HOW MUCH DO FARMERS VALUE THEIR INDEPENDENCE?

ESTIMATING THE RISK AND AUTONOMY PREMIA ASSOCIATED WITH PRODUCTION CONTRACTS

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Abstract. A farmer's decision to contract or produce independently depends on the distribution of income under both arrangements, and on attributes associated with both business arrangements. Risk-averse farmers should be willing to pay a risk premium for the reduction in price risk provided by a contract. Farmers with a preference for "autonomy" should be willing to pay a premium for certain attributes associated with independent production, such as the right to make management decisions and own the commodity they produce. The benefits to growers from contracting (such as risk reduction) may be over-estimated if the non-pecuniary benefits enjoyed by independent producers are not accounted for. This study uses national survey data to estimate the risk premium, the change in expected income, and the autonomy premium associated with hog production contracts.

Key words: agricultural contracts, autonomy, nonpecuniary benefits, risk

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1. Introduction

Several studies have demonstrated that contracts reduce the income risk of livestock growers, implying that risk-averse growers should be willing to pay a premium for these contracts (e.g., Kliebenstein and Lawrence; Johnson and Foster; Martin). Parcell and Langemeier use this logic to determine the minimum level of contract payments required for contract growing to be preferred to independent production for growers with different levels of risk aversion. Among other results, Johnson and Foster determine the breakeven levels of risk aversion at which point farmers switch their order of preferences for different types of contracts and independent production.

In addition to the distribution of income under both arrangements, a farmer's decision to contract versus produce and market goods independently will depend on attributes associated with both arrangements. Farmers with a preference for "autonomy" will need to be compensated by contractors for giving up nonpecuniary benefits associated with independent production. Nonpecuniary benefits associated with independent production may include the sense of responsibility associated with making management decisions, the sense of independence that comes from being self-supervised, or pride related ownership of the product. These benefits are greater under independent production because contracts usually require growers to surrender some control over the production process, and submit to various rules regarding management decisions. In addition, contracts often designate legal ownership of the crop or livestock to the contractor. Other non-pecuniary net benefits from independent production may result from negative attributes associated with contracting – for example, contracting may cause growers to feel vulnerable to changes in contract terms, or other forms of manipulation by contractors.

These types of grower concerns are demonstrated by recent legislative efforts to regulate agricultural contracts such as the Producer Protection Act (Boehlje, et al).

If growers prefer autonomy then the minimum level of payments required for growers to accept a contract will be greater, all else equal. Consequently, studies that incorrectly assume that growers are indifferent between the attributes of independent or contract production, will under-estimate the contract payment necessary for growers to accept a contract, or will underestimate the level of risk aversion required for a grower to accept a contract. Similarly, studies that infer attitudes toward risk based on the premium that contractees are willing to pay to enter a contract will under-estimate grower risk aversion – attributing a relatively small (or even negative) risk premium to a grower's lack of risk aversion rather than to a grower's preference for autonomy.

The goal of this study is to estimate the nonpecuniary benefits of independent farming, paying particular attention to the importance of risk reduction in farmers' decision to contract or remain independent. Researchers have long been interested in measuring the value that workers place on nonpecuniary aspects of their work. Examples of this research include measuring the value lawyers place on "public-interest" versus private-sector work (Goddeeris, 1988); the willingness to pay for job safety (e.g., Viscusi and Hersh, 2001); the nonpecuniary benefits of self-employment (e.g., Hamilton, 2000); and non-pecuniary rewards associated with leadership (Cavalluzzo, 1991). Understanding growers' incentives to contract is particularly important in analyses of the structural changes taking place in the hog sector as the adoption of new business arrangements has important consequences for efficiency and grower welfare.

Rather than using a contingent valuation survey to estimate the value farmers place on their autonomy (e.g., Gillespie and Eidman), this paper takes a new approach that uses detailed information on returns to contract and independent feeder-to-finish hog production. First, we use information from a national survey of feeder-to-finish hog producers and ten years of monthly price data to estimate the mean and coefficient of variation of net returns from independent hog production. Second, using the same national survey we use a treatment effects model to estimate how much of the difference in per unit income between contract and independent operations can be attributed to contracting. For a given level of risk aversion, we use the estimated variation in contract and non-contract income to compute the risk premium – the amount a representative grower would pay for the risk reducing benefits of the contract. Finally, we estimate the autonomy premium – the nonpecuniary benefits of independent production – as the sum of the expected difference in contract and non-contract income and the risk premium. The next section provides a theoretical basis for the empirical approach used in sections 3 and 4.

