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APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

**Do Transaction Costs and Risk Preferences  
Influence Marketing Arrangements in  
the Illinois Hog Industry?**

by

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Suggested citation format:

Franken, J. R. V., J. M. E. Pennings, and P. Garcia. 2008. "Do Transaction Costs and Risk Preferences Influence Marketing Arrangements in the Illinois Hog Industry?" Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [<http://www.farmdoc.uiuc.edu/nccc134>].

## **Do Transaction Costs and Risk Preferences Influence Marketing Arrangements in the Illinois Hog Industry?**

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*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management  
St. Louis, Missouri, April 21-22, 2008*

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## Do Transaction Costs and Risk Preferences Influence Marketing Arrangements in the Illinois Hog Industry?

*Studies of hog industry structure often invoke risk reduction and transaction costs explanations for empirical observations but fail to directly examine the core concepts of risk behavior and transaction costs theories. Using a more unified conceptual framework and unique survey and accounting data, this study demonstrates that risk preferences and asset specificity impact Illinois producers' use of contracts and spot markets as suggested by theory. Factor analytic methods limit measurement error for indirectly observable risk and transaction costs variables employed in logit regressions. In particular, related investments in specific hog genetics and specific human capital regarding the production process increase the probability of selecting long-term contracts over spot markets. Producers who perceive greater levels of price risk and/or are more averse to it appear more (less) likely to use long-term contracts (spot markets), and hence, to make such investments.*

**Keywords:** risk behavior, transaction costs economics, risk attitude and risk perception, asset specificity, contracts, hogs.

### Introduction

Once dominated by spot exchanges, the U.S. hog industry has experienced the greatest consolidation and increase in contract use of any major commodity in the last decade (Grimes and Plain 2005, 2007; Key 2004). Vertical coordination has taken a different path in traditional Midwest production regions than in areas of recent expansion in the East, like North Carolina (Rhodes 1995; Kliebenstein and Lawrence 1995; Zering 2007). Marketing contracts which may include cost-plus or price-window risk-sharing, are more common in the feedstuff abundant Midwest than input-providing production contracts and vertical ownership, which are prevalent in the East.<sup>1</sup> Each of these arrangements are used by packers to secure specific hog genetics for branded pork products (Martinez 2002).

The rapid restructuring of the industry and growth in alternative marketing arrangements has led to regulatory efforts at various levels of the government (c.f., Boehlje et al. 2001; Reimer 2006; Henderson 2007). Concerns for efficient price discovery with lower quantity and quality of livestock traded in spot markets prompted a \$4.5 million Congress-mandated study (i.e., Muth et al. 2005), which found that alternative marketing arrangements benefit not only packers but also producers and consumers. In light of these benefits, the factors influencing producers' use of marketing arrangements are of interest to policymakers, economists, and industry participants.

Transaction costs economics (Williamson 1975), positive agency theory (Alchian and Demsetz 1972), and property rights theory (Grossman and Hart 1986; Hart and Moore 1990)

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<sup>1</sup> The USDA's Agricultural Resource Management Survey (USDA-ARMS) recognizes two broad categories of contracts: marketing contracts govern only the terms of sale, while production contracts also involve contractor provision of inputs and may or may not bind the grower to a particular production process (Key and McBride 2003).

have been used extensively to explain organizational arrangements in many industries. However, as Robins (1987), Klein, Frazier, and Roth (1990), and Chiles and McMackin (1996) suggest, the predictive power of such efficiency-based theories may be enhanced by explicitly accounting for heterogeneity in risk preferences.<sup>2</sup>

Previous research on the U.S. hog industry has offered either risk reduction (e.g., Johnson and Foster 1994; Kliebenstein and Lawrence 1995; Parcell and Langemeier 1997) or transaction costs (e.g., Cozzarin and Westgren 2000; Key and McBride 2003; Reimer 2006) explanations for marketing arrangements without explicitly examining the core concepts in risk behavior and transaction costs theories. In the only study known to apply both theories, Davis and Gillespie (2007) were unable to find direct support for key risk behavior and transaction costs variables. Studies on the Dutch hog industry have found that producers' preferences for price risk influence their marketing arrangements but have not examined the impact of transaction costs variables (e.g., Pennings and Smidts 2000, 2003; Pennings and Wansink 2004).

Here, using a unified conceptual framework and unique survey and accounting data, we demonstrate that risk preferences and asset specificity, a transaction attribute, significantly impact Illinois producers' marketing arrangements, as suggested by theory. Marketing contracts that are common in the Midwest receive greater attention than in prior research, which focuses on production contracts and vertical ownership. A major contribution is incorporation of risk behavior theory (Pratt 1964; Arrow 1971) into the transaction costs framework (Williamson 1975). Transaction costs theory suggests that higher levels of uncertainty and investments in assets that are specialized to a particular exchange relationship increase the likelihood of contracting. However, since managers hold varying perceptions and attitudes regarding risk or uncertainty, the interaction of risk attitude and risk perception may better explain their choices (Pennings, Wansink, and Meulenberg 2002; Pennings and Wansink 2004).

