences may differ significantly from those of the independent producers we surveyed. One would expect contracts to be more attractive to new entrants due to such factors as higher risk aversion (since they often have lower associated net worth) and lower autonomy premia (since they are not accustomed to a particular mode of production). Also, because new entrants are likely to build larger scale facilities to capture the economies of size, contracts sometimes offer an increased ability to obtain capital to begin production as well as risk reduction for larger scale, often nondiversified operations. It is likely that most of the expansion of contracts has been with new entrants while independent producers have continued to go out of business. This is consistent with research by Gillespie and Fulton who report new entrants in states without anti-corporate farming laws and more contracts, and a decrease of small, likely independent producers. It is important to note that these results are unlikely to hold for independent producers in regions other than the Upper Midwest, where contracting in other enterprises has been common and/or hog markets have become thin.

There are several possibilities for future research in this area. A challenge that is faced in developing net returns distributions for ABAs is that some ABAs require producers to adopt new technology. The implication is that, even though the arrangements typically split returns between the contractor and the producer, an increase in total profits may result. Further research might investigate the typical path taken by existing independent producers who accept contracts. Do they expand significantly and adopt new technology? And if so, how are their profits and variability of profits affected?

Other research that could build upon this model might conduct a similar analysis with a larger sample of producers. Personal farmer interviews usually lead to small sample sizes due to the cost of interviewing. Further study might be conducted via mail not only to increase the sample size, but also to analyze regional differences in attitudes. Though Gunjal and Legault found no differences in risk preference between integrated and non-integrated hog producers in Quebec, an investigation of differences in autonomy preference between these two groups would be of interest. Using a mail survey, risk attitude might be investigated using the interval approach (Wilson and Eidman). Quantification of the effects of the subattributes of autonomy on the size of the autonomy premium could be analyzed. Given the rapid evolution of the industry, results could provide policy makers, contractors, and academics a greater insight into how traditional family hog operations likely will be affected under the new industry structure.

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Appendix: Estimating Comparative Risk Premia

Using the Ramsey approach, income ω_i is elicited which makes the decision maker indifferent between the two lotteries, and (A1) holds:

$$\text{(A1)}\quad U(x_{1i}) + U(x_{2i}) = U(x_{3i}) + U(\omega_i).$$

To prevent problems associated with chained responses with Ramsey responses, the error-in-response model (Knowles) is used, utilizing an inverse utility function (A2) which follows from (A1):

$$\text{(A2)}\quad x_{4k} = U^{-1}[U(x_{1k}) + U(x_{2k}) + U(x_{3k})] + r_k,$$

where r_k represents the error in response.

Using ordinary least squares, b minimizes the sum of squared residuals, as specified in (A3):

$$\text{(A3)}\quad \text{Min} \sum_k [x_{4k} - U^{-1}(U(x_{1k}; b) + U(x_{2k}; b) - U(x_{3k}; b); b)]^2.$$

Estimating the parameters of (A3) treats the response as the dependent variable and associates the error with the response. Because SCAR is not invertible, an iterative Gauss-Newton procedure employing SAS/ETS is used to obtain parameter estimates.

With resulting utility functions, Arrow-Pratt coefficients of absolute risk aversion $R(I)$ are estimated at the producers' expected income levels using (A4):

$$\text{(A4)}\quad R(I) = -U''(I)/U'(I).$$

The certainty equivalent for each arrangement is estimated using (A5):

$$\text{(A5)}\quad U(CE_i) = \sum_{m=1}^{n} U(x_m)/n,$$

where i is the business arrangement and x_m denotes the n income levels in the distribution (Keeney and Raiffa, p. 145). Comparative risk premia are then calculated as (A6):

$$\text{(A6)}\quad CRP = CE_{ABA} - CE_{IP},$$

where CE_{ABA} and CE_{IP} are certainty equivalents of the ABA and independent production, respectively.