2. Theory

If farmers prefer the attributes of independent production to those of contract production and each business arrangement earns the same certain fixed income Y_0 , then growers will always experience greater utility under independent production U^I compared to under contract U^C:

(1) $$U^I(Y_0) > U^C(Y_0).$$

In hog producing regions there are often few contractors, which may allow contractors to exercise monopsony power. When this is the case, contractors need only pay contractees their reservation wage, so that contractees are indifferent between contract and independent production:

(2) $$EU^{I}\left(Y^{I}\right)=EU^{C}\left(Y^{C}\right),$$

where Y^{I} and Y^{C} are the uncertain net returns from independent and contract production. For (1) and (2) to hold, the "benefit" from contracting resulting from the change in average income and lower risk must exactly compensate for the lower utility resulting from the loss of autonomy. Hence, the "autonomy premium" α can be defined as this benefit – the amount the independent farmer would be willing to pay for the income distribution available under contract:

$$EU^{I}\left(Y^{I}\right)=EU^{I}\left(Y^{C}-\alpha\right)$$

Following Newbery and Stiglitz (pp 92-93), the benefit α to a scheme that changes the mean and variance of income can be approximated as the change in expected income plus a risk premium ρ:

(3) $$\alpha \cong \left(\bar{Y}^{C}-\bar{Y}^{I}\right)+\rho \quad \text{where, } \rho=\frac{1}{2}R\left[\left(CV^{I}\right)^{2}-\left(CV^{C}\right)^{2}\right]*\bar{Y}^{I}$$

The risk premium is a function of the coefficient of relative risk aversion R, and the reduction in the coefficient of variation of income due to contracting.[1] The autonomy premium is positive if the farmer prefers autonomy. If the risk premium is zero (the farmer is risk neutral) then the autonomy premium is just the gain in expected income from contracting. If contracting

[1] By definition, $R=-\bar{Y}U''\left(\bar{Y}\right)/U'\left(\bar{Y}\right)$.

and independent production have the same expected income, then the autonomy premium equals the risk premium. Note that (3) places no a priori restrictions on the sign or relative magnitude of the autonomy premium – α can be positive or negative and bigger or smaller than the risk premium.

Finally, the "contract premium" Δ_t can be defined as the additional income in period t that can be earned by contracting rather than producing independently:

$$Y_t^C = Y_t^I + \Delta_t$$

The expected contract premium $E\Delta$ is therefore the expected income from contracting less the expected income from independent farming.

Figure 1 illustrates the risk and autonomy premia, in the simple case where income from independent production can be low Y_L^I or high Y_H^I, and income from contracting Y^C does not vary ($Y^C = EY^C$). In the figure, $U^I(Y)$ is the utility from income given that the farmer is independent. The utility function is concave due to the risk aversion of the farmer. As shown in the figure, contracting provides a lower level of utility $U^C(Y)$ at any level of income, for the reasons discussed above.

If the contract income does not vary, the risk premium ρ is the difference between the expected income under independent production EY^I and the certainty equivalent income Y_{CE}^I.[2] If the farmer contracts, his risk is lowered, he loses autonomy, and he receives a different

[2] This is the definition of the risk premium. It can be shown (e.g. Newberry and Stiglitz, p 69-73) that for the situation described in the graphical analysis, $\rho = \frac{1}{2} R\left[\left(CV^I\right)^2\right] * \bar{Y}^I$, which is consistent with (3).

expected income. Because the farmer is paid his reservation wage, the benefit that contracting provides in terms of the reduction in risk and the change in expected income must just compensate for the loss of autonomy. Hence, the autonomy premium α is the risk premium plus the difference in expected income (positive or negative) between contracting and independent production. In the figure, the risk premium is larger than the autonomy premium, but this is not necessarily the case.

For the income distribution illustrated in figure 1, in low price years the contracting premium is positive, while in high price years the premium is negative. Our survey was conducted in 1998, a year with unusually low prices for finished hogs. As a result, it would not be surprising if the contract premium was positive in 1998, even if contracting has a lower expected income than independent production.

3. Data and Methods

It is possible to compute the risk and autonomy premia as functions of the relative risk aversion coefficient using (3), given estimates of the mean and coefficient of variation of income for both independent and contract operations. We obtain these estimates in two steps. First, we estimate the mean and coefficient of variation of income for a representative independent hog producer using historical product and input price data. Second, we estimate the contract premium in the survey year using a treatment effects model. Conditional on the assumption that contract and independent incomes covary (as explained below), it is possible to estimate the mean and coefficient of variation of contract income.

Data are from two sources: operator and farm level data are from the 1998 USDA ARMS of the hog sector, and county-level characteristics are from the 1997 US Agricultural Census.

Table 1 reports the results of tests of equal means between contract and independent operations for the variables used in this section.[3] Table 1 lists the mean values of the variables used in this section. As shown in the table, both contract and independent operators earned negative per unit net returns on average in 1998.[4] However, contract operators earned significantly more – earning on average $19.21 more per hundredweight of hog produced.

The table highlights several clear differences between the two groups. On average, contractees are younger and have much less experience in the hog business. Contractees do not have significantly more total assets employed in farming, yet they produce over three times as much pork. Contract and independent producers are also located in different geographical regions and contract operations are much larger than independent producers.

3.1 Independent Production

The mean and coefficient of variation of independent hog income is estimated using measures of the value of production and costs derived from the 1998 USDA Agricultural Resource Management Study (ARMS) of the hog sector, and ten years of monthly hog and feed prices from the National Agricultural Statistics Service. Because of the broad differences in production techniques among various types of hog operations, we limit the ARMS data to feeder pig-to-finish hog operations.[5] This group of producers accounted for about a third of total finished hog farms and production in 1998.