Survey data were collected in personal interviews with producers who participate in the Farm Business Farm Management (FBFM) program that resides at University of Illinois and keeps records on their operations. The secondary data were used to control for business characteristics, such as size and debt or leverage, while the primary survey data offer superior measures of theoretical concepts like asset specificity (Macher and Richman 2006). Factor analysis (Hair et al. 1995) determines which combinations of survey items best measure the risk and transaction costs variables which are only indirectly observable with error.

## **Transaction Costs and Risk Behavior Theories**

Marketing channel literature remains fragmented in economic and behavioral approaches. Transaction costs theories based on Coase's (1937) seminal work have been applied extensively, while risk behavior theory (Pratt 1964; Arrow 1971) has been relatively underutilized.

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<sup>2</sup> Mahoney and McNally (2004) note that transaction cost economics assumes exchange between risk neutral principals and agents (Chiles and McMackin 1996), while agency theories assume that the agent is risk averse (Eisenhardt 1989).

Transaction cost economics, positive agency theory, and property rights theory grew from Coase's (1937) insight that the costs of operating alternative organizational forms and reassigning property rights render the organization of exchange and the initial assignment of property rights relevant for efficient outcomes. There has been substantial progress towards joining these three theories of organizational economics (e.g., Mahoney 1992; Kim and Mahoney 2005), which are all *positive transaction costs theories*. Adopted organizational forms minimize these costs. As transaction costs are not easily measured (Klein, Frazier, and Roth 1990), researchers typically test for the predicted alignment of organizational forms with transaction attributes – asset specificity and uncertainty.

Asset specificity is an asset's degree of specialization toward an exchange relationship (Lajili et al. 1997). Williamson (1985) categorizes specific assets as physical (e.g., specialized tools or equipment), human (e.g., firm-specific knowledge), or site (e.g., co-location of an electric plant and a coal mine). Such investments have lower (salvage) value outside of the relationship. The difference in value, a *quasi-rent*, is subject to the threat of appropriation via superior bargaining power, if not properly safeguarded (Klein, Crawford, and Alchian 1978). Long-term contracts sufficiently protect quasi-rents at intermediate levels of asset specificity (Joskow 1987), but vertical ownership is necessary at extreme levels of asset specificity (Mahoney 2005).

Reviews of empirical transaction costs studies (e.g., Mahoney 1992; Shelanski and Klein 1995; Rindfleisch and Heide 1997; Macher and Richman 2006; David and Han 2004) reveal that most types of uncertainty encourage tighter coordination of marketing channels.<sup>3</sup> Contracts limit exposure to environmental uncertainty regarding supply, demand, prices, and revenues, whereas vertical ownership counteracts behavioral uncertainty (called *performance ambiguity* in positive agency theory) by facilitating performance evaluation (Mahoney 1992; Rindfleisch and Heide 1997). When outcome measurement is difficult, agents' actions may be monitored in vertically integrated firms if task programmability is high, meaning that principals (managers) can specify the steps of the contracted task in advance (Alchian and Demsetz 1972).

The above discussion reveals that market governance is efficient only under sufficiently low uncertainty and asset specificity if the traded product or service is easily measured, e.g., standardized commodity like #2 yellow corn (Mahoney 1992; Mahoney and McNally 2004). The following hypotheses relate these transaction attributes to the organizational form of interest in this study – long-term contracts.

H1      Greater uncertainty leads to greater (less) use of contracts (spot markets).

H2      Greater asset specificity leads to greater (less) use of contracts (spot markets).

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<sup>3</sup> As an exception, uncertainty regarding the rate of technological change deters vertical integration (Balakrishnan and Wernerfelt 1986), which results from a reluctance to invest in specific assets that may soon be obsolete (Stump and Heide 1996).

While uncertainty and complexity contribute to market failures and incomplete contracting in the above reviewed theories, none of them explicitly address individuals' awareness (i.e., perceptions) and attitudes about risk. Pennings, Wansink and Meulenberg (2002) showed that the Pratt (1964) and Arrow (1971) framework implies that risk management, as reflected in the risk premium, is a function of risk attitude and risk perception (the latter reflected in the variance of additional wealth). Based on this result, Pennings and Wansink (2004, p. 699) conjectured:

“We do not expect risk attitude and risk perception to individually have a direct impact on the contract strategies employed by channel members. Instead ... we believe it is the combination of risk attitude and risk perception that influences behavior. After all, regardless of one's individual risk attitudes a channel member will not change his or her behavior if no risk is perceived in a given situation.”

Following Pennings and Wansink (2004), the interaction between risk attitude and risk perception (IRAP) is positive when channel members perceive risk and are risk-averse, negative when channel members perceive risk and are risk-seeking, and zero when channel members either do not perceive any risk or when they are risk neutral. In this context, we offer the following hypothesis.

H3     Greater IRAP values lead to greater (less) use of contracts (spot markets).

Viewing price risk as a type of environmental uncertainty, hypothesis H3 is a refinement of the transaction costs hypothesis H1 with uncertainty replaced by IRAP.<sup>4</sup> This perspective offers a more complete treatment of managerial choice by explicitly incorporating risk preferences. Thus, replacing hypothesis H1 in the transaction costs framework by hypothesis H3 yields a more unified conceptual model.

## Review of Hog Industry Research

Several research studies have examined the factors affecting the structure of the U.S. hog industry, but have provided limited support for risk reduction and transaction costs explanations. Whereas Cozzarin and Westgren (2000) and Reimer (2006) ran simulations to predict optimal marketing arrangements, Key and McBride (2003) and Davis and Gillespie (2007) explained actual marketing arrangements.

Cozzarin and Westgren (2000) simulated rent sharing across farrowing, nursery, and finishing stages for North Carolina integrators (franchisors) compared to three-firm alliances.<sup>5</sup> In accord with property rights theory, simulations implied that to be competitive with integrators,

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<sup>4</sup> Knight's (1921) distinction between risk (randomness with knowable probabilities) vs. uncertainty (randomness with unknowable probabilities) parallels transaction cost theory's distinction between uncertainty vs. uncertainty plus complexity compounded by bounded rationality.

<sup>5</sup> The integrator owns the first stage and contracts the second and third stages, providing inputs and retaining ownership of the hogs. In contrast, hogs are owned jointly under the alliance, and the input costs of each stage are incurred by the stages' respective operators.

alliances must shift claims to residual rents from finishing to farrowing, the stage which most impacts system profits. In contrast to positive agency theory, pig-space guarantees did little to offset downstream financial risks associated with underproduction in farrowing by integrators.<sup>6</sup>

Reimer (2006) applied Grossman and Hart's (1986) property rights model to processors' choice between in-house and contract feeder pig production. Numerical solutions revealed that production contracts are optimal except in a small numbers scenario of few producers where both contract and hired producers underinvest or in the scenario where processors' (specific) investments in value-added or branded products are more important to system profits than investments in the managerial ability of producers.

Key and McBride (2003) suggested that their finding of greater production contract usage by larger farms reflects buyers minimizing transaction costs by contracting with fewer and larger farms. Contractees also were significantly more likely to have less education, less experience raising hogs, a major occupation off-farm, and lower average net returns to their hog operations (suggesting a lower reservation wage). In contrast to the conjecture that risk-reducing contracts may enhance producers ability to obtain debt financing, Key and McBride (2003, p. 132) found "no significant difference between contractees and independent producers in terms of their debt-to-asset ratio" and suggested that "for the same investment, contract growers can produce more because they do not have to purchase animals, feed, and the equipment provided by contractors."

Davis and Gillespie (2007) drew upon transaction costs and risk behavior theories to explain use of spot markets, cooperatives, and flat-fee and incentive-based production contracts using a multinomial logit model. Moving along this continuum, autonomy became successively and significantly less important to producers. College educated producers were more likely to use cooperatives than flat-fee contracts, and older producers were more likely to remain independent than use cooperatives. The results also were consistent with independent producers managing risk via diversified agricultural production and smaller producers (with less than 3,000 head of hogs) reducing risk with flat-fee contracts.<sup>7</sup> Producers also raising corn were less likely to select cooperative or contract production, as such arrangements may limit the use of on-farm-raised feedstuffs. The variables of arguably the most theoretical interest – risk attitude and specialization in stages of hog production – lacked statistical significance for any marketing arrangement.<sup>8</sup>

Pennings and Smidts (2000) found that use of futures contracts and average price sales through cooperatives was significantly more likely as Dutch hog producers became risk-averse.

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<sup>6</sup> Under the pig-space guarantee the integrator (franchisor) pays a fixed fee per pig-space to cover the franchisee's fixed facility costs.

<sup>7</sup> Though the authors hypothesized a positive relationship between contract use and farm size, they note that the negative relationship found for flat-fee contracts is plausible if these contracts are mostly between farmers, where the grower has empty, older facilities and the contractor wishes to expand.

<sup>8</sup> Based on the task programmability argument of positive agency theory, contracting was hypothesized to be more likely for farms specializing in one or two of the three stages, since it is easier to specify the steps of a single stage such that provided inputs yield a certain output.

Both options entail less risk than spot market sales. There was evidence that the interaction of risk attitude and risk perception (IRAP) impacts transaction frequency, suggesting that risk-averse producers who perceive high risks sell more frequently to receive average market prices.