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[3] In computing the difference of means, parameters, and significance tests in all the regressions in the paper, the survey data were weighted to account for sample design.

[4] Net return per unit is defined as revenue from hog production less the costs of all inputs to hog production except unpaid labor that were incurred by the operator per hundredweight of hog produced. For independent operators, revenue equals the gross value of hog production. For contract operators revenue equals contract fees for hogs produced under contract plus the gross value of production for hogs produced without a contract.

[5] Feeder pig-to finish operations are defined as those on which feeder pigs (30-80 pounds) are purchased/placed, finished and later sold/removed for slaughter at a weight of approximately 200-260 pounds.

The average independent operation produced 2678 hundredweight of hogs, valued at $116,123 in 1998. Due mostly to low hog prices, total costs in 1998 were actually higher than the value of production resulting in net losses of $28,793 for the average producer. Total feed costs in 1998 averaged $56,923 – the largest input in the production of hogs, accounting for 39.3% of total costs for an average producer. Corn comprised approximately 75.4% of the feed costs, soybean the remaining 24.6%.[6] Using the survey year (1998) as the base year, income from independent hog production in year *t* can be approximated as:

$$Y_t^{Indep} = VOP_{98}\left(\frac{p_t^q}{p_{98}^q}\right) - \left(\frac{\phi p_t^c + (1-\phi)p_t^s}{\phi p_{98}^c + (1-\phi)p_{98}^s}\right)FC_{98} - (TC_{98} - FC_{98})$$

where

VOP_{98} = average value of hog production in survey year (1998).

$\frac{p_t^q}{p_{98}^q}$ = ratio of deflated finished hog price in year *t* to price in survey year.

$\frac{\phi p_t^c + (1-\phi)p_t^s}{\phi p_{98}^c + (1-\phi)p_{98}^s}$ = ratio of feed costs in year *t* to costs in survey year, where p_t^c and p_t^s are the deflated price of corn and soybean in year *t*, and ϕ is the share of feed costs comprised of corn.

FC_{98} = feed costs in survey year.

TC_{98} = total costs in survey year (includes the costs of all inputs except unpaid labor).

[6] Estimates of corn and soybean shares were derived from the average cost shares of grain and protein, respectively, in total feed costs in the 1998 USDA ARMS.

The estimated monthly value of production, total costs, and net income from 1988 to 1998 are illustrated in figure 2. Ten years (1988-97) of monthly net hog income estimates are used to compute an expected independent hog farm income (return to unpaid labor) of $30,561 having a coefficient of variation of 0.911.

3.2 Contract Production

To estimate the expected contract income Y^C in 1998 we estimate how much more income an independent operation would have earned had it contracted – that is, the contracting premium Δ_{98}:

(4) $$Y_{98}^C = Y_{98}^I + \Delta_{98}$$

In the survey year of 1998, prices were well below their historical mean. Consequently, we would expect the contract premium in 1998 to be larger than average. For convenience, we define δ_t as the *per unit* contract premium, so $\Delta_t = \delta_t q$, where q is total output.

To measure the per unit contract premium, while controlling for differences in operator, operation, regional, and scale characteristics, we could use a linear regression:

(5) $$y_i = X_i\beta + C_i\delta + \varepsilon_i$$

where y_i is the per unit net return to hog production for operation i, X_i is a vector of exogenous characteristics, C_i is a dummy variable indicating whether or not the operation contracts.

However, it is possible that unobservable variables are correlated with both the farmer's decision to contract and farm income. For example, farmer ability which is unobservable could be positively correlated with the decision to contract. This correlation could lead to an under-estimation of the impact of contracting on income, if it were not accounted for (Greene, 714). In the "treatment effects" sample selection model, the net benefits to contracting compared to independent production are given by the latent variable C_i^*:

(6) $$C_i^* = Z_i\gamma + u_i$$

$$C_i = 1 \text{ if } C_i^* > 0 \text{, 0 otherwise,}$$

where Z_i is a vector of farm and regional characteristics. If the latent variable is positive then the dummy variable indicating contracting C_i equals one, and equals zero otherwise.

If the decision to contract is determined by unobservable variables (management ability, regional characteristics, etc.) that also affect performance, the error terms in (5) and (6) will be correlated, leading to biased estimates of δ (and β). We can account for this selection bias by assuming a joint normal error distribution with the following form:

$$\begin{bmatrix} u \\ \varepsilon \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & \sigma^2 \end{bmatrix}\right)$$

and by recognizing that the expected performance of contractees is given by:

$$E\left[y_i \middle| C_i = 1\right] = X_i\beta + \delta + \rho\sigma\lambda_i$$

where λ_i is the inverse Mills ratio. To derive a consistent estimates of δ and β we can use a two-stage approach starting with a probit estimation of (6). In the second stage, estimates of γ are used to compute the inverse Mills ratio, which is included as an additional term in an OLS estimation of (5).