Pennings and Wansink (2004) showed that use of spot transactions and fixed-price contracts by Dutch hog producers, wholesalers, and processors can be explained partly by IRAP, their bargaining power, and market structure. Channel members with positive IRAP scores (risk-averse) bought and sold using fixed-price contracts in markets without natural hedges and spot transactions when natural hedges existed. Channel members with negative IRAP scores (risk-seeking) bought and sold using spot transactions in markets without natural hedges, while they used contracts on either the buying or selling side and spot transactions on the other when natural hedges existed.

## Research Design

One hundred and three producers were identified as possible survey participants in the University of Illinois Extension's Farm Business Farm Management (FBFM) cooperator database. The farms were selected to be representative of commercial hog farms in the state (Lattz, Cagley, and Raab 2005, p. 1). Four rounds of pre-tests – two with FBFM personnel and two with producers – were performed. In each case, survey items were modified, eliminated, and added based on the comments.

All producers were contacted, and as encouragement for their participation were offered a chance at one of ten \$100 lottery prizes. In total, 50 producers participated in personal interviews that lasted an average of one hour and twenty minutes. One producer's responses were not included in the analysis due to incomplete accounting data. Binary dependent variables – CONTRACT and SPOT – are coded based on the producers' primary marketing arrangements (Table 1). The design is consistent with Pennings and Wansink (2004, p. 707), where it was “coded whether channel members used fixed-price contracts or spot transactions with their main contract parties.” CONTRACT equals one if 1 if greater than 50 percent of production is sold using long-term marketing or production contracts and equals zero otherwise. SPOT equals one if greater than 50 percent of production is sold at spot prices through spot market transactions, verbal commitments, or cooperative sales and equals zero otherwise.<sup>9</sup> Empirical results are reported for the full sample of 49 producers, but a subsample comprised only of 29 producers that use primarily marketing contracts or spot market sales yields qualitatively similar results for transaction costs and risk variables of primary interest.

Secondary accounting data provided measures of farms' size and leverage, while primary survey data capture producers' age, experience, and education and whether they specialize in particular stages of the hog production process. These variables are defined in Table 2.

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<sup>9</sup> Following convention in transaction costs economics, we distinguish verbal commitments from formal (written), legal contracts subject to third-party (judicial) sanctions (Masten and Saussier 2002). Producer-ownership distinguishes cooperatives from contract and independent production. Davis and Gillespie's (2007) results suggest that independent producers significantly differ from cooperative producers only in that they are older and value autonomy even more.

## Empirical Methods

### *Factor Analytic Methods to Account for Measurement Error*

Measures for risk behavior and transaction costs variables are constructed from survey items (Table 3) using factor analysis, since these theoretical concepts are observable only indirectly with error (Hair et al. 1995). Relationships between relevant survey items (i.e., indicants) are summarized in a smaller set of more parsimonious variables (i.e., eigenvectors called factors) that are used in subsequent analyses to conserve degrees of freedom and improve power against Type II error (Thompson 2004). Furthermore, the unreliable variance in the original variables tends to be discarded once they are reexpressed as factors.

### *Logit Regressions*

Though organizational research deals with the extent of vertical integration along a continuum from spot transactions to complete vertical ownership, much of the research investigates questions of a more dichotomous nature (e.g.,  $y = 1$  if contract;  $y = 0$  otherwise). Here, we use logit regressions to investigate the factors influencing contract and spot market use, assessing the ability of the transaction costs, risk behavior, and unified frameworks to explain behavior. Logit procedures estimate the probability  $\text{Pr}(y = 1 | \mathbf{x}) = (e^{\mathbf{x}'\boldsymbol{\beta}}) / (1 + e^{\mathbf{x}'\boldsymbol{\beta}}) = F(\mathbf{x}'\boldsymbol{\beta})$ , where  $\mathbf{x}$  and  $\boldsymbol{\beta}$  are vectors of explanatory variables and coefficients, respectively, and  $F(\cdot)$  is the logistic cumulative distribution function. Sykuta (2005) and Hoetker (2007) summarize best practices for logit (and probit) models which are followed here.

Though statistical significance usually can be inferred directly from coefficient test statistics, the economic significance (or marginal effect) of an explanatory variable depends on the values of the other explanatory variables (Sykuta 2005; Hoetker 2007). Unless particular values are of interest, marginal effects are often computed at the mean (Long 1997). We report the average of marginal effects computed for each observation, since no observation is likely to have mean values for all variables (Train 1986). These average marginal effects can differ from those computed at the mean by a factor of three (Talvitie 1976) but are very similar for our data. The marginal effects of continuous variables are  $\partial F(\cdot) / \partial \mathbf{x} = F(\cdot)[1 - F(\cdot)]\boldsymbol{\beta}$ , and the marginal effect of a dummy variable is the change in the expected probability when the dummy changes from zero to one, evaluated at specified values of the other explanatory variables (Sykuta 2005). The standard error of the marginal effect is computed as the square root of the variance of the marginal effect  $(\mathbf{G} \times \mathbf{V}(\boldsymbol{\beta}) \times \mathbf{G}')^{0.5}$  using the delta method (c.f., Greene 2003, p. 674), where  $\mathbf{G}$  contains the derivatives of marginal effects with respect to parameter estimates and  $\mathbf{V}(\boldsymbol{\beta})$  is the estimated variance-covariance matrix of parameter estimates.

As Hoetker (2007) notes, several different pseudo- $R^2$  measures exist for logit models, none of which equate to  $R^2$  in ordinary least squares regressions. A model's proportion of correct predictions can also be misleading, since a naïve model always predicts at least fifty percent correctly. Hence, the proportion correctly predicted by the naïve model is listed alongside that of the models presented here for comparison.

## Empirical Findings

Following the “K1” rule, notable factors possess characteristic roots (i.e., eigenvalues) greater than one. Such factors consist of survey items with high factor loadings and explain the majority of common variance. Our measures are reliable (Table 4), as indicated by Cronbach’s (1951) alpha, which should be greater than 0.70 (Streiner and Norman 1995).

Correlations are presented in Table 5. First, observe that CONTRACT and SPOT are nearly inverses except for slight deviation due to futures and options or forward contract usage. These dependent variables have less correlation with the risk perception factor than with the risk attitude and IRAP factors. AGE and EXPERIENCE are highly correlated, as are IRAP and the risk attitude factor. Highly correlated variables are not included simultaneously in regressions to prevent multicollinearity.

SIZE (i.e., thousands of hogs marketed per year) and various measure of asset specificity exhibit moderate positive correlation with the dependent variables. The largest of these correlations is for the fifth physical asset specificity item which reflects investments in specific hog genetics. This item loaded nearly evenly on HUMAN and PHYSICAL factors, and hence, was excluded from their computations to preserve the unidimensionality of the factors. Interestingly, the magnitude of the correlations between the dependent variables and human (and genetic, i.e., physical) asset specificity are similar to those with IRAP (and risk attitude).

Logit results for transaction costs, risk behavior, and unified frameworks are compared in Table 6. Here, asset specificity is operationalized by the survey item concerning investments in specific hog genetics. The human asset specificity factor behaves similarly but exhibits slightly lower statistical significance, while physical and site asset specificity factors are insignificant.

The risk behavior models outperform the transaction costs models in terms of the proportion of observations on CONTRACT and SPOT correctly predicted but yield the lowest values of McFadden’s R-square. The unified framework offers even greater predictive power for CONTRACT but not for SPOT. Closer inspection reveals that in four of the six cases where the risk behavior model outperforms the unified framework the estimated probabilities of spot market use were very close for each model but on opposite sides of the 50 percent cut-off value for a prediction of one.

In each model, the findings for business characteristics corroborate prior research, lending credence to our treatment of cooperative producers and producers with verbal commitments as spot market participants. As in Key and McBride (2003), larger farms are more likely to contract. Average marginal effects for SIZE suggest that the probability of using long-term contracts (spot markets) increases (decreases) around two to three percent for every additional thousand hogs sold. While Key and McBride (2003) find no evidence that production contracts improve producers’ access to external debt, Davis and Gillespie’s (2007) results suggest that contract producers incur fewer input costs and hence bear less debt than independent producers. Here, greater capacity to repay debt, as reflected by higher values of LEVERAGE, is associated with less contracting and greater spot market use. Consistent with Davis and Gillespie’s (2007) expectations for age and Key and McBride’s (2003) findings for experience, we find that older (likely more experienced) producers are more likely to use spot markets than

long-term contracts. While the sign on EDUCATION is consistent with Key and McBride's (2003) findings, it is statistically significant only in the risk behavior model for SPOT.<sup>10</sup>

The most important finding, however, is that this research offers the first direct empirical support for the significance of asset specialization and risk preferences as predictors of marketing arrangements in the U.S. hog industry. Though UNCERTAINTY offers no significant support for hypothesis H1 (Greater uncertainty leads to greater (less) use of contracts (spot markets)), SPECIFIC GENETICS provides stronger support for hypothesis H2 (Greater asset specificity leads to greater (less) use of contracts (spot markets)). Strong statistically significant support also is obtained for hypothesis H3 (Greater IRAP values lead to greater (less) use of contracts (spot markets)), as average marginal effects indicate that a unit increase in IRAP increases (decreases) the probability of using long-term contracts (spot markets) by one to two percent. As in Davis and Gillespie (2007), however, STAGE provides no statistically significant support for the positive agency theory concept of task programmability in unreported results.

Notice that the moderately correlated risk and transaction costs variables (Table 5) vie for significance in the unified model (Table 6). The inclusion of IRAP in SPOT regressions erodes the significance of SPECIFIC GENETICS, relative to the results for the transaction costs model. Conversely, IRAP loses significance with the inclusion of SPECIFIC GENETICS in CONTRACT regressions, relative to the risk behavior model. Such results may imply that it is often risk-averse producers who accept processors' contracts requiring specific investments. The resulting correlation between risk and transaction costs variables contributes to the difficulty in disentangling their effects. In SPOT regressions, lower (higher) significance of asset specificity (IRAP) variables may also reflect use of futures, options, and forward contracts, which entail no asset specificity but mitigate risk. Overall, the results support hypotheses H2 and H3.