The result of the first-stage binomial logit estimation of (6) are presented in table 2. Estimation results indicate that for an average operation, an increase in years of experience in the hog business lowers the probability that the farmer will contract. County-level measures of income and hog farm concentration are included as measures of the availability, and consequently the net benefits of contracting to growers. Contractors choose to locate and expand production in regions where they can operate most profitably -- where the opportunity costs to hog farming are low, or where there is a high density of hog producers, which lowers transaction costs. While most hog farmers may have some opportunity to contract, the net benefits of contracting will be higher where the availability of contracting is greater. As expected, being located in county with more hog production increases the likelihood of contracting, and being in a county with a higher average net return to farming lowers the probability that a farmer contracts. The probability of contracting increases at a decreasing rate with the scale of production.

The results of the second-stage selection model (5) are presented in table 3. The variables associated with an increase in net returns include year in the hog business, being located in a Western state, and a larger scale of production. The results also show that after correcting for observable operator, operation, and regional factors, and for unobservables correlated with the decision to contract and net returns, contracting raised net returns by $17.91 per hundredweight of hog produced in 1998. The inverse Mills ratio is not significantly different from zero, indicating that we cannot reject the hypothesis of no correlation between the errors of the selection and treatment equations.

With the estimate of the contract premium in 1998 ($\hat{\Delta}_{98} = \hat{\delta}_{98} q$), we can use (4) to estimate Y_{98}^{C} -- what net returns would have been for a representative independent producer in 1998 if they had contracted. Next, we make two assumptions about the distribution of contract income in order to compute the mean and coefficient of variation of contract income. The first assumption is that contract and independent hog income covary:

(7) $$\frac{Y_t^I - \bar{Y}^I}{\sigma_I} = \frac{Y_t^C - \bar{Y}^C}{\sigma_C}$$

The second assumption is that the variation in contract income is a fixed proportion $(0 \le \theta \le 1)$ of the variation in independent income:

(8) $$\theta = \sigma_C / \sigma_I .$$

In other words, contract income moves synchronously with independent income, but has less variation. Plugging (8) into (7) and solving for the expected contract income gives:

$$\bar{Y}^C = Y_{98}^C + \theta\left(\bar{Y}^I - Y_{98}^I\right).$$

From (8) it follows that the coefficient of variation of contract income can be computed:

$$CV_C = \frac{\theta \overline{Y}^I}{\overline{Y}^C} CV_I \, .$$

4. Results

Table 4 presents a summary of the estimated means and coefficients of variation of net returns for independent and contract producers used to compute the risk and autonomy premia. Three values for the contract risk factor θ are used: a low value (θ = 0) which implies that contracts provide perfect insurance; a "best guess" value (θ = 0.1); and a high value (θ = 0.2) which implies that contracts pass through a significant portion of income risk to growers. These values are consistent with values reported in previous studies. For example, Johnson and Foster (p. 399) report standard deviations that are equivalent to values of θ between 0.06 and 0.15 for four different types of hog contracts they consider. Similarly, Martin (p. 272) reports an average value of θ equal to 0.095 for 25 hog producers.

As shown in table 4, estimates of the expected contract premium (the expected contract net returns less the expected net returns to independent production) are sensitive to assumptions about contract risk, θ. The estimated expected contract premium is negative if θ=0.0 or θ=0.1, equal to $-11,387 (-$4.25/cwt) and $-5452 ($-2.03/cwt), respectively. However, if contracts are quite risky (θ=0.2) then the large contract premium in 1998 estimated using the selection model implies that contract growers earn $484 ($0.18/cwt) more on average than under independent production.

Tables 5 and 6 present the estimated risk premium and autonomy premium as a function of the coefficient of relative risk aversion R and the contract risk factor θ. Table 5 presents the premia levels and as a percent of the average net returns for an independent hog operation. Table 6 presents the per-unit premia levels and as a percent of the historical price. The range of the coefficient of relative risk aversion ($0 \leq R \leq 2$) in tables 5 and 6 correspond to values estimated in the literature. For example, Szpiro using insurance data estimated that R is between 1.2 and 1.8; Hansen and Singleton used aggregate data to estimate a value between 0.35 and 1.0; and Newberry and Stiglitz (pp 101-108) synthesize evidence from several empirical studies to conclude that R is in a range from 1-2.

The high coefficient of variation of income for independent hog producers (0.911) means that if these producers are risk-averse, they would be willing to pay a sizeable risk premium to reduce their coefficient of variation to the level of contract producers (0.111 for θ=0.1). As shown in table 5 for θ=0.1, growers with moderate aversion to risk (R=1) would be willing to pay about $12488 or 40.9% of their expected total net returns for the risk-reduction benefits associated with the contract income. As shown in table 6, this risk premium is equivalent to a price premium of $4.66/cwt., which is 8.7% of the historical price.

Since a moderately risk averse grower is willing to pay $4.66/cwt to reduce risk but instead pays an estimated expected per-unit contract premium of only $2.03/cwt (from table 4), the difference ($2.63/cwt.) is the autonomy premium. In other words, a representative grower is willing to pay $2.63/cwt. (which is equivalent to 4.9% of the price) for the attributes associated with independent production. As shown in table 5, this autonomy premium has a total value of $7036 for a representative farm, which is equivalent to 23% of net returns.