## Discussion and Conclusions

Previous research has offered risk avoidance and/or transaction costs minimization explanations for U.S. hog industry structure, with little empirical support. Here, we examine factors influencing the marketing arrangements of hog producers in Illinois, and verify the relevance of risk behavior and transaction costs theories using a unified framework of organizational theories. The unified framework outperforms separate risk behavior and transaction costs frameworks in terms of the ability to predict producers' use of long-term contracts.

By incorporating a more explicit treatment of risk preferences within the transaction costs framework, we find that risk preferences and investments in assets tailored for a specific exchange relationship are significant predictors of marketing arrangements. For instance, the interaction of risk attitudes and risk perceptions (IRAP), as defined by Pennings and Wansink (2004), has a positive (negative) impact on contract (spot market) use. Thus, consistent with risk behavior theory (Pratt 1964; Arrow 1971), producers who are more averse to price risk and

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<sup>10</sup> If cooperative and independent production are indeed similar, the sign on EDUCATION is also consistent with Davis and Gillespie's (2007) finding of a significantly negative impact of education on the use of long-term contracts relative to cooperatives.

perceive more of it are more likely to select contracting over spot market sales. Failure by Davis and Gillespie's (2007) to identify a risk attitude effect likely reflects their focus on investment rather than price risk.

Consistent with transaction costs economics (Williamson 1975), producers' investments in human capital and hog genetics that are specific to the relationship with their primary buyer also are positively (negatively) related to their use of long-term contracts (spot markets). However, no statistically significant support was found for such investments in physical assets (e.g., equipment and facilities) or assets that are site specific. As observed by Ménard and Klein's (2004), site specificity may be less important in the hog industry than in the poultry industry, because hogs can be transported greater distances without losing value. The general consistency of our results with the efficiency-based predictions of transaction costs economics further supports Muth's (2007) testimony to policymakers that livestock industry participants adopt marketing arrangements that benefit all involved.

Despite a limited sample size, the study identifies significant effects using a unique combination of accounting data and survey data. The use of factor analysis (Hair et al. 1995) to summarize survey items as a smaller and more parsimonious set of reliable transactions costs and risk behavior variables contributed to this success by conserving degrees of freedom and improving power against Type II error (Thompson 2004). Future agricultural marketing channel research should consider the use of these procedures to assess systematically the factors influencing observed behavior. Even with these carefully developed procedures, it is difficult to completely identify the theoretical framework and empirical representations that are most consistent with observed behavior. Based on our findings, researchers may need to dig more deeply into appropriate procedures and data sets to understand the core features influencing observed behavior in marketing channels.

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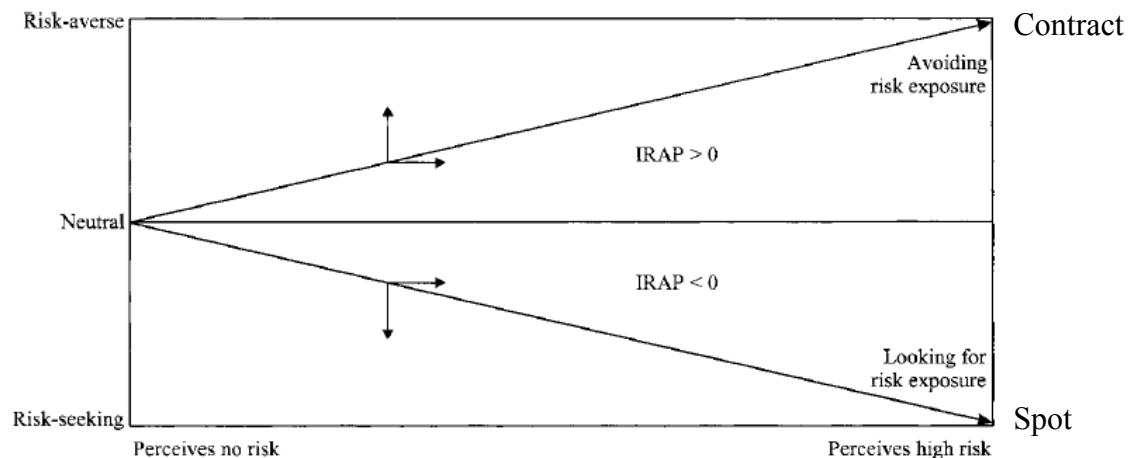
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**Figure 1. The Influence of the Interaction of Risk Attitude and Risk Perception on Adoption of Marketing Arrangements.**



Note: Adapted from Pennings and Wansink (2004).

**Table 1. Primary Marketing Arrangements used by Sampled Producers.**

<u>Primary Sales Method</u>	Number of <u>Producers</u>
Processing Cooperative	7
Pooling Cooperative	6
Forward Contracts	1
Verbal Commitments	4
Marketing Contracts	13
Production Contracts	1
<u>Spot Markets</u>	17

Note: Statistics reflect use of a particular marketing arrangement for over fifty percent of production.

**Table 2. Definitions of Directly Measured Explanatory Variables.**

<u>Variable</u>	<u>Definition</u>
SIZE	Thousands of hogs sold in 2006.
LEVERAGE	Capital replacement and term debt repayment margin, which at higher values indicates greater capacity to replace capital assets, repay debt, and service additional debt (Financial Guidelines for Agricultural Producers 1997).
AGE	Producer's age in years.
EXPERIENCE	Number of years that the producer has raised hogs.
EDUCATION	Equals one if the producer has completed four or more years of college and equals zero otherwise.
STAGE	Equals one if the producer operates only one of the three stages of hog production and equals zero otherwise.

**Table 3. Risk Perception, Risk Attitude, and Asset Specificity Survey Items.**

<u>Risk Perception Items</u>	
RP1	How risky do you consider market prices for hogs?
RP2	How risky do you consider selling your hogs in cash markets?
RP3	How do you rate market prices for (weaner, feeder, finished) hogs in terms of financial risk they pose to your farm income?
RP 4	I see large fluctuations in hog prices that expose me to risk.
RP 5	Hog prices possibly could fall below my cost of production, and hence, expose me to risk.
RP 6	I can predict hog prices.
RP 7	The cash hog market is <u>not</u> risky at all.
<u>Risk Attitude Items</u>	
RA1	I usually like “playing it safe” (for instance, “locking in a price”) instead of taking risks for market prices for (weaner, feeder, finished) hogs.
RA2	When selling/marketing my hogs, I prefer financial certainty to financial uncertainty.
RA3	When selling/marketing my hogs, I am willing to take higher financial risks in order to realize higher average returns.
RA4	I like taking financial risks with my hog farm business.
RA5	I accept more risk in my hog farm than other hog farmers.
RA6	With respect to the conduct of business, I dislike risk.
<u>Asset Specificity Items</u>	
Human1	I have learned about production methods that my primary buyer wants me to use, and this knowledge is of little value if I deliver to a different buyer.
Human2	The relationship with my primary buyer has become valuable in terms of the experience/knowledge that we share regarding each other's practices & needs.
Human3	Experience (information) regarding each other's practices and needs is an aspect of the relationship with my primary buyer that I value.
Human4	Experience (information) regarding each other's practices and needs is an aspect of our relationship that my primary buyer likely values.
Human5	My primary buyer considers my understanding of its input needs and/or operating/trade procedures key to our relationship.
Physical1	I could not recover the full value of my investments in specialized equipment and/or facilities if the relationship with my primary buyer ended.
Physical2	My production system has been tailored to meet the requirements of dealing with my primary buyer.
Physical3	I've made significant investments in equipment and/or facilities dedicated to the relationship with my primary buyer.
Physical4	I own equipment and/or facilities that were required by my primary buyer.
Physical5	My primary buyer requires me to use specific genetics or blood lines.
Site1	My primary buyer likely values the close location of my production operations for timely delivery of hogs.
Site 2	My primary buyer sources its hogs from a particular region.
Site 3	The nearness of my production operations to my primary buyer's location is beneficial to me.
Site 4	The distance I must travel to deliver my product (transportation costs) plays a role in my choice of a primary buyer.
Site 5	<u>The number of nearby buyers impacts my choice of a primary buyer.</u>

Note: Risk perception items 1 through 3 scaled 1 = “not at all risky” through 9 = “very risky.” Risk perception items 4 through 7 and Risk attitude items scaled 1 = “strongly disagree” through 9 = “strongly agree.” Asset specificity items scaled 1 = “strongly disagree” through 7 = “strongly agree.”

**Table 4. Results of Reliability Analysis for Components of Constructs.**

Bootstrapped Factors	Survey Items	Cronbach's Alpha	
		Original Items	Standardized Items
RISK PERCEPTION	RP1-RP5, RP7	0.777	0.783
RISK ATTITUDE	RA1-RA6	0.785	0.780
HUMAN ASSET SPECIFICITY	HU1-HU5	0.897	0.896
PHSICAL ASSET SPECIFICITY	PH1-PH4	0.902	0.913
SITE ASSET SPECIFICITY	SI1-SI5	0.845	0.845

Note: RP, RA, HU, PH, and SI respectively denote risk perception, risk attitude, and human, physical, and site asset specificity items. The items were reverse coded when appropriate.