Estimates of the risk and autonomy premia are sensitive to assumptions about growers' attitudes towards risk. Additionally, the autonomy premium is sensitive to assumptions about the contract risk θ. If we assume that growers are risk neutral (R=0) and therefore place no value on risk reduction, the estimated negative contract premium implies that growers are willing to *pay* for the right contract, by the amount of the contract premium ($2.03/cwt). In other words, a negative contract premium and risk-neutrality imply a negative autonomy premium. In contrast, if growers are quite risk averse (R=2), then the risk and autonomy premium are quite large – equal to 81.7% and 63.9%, respectively, of net returns (for θ=0.1).

There are two methodological issues worth exploring in future work. First, there may be ways for growers to manage price risk – such as futures markets – that would reduce the insurance value of production contracts for independent growers. If this were the case, the methods used here would over-estimate the risk of independent production, thereby over-estimating the risk premium and autonomy premium. Second, this study uses a representative farmer approach to derive estimates of the risk and autonomy premia. This approach cannot account for the likelihood that contractees are more risk-averse and have weaker preferences for autonomy than independent growers. However, it is ambiguous, how this would bias the estimation results.

Conclusion

This paper uses detailed information on net returns to contract and independent feeder-to-finish hog production to estimate the value farmers place on their autonomy. Estimates of the net returns to independent hog production using historical prices show that the risk-reducing properties of contracts are quite valuable to risk-averse growers. For example, under the assumption that growers are moderately risk-averse, growers would be willing to pay about a price premium of about 8.7% to eliminate their income risk. In addition, after controlling for operator, operation, and regional characteristics, and for possible sample selection bias – a representative hog farmer is estimated earn less under contract compared to independent production – equivalent to a 3.8% price reduction. The implication is that growers place significant value on the attributes associated with independent production - being willing to pay an estimated autonomy premium equivalent to about 4.9% of the historical price. In other words, the autonomy premium for a moderately risk averse growers is worth a little over half the value of the risk premium.

Estimated values for the risk and autonomy premia are sensitive to assumptions about growers' attitudes toward risk, and the risk reducing capacity of contracts. However, over a wide range of reasonable assumptions, the autonomy premium is positive, large enough to be economically important, and of the same order of magnitude as the risk premium. This result demonstrates that analyses that compare the desirability of contracts based only on how they affect grower income distribution without considering the attributes of the production process that also affect grower welfare ignore important influences on farmer decision making. More specifically, the results demonstrate that not accounting for the value of autonomy would lead to an under-estimation of the fee necessary to attract farmers to a contract. Similarly, ignoring the value of autonomy in calculating a risk premium would result in an under-estimation of the value farmer's place on risk reduction, or equivalently, an under-estimation of growers' risk aversion.

The study suggests several areas for future research. As mentioned above, there are many attributes associated with independent production. However, the approach developed here cannot determine the value of these attributes. For example, we do not know how much value growers place on the right to make management decisions versus not having to worry about having a contractor renege on contract obligations. Estimating the value of the components of the autonomy premium would add to our understanding of grower incentives (Gillespie and Eidman). Second, as mentioned in the last section, the study made several simplifying assumptions that may have biased estimates of the risk and autonomy premia. Future work could attempt to account for the ability of growers to manage risk and to account for the likelihood that contractees are more risk-averse and have weaker preferences for autonomy than independent growers.

As shown in this paper, input and product prices make hog production a risky undertaking. Contracts have the potential to greatly reduce income risk for growers. Economists and policy makers have long recognized the importance of risk in farmers' choice of business arrangement, and many agricultural policies have focussed on developing infrastructure and marketing information to reduce risk. On the other hand, few studies have taken into account factors besides risk and expected income in analyzing farmers' decisions to contract. Strong preferences for autonomy offer a potential explanation for why contracting is not more widely used and may explain why some farmers have lobbied for legislation to outlaw contract arrangements (Hamilton and Andrews).