**Table 5. Correlations of Dependent and Explanatory Variables.**

	<u>CONTRACT</u>	<u>SPOT</u>	<u>AGE</u>	<u>EXP</u>	<u>ED</u>	<u>SIZE</u>	<u>LEV</u>	<u>STAGE</u>	<u>HU</u>	<u>SI</u>	<u>PH</u>	<u>Physical5</u>	<u>RP</u>	<u>RA</u>	<u>IRAP</u>
CONTRACT	1.00														
SPOT	-0.83	1.00													
AGE	-0.19	0.36	1.00												
EXP	0.06	0.12	0.81	1.00											
ED	-0.20	0.23	0.14	0.05	1.00										
SIZE	0.26	-0.27	0.06	0.16	0.06	1.00									
LEV	-0.27	0.20	-0.12	-0.14	0.13	-0.56	1.00								
STAGE	0.09	-0.02	0.17	0.00	-0.12	-0.04	0.01	1.00							
HU	0.35	-0.28	0.06	0.13	-0.13	0.15	-0.30	0.11	1.00						
SI	0.07	-0.09	0.05	0.06	-0.37	0.05	-0.09	0.15	0.36	1.00					
PH	0.18	-0.12	0.00	-0.11	-0.04	0.07	-0.04	0.17	0.53	0.24	1.00				
Physical5	0.52	-0.38	-0.02	0.10	-0.10	0.18	0.04	0.01	0.56	0.11	0.6	1.00			
RP	0.03	-0.03	0.31	0.32	0.07	0.09	0.08	0.11	0.00	0.23	-0.03	0.10	1.00		
RA	0.32	-0.41	-0.19	-0.05	0.01	0.18	-0.05	0.05	0.45	0.20	0.32	0.41	0.04	1.00	
IRAP	0.30	-0.37	-0.18	-0.05	0.04	0.17	-0.04	0.00	0.47	0.19	0.33	0.41	-0.06	0.98	1.00

Note: Observations = 49. EXP, ED, and LEV respectively denote experience in years, education (= 1 if 4 years of college; = 0 otherwise), and leverage as measured by the capital replacement and term debt repayment margin. STAGE denotes specialization in one of the three stages of hog production. RA, RP, and IRAP respectively denote risk attitude and risk perception factors and their interaction. HU, PH, and SI respectively denote human, physical, and site asset specificity factors. Physical5 similarly denotes specific investments in hog genetics.

**Table 6. Marginal Effects for Various Logit Models of Marketing Arrangements.**

<i>Marginal Effect</i>	Transaction Costs Model		Risk Behavior Model		Unified Framework	
	<u>CONTRACT</u>	<u>SPOT</u>	<u>CONTRACT</u>	<u>SPOT</u>	<u>CONTRACT</u>	<u>SPOT</u>
SIZE	0.0155 (0.0118)	-0.0280** (0.0125)	0.0243* (0.0132)	-0.0322*** (0.0118)	0.0159 (0.0116)	-0.0269** (0.0118)
LEVERAGE	-0.0007*** (0.0003)	0.0008*** (0.0003)	-0.0007** (0.0003)	0.0007*** (0.0003)	-0.0007** (0.0003)	0.0007*** (0.0003)
AGE	-0.0145*** (0.0055)	0.0273*** (0.0064)	-0.0131* (0.0068)	0.0237*** (0.0063)	-0.0129** (0.0054)	0.0231*** (0.0061)
EDUCATION	-0.1156 (0.0991)	0.1616 (0.1034)	-0.1615 (0.1130)	0.1813* (0.1099)	-0.1195 (0.1052)	0.1612 (0.1003)
RISK PERCEPTION	0.0273 (0.0505)	-0.0554 (0.0464)	–	–	–	–
IRAP	–	–	0.0113** (0.0056)	-0.0127*** (0.0048)	0.0052 (0.0061)	-0.0101* (0.0055)
SPECIFIC GENETICS	0.0599*** (0.0126)	-0.0393** (0.0170)	–	–	0.0572*** (0.0135)	-0.0302* (0.0178)
McFadden's R <sup>2</sup>	0.4259	0.4045	0.2632	0.3913	0.4334	0.4303
% Correctly Predicted	78	82	84	88	92	82

Note: 49 observations. \*\*\*, \*\*, \* denote statistical significance at 1%, 5%, 10%, respectively. Standard errors are in parentheses. 71% (63%) of observations for CONTRACT (SPOT) are correctly predicted by naïve models. CONTRACT = 1 if primarily production or marketing contract sales; else 0. SPOT = 1 if primarily spot sales; else 0. SIZE is thousands of hogs sold per year. LEVERAGE is the capital replacement and term debt repayment margin, which indicates greater ability to pay back debt at higher values. AGE is in years. EDUCATION = 1 if 4 years of college; else 0. RISK PERCEPTION is the risk perception factor. IRAP is the product of risk attitude and risk perception factors. SPECIFIC GENETICS is the survey item regarding producers' investments in specific hog genetics.