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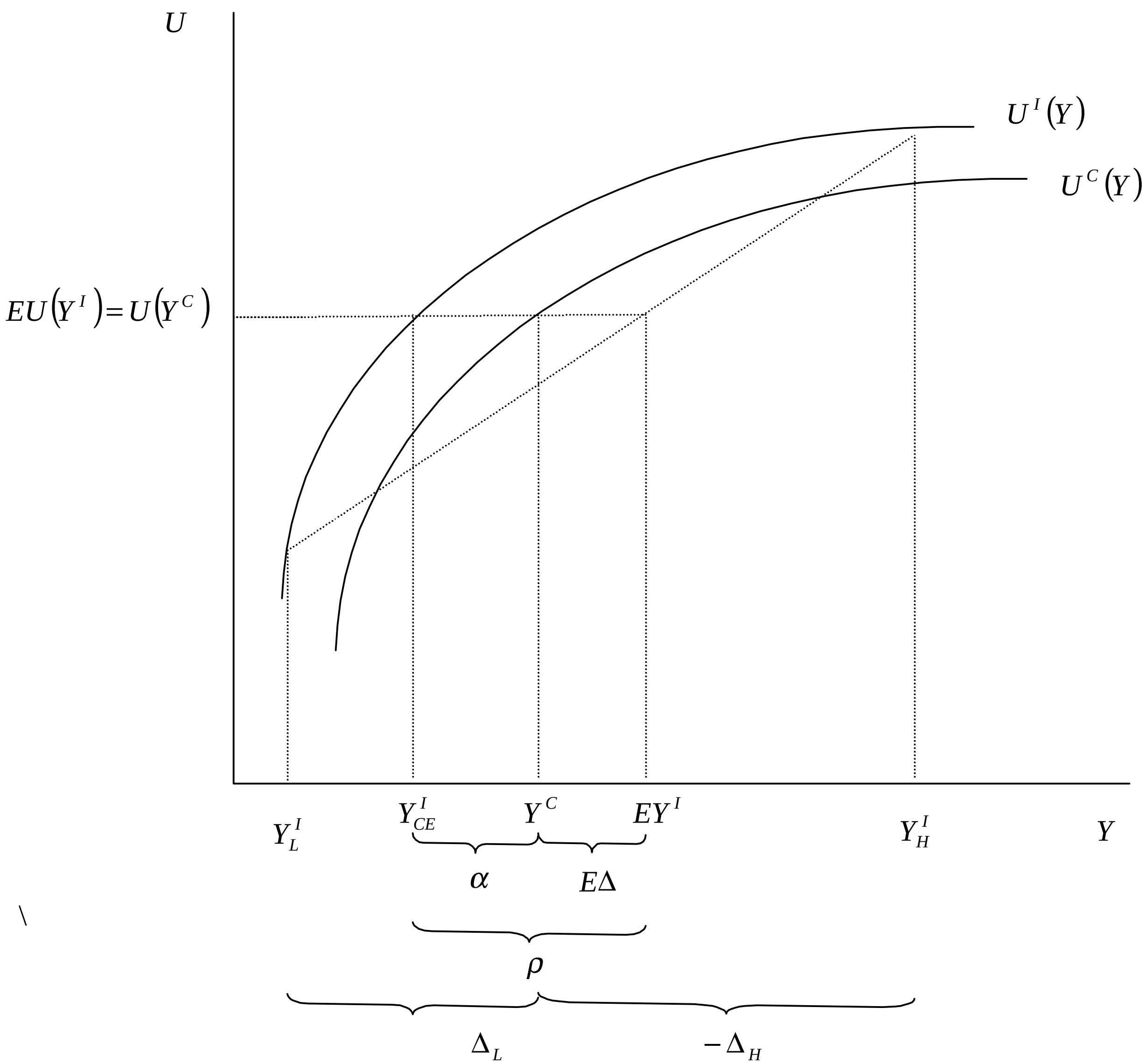
Figure 1. Risk, Autonomy and Contract Premia



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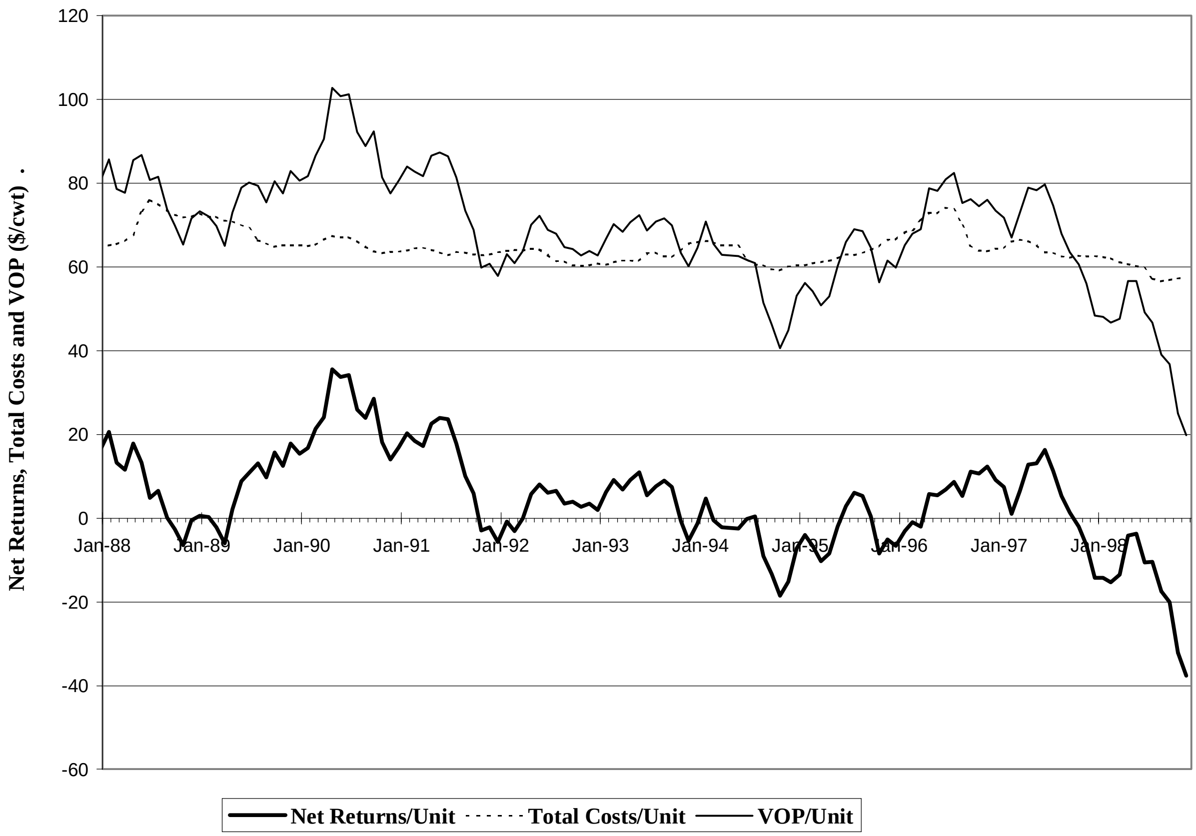
Y_L^I, Y_H^I = Income from independent production in a low and high income period, respectively
Y_{CE}^I = Certainty equivalent income from independent production
EY^I = Expected income from independent production
Y^C = Income from contract production ($= EY^C$ in figure because contract income is constant)
ρ = Risk premium
α = Autonomy premium
Δ_L, Δ_H = Contract premium in low and high income periods ($Y^C - Y_L{}^I$, $Y^C - Y_H{}^I$)
$E\Delta$ = Expected contract premium ($EY^C - EY^I = Y^C - EY^I$)

Figure 2. Value of Production, Total Costs, and Net Returns Per Unit for a Representative Independent Hog Producer from 1988 to 1998



Source: Value of production, total costs and net returns in 1998 from USDA ARMS. Estimates for other years computed using USDA NASS monthly price data (see text for details). All Values are in 1998 Dollars.

Table 1. Test of Equality of Means for Independent and Contracting Operations

Variables	Mean Independent Operators	Mean Contract Operators	t-stat	Prob $>\|t\|$
Operator and Operation Characteristics				
Age (years)	50.6	47.0	3.78	0.000
Education (years)	13.0	12.9	0.06	0.953
Years in hog business	24.1	14.8	9.03	0.000
Total farm assets ($100,000)	7.62	8.70	-1.25	0.211
Regional Characteristics				
Northern state (MI, MN, SD, WI)*	0.194	0.232	-1.02	0.306
Southern or Eastern state (AL, AR, GA, KY, MO, NC, SC, TN, VA)*	0.100	0.236	-4.03	0.000
Western state (CO, KS, NE, OK, UT)*	0.159	0.067	3.20	0.001
Central Midwestern state (IA, IL, IN,OH)*	0.548	0.463	3.17	0.064
County aver. net cash return per farm ($1000)	34.86	46.54	-4.64	0.000
County aver. swine sales per farm ($1000)	23.63	70.73	-6.80	0.000
Output and Income				
Hog production (cwt.) [1]	2678	10672	-9.67	0.000
Scale Class 1 (cwt. < 750)	0.374	0.061	10.39	0.000
Scale Class 2 (750 ≤ cwt. < 2250)	0.309	0.204	2.64	0.009
Scale Class 3 (2250 ≤ cwt. < 6000)	0.229	0.235	-0.15	0.881
Scale Class 4 (6000 ≤ cwt.)	0.089	0.501	-11.80	0.000
Net return per unit ($/cwt.)[2]	-24.33	-5.12	-9.89	0.000
Number of Observations	233	244		

Note: All data are from the 1998 USDA-ERS ARMS except county-level variables, which are from the 1997 US Agricultural Census. Means are weighted to account for survey design. Prob$>|t|$ is the two-tailed significance probability under the null hypothesis of equal means.

* Dummy variable equal to 1 if statement is true or located in region, 0 otherwise.

(1) Hog production is measured as hundredweight of hogs sold or removed under contract less hundredweight of hogs purchased or placed under contract, plus hundredweight of inventory change.

(2) Net return per unit is defined as revenue from hog production less the costs of all inputs to hog production except unpaid labor that were incurred by the operator per hundredweight of hog produced. For independent producers, revenue equals the gross value of hog production. For contract producers revenue equals contract fees for hogs produced under contract plus the gross value of production for hogs produced without a contract.

Table 2. Logit Model Maximum Likelihood Estimation: Contract/No Contract

Variable	Coeff.	Std.Err.	t-ratio	P-value
Constant	0.575	1.329	0.433	0.665
Age (years)	0.001	0.016	0.081	0.935
Education (years)	-0.240	0.083	-2.879	0.004
Years in hog business	-0.058	0.015	-3.832	0.000
Total farm assets ($100,000)	1.172	0.369	3.175	0.001
Primary Occupation Off-farm	-0.002	0.015	-0.151	0.880
Scale Class 2	2.762	0.570	4.843	0.000
Scale Class 3	3.015	0.577	5.230	0.000
Scale Class 4	4.793	0.611	7.844	0.000
Southern/Eastern state	-0.244	0.447	-0.547	0.585
Northern state	0.679	0.340	1.997	0.046
Western state	-0.324	0.461	-0.704	0.481
Co. average net return per farm ($1000)	-0.023	0.010	-2.409	0.016
Co. average swine sales per farm ($1000)	0.016	0.005	3.222	0.001

Notes: Dependent variable: Uses a Production Contract (1,0); Number of observations: 477; Log-likelihood = -191.18; McFadden pseudo R-squared = 0.41; Chi-squared: 231.2, Degrees of freedom: 13, Significance level: 0.000. The P-value is the value for a two-tailed test of the hypothesis that the coefficient equals zero.

	Predicted		
Actual	0	1	Total
0	194	39	233
1	49	195	244
Total	243	234	477

Table 3. Sample Selection Model Two Stage Least Squares Regression

	Coeff.	Std.Err.	Coeff./ Std.Err.	P-value
Constant	-44.596	11.370	-3.922	0.000
Age (years)	0.087	0.122	0.717	0.473
Education (years)	-0.298	0.707	-0.421	0.674
Years in hog business	0.245	0.127	1.930	0.054
Total farm assets ($100,000)	1.634	3.128	0.522	0.602
Primary Occupation Off-farm	-0.118	0.123	-0.962	0.336
Scale Class 2	15.715	3.608	4.356	0.000
Scale Class 3	23.711	4.278	5.543	0.000
Scale Class 4	25.820	6.804	3.795	0.000
Southern/Eastern state	-0.375	3.205	-0.117	0.907
Northern state	-4.503	2.766	-1.628	0.104
Western state	6.541	3.266	2.003	0.045
Contract	17.914	8.756	2.046	0.041
Lambda	-5.227	5.222	-1.001	0.317

Notes: Dependent variable is Net Returns to Unpaid Labor. Observations = 477; Adjusted R-squared = 0.28; Model test: F[13, 463] = 14.89, Prob value = 0.000; Estimated correlation of disturbance in regression and selection criterion (ρ) = -0.242; The P-value is the value for a two-tailed test of the hypothesis that the coefficient equals zero.

Table 4. Estimates of Net Returns for Independent and Contract Hog Production

	Expected Value	**Estimated Std. Dev.**	**Estimated Coeff. of Variation**
Net return from independent production (Y^I)			
Total (dollars)	30,561	27,834	0.911
Per unit (dollars/cwt.)	11.41	10.40	0.911
Net return from contract production (Y^C)			
$\theta = 0.0$			
Total (dollars)	19,174	0	0
Per unit (dollars/cwt.)	7.16	0	0
$\theta = 0.1$			
Total (dollars)	25,109	2,783	0.111
Per unit (dollars/cwt.)	9.38	1.04	0.111
$\theta = 0.2$			
Total (dollars)	31,045	5,567	0.179
Per unit (dollars/cwt.)	11.59	2.08	0.179

Note: θ is the ratio of the standard deviation of contract income to independent income.

Table 5. Estimated Risk and Autonomy Premia as a Percent of the Average Net Returns for an Independent Hog Operation

R	**Risk Premium** (Dollars)			**Autonomy Premium** (Dollars)		
	$\theta = 0.0$	$\theta = 0.1$	$\theta = 0.2$	$\theta = 0.0$	$\theta = 0.1$	$\theta = 0.2$
0.0	0 (0.0%)	0 (0.0%)	0 (0.0%)	-11387 (37.3%)	-5452 (17.8%)	484 (1.6%)
0.5	6338 (20.7%)	6244 (20.4%)	6092 (19.9%)	-5050 (16.5%)	792 (2.6%)	6575 (21.5%)
1.0	12675 (41.5%)	12488 (40.9%)	12184 (39.9%)	1288 (4.2%)	7036 (23.0%)	12667 (41.4%)
1.5	19013 (62.2%)	18732 (61.3%)	18276 (59.8%)	7626 (25.0%)	13279 (43.5%)	18760 (61.4%)
2.0	25351 (83.0%)	24975 (81.7%)	24368 (79.7%)	13963 (45.7%)	19523 (63.9%)	24852 (81.3%)

Note: The average net returns for an independent hog producer in the 1988-1997 period was $30561.45 in 1998 dollars.

Table 6. Estimated Per Unit Risk and Autonomy Premia as a Percent of the Historical Price

R	**Risk Premium** (Dollars/Cwt.)			**Autonomy Premium** (Dollars/Cwt.)		
	$\theta = 0.0$	$\theta = 0.1$	$\theta = 0.2$	$\theta = 0.0$	$\theta = 0.1$	$\theta = 0.2$
0.0	0 (0.0%)	0 (0.0%)	0 (0.0%)	-4.25 (7.9%)	-2.03 (3.8%)	0.18 (0.3%)
0.5	2.37 (4.4%)	2.33 (4.3%)	2.28 (4.2%)	-1.89 (3.5%)	0.30 (0.6%)	2.46 (4.6%)
1.0	4.73 (8.8%)	4.66 (8.7%)	4.55 (8.5%)	0.48 (0.9%)	2.63 (4.9%)	4.73 (8.8%)
1.5	7.10 (13.2%)	7.00 (13.0%)	6.83 (12.7%)	2.85 (5.3%)	4.96 (9.2%)	7.01 (13.0%)
2.0	9.47 (17.6%)	9.33 (17.4%)	9.1 (16.9%)	5.21 (9.7%)	7.29 (13.6%)	9.28 (17.3%)

Note: The average price for the 1988-1997 period was $53.75 in 1998 dollars.