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

Jason R.V. Franken, Joost M.E. Pennings, and Philip Garcia

Risk reduction and transaction costs are often used to explain contracting in the U.S. hog industry with little empirical support. Using a unified conceptual framework that draws from risk behavior and transaction cost theories, in combination with unique survey and accounting data, we demonstrate that risk preferences and asset specificity impact Illinois producers' use of contracts and spot markets. In particular, producers' investments in specific hog genetics and human capital are related to selection of long-term marketing contracts over spot markets. Producers who perceive greater levels of price risk and/or are more averse are more (less) likely to use contracts (spot markets).

Key words: asset specificity, contracts, hogs, risk attitude, risk behavior, risk perception, transaction costs economics

Introduction

Once dominated by spot exchanges, the U.S. hog industry has experienced more consolidation and growth in contract use over the last decade than any other major commodity (Key, 2004). However, vertical coordination, used by packers to secure specific hog genetics for branded pork products (Martinez, 2002), has taken a different path in traditional Midwest production regions than in areas of recent expansion (Kliebenstein and Lawrence, 1995). Marketing contracts which may include cost-plus or price-window risk-sharing are more common in the feedstuff-abundant Midwest, while input-providing production contracts and vertical ownership are prevalent in the East.[1]

Rapid restructuring of the industry and growth in marketing arrangements have led to regulatory efforts at various levels of government (Reimer, 2006). However, a $4.5 million Congress-mandated study, motivated by concerns for efficient price discovery with lower quantities traded in spot markets, has found that observed marketing arrangements benefit not

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

only packers but also producers and consumers (Vukina et al., 2007). In light of these benefits, factors influencing producers' use of marketing arrangements are of interest to policy makers, economists, and industry participants.

Previous research on the U.S. hog industry has offered either risk reduction (e.g., 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 explicit empirical evidence. In the only study to directly assess both explanations (Davis and Gillespie, 2007), key relationships were unsupported. Research on U.S. and Dutch hog industries has shown that producers' preferences for price risk impact marketing arrangements but has neglected transaction costs (e.g., Zheng, Vukina, and Shin, 2008; Pennings and Smidts, 2000; Pennings and Wansink, 2004).

We compare risk behavior and transaction cost models with a more unified framework and demonstrate that risk preferences and asset specificity, a key transaction attribute, impact contract and spot market use. Unique survey and accounting data and the use of factor analysis (Hair et al., 1995) to develop reliable explanatory variables facilitate detection of significant effects. Personal interviews with producers in the Farm Business Farm Management (FBFM) program at the University of Illinois supply enhanced measures of theoretical concepts like asset specificity (Macher and Richman, 2006), while FBFM records control for business characteristics such as size and leverage. Our sample focuses on marketing contracts which are prevalent in the Midwest, whereas prior research deals with production contracts and vertical ownership.

A major contribution is incorporation of risk behavior theory (Pratt, 1964; Arrow, 1971) into transaction cost economics (Williamson, 1975). Transaction cost economics and related efficiency-based frameworks, such as positive agency theory (Alchian and Demsetz, 1972) and property rights theory (Grossman and Hart, 1986), are leading approaches in organizational economics. From this perspective, comparatively better organizational forms minimize the costs of organizing exchange and enforcing property rights which vary with the characteristics of the investments required and various types of uncertainty. However, as Robins (1987), Klein, Frazier, and Roth (1990), and Chiles and McMackin (1996) suggest, the predictive power of these theories may be enhanced by allowing for heterogeneity in risk preferences.[2] In particular, since producers hold varying perceptions and attitudes regarding risk, the interaction of risk attitude and risk perception should impact their marketing decisions (Pennings, Wansink, and Meulenberg, 2002; Pennings and Wansink, 2004). Whereas separate transaction cost and risk behavior approaches may omit relevant aspects of the choice among marketing arrangements, a more unified approach allows us to weigh their relative importance in explaining marketing behavior and offers insight into how producers respond to increasing pressures for vertical coordination.

Transaction Cost and Risk Behavior Theories

Transaction cost economics, positive agency theory, and property rights theory grew from Coase's (1937) insight that transaction costs render the adopted organizational form and the initial assignment of property rights relevant for efficient outcomes. There has been substantial progress toward joining these *positive transaction cost theories* (e.g., Mahoney, 1992;

[2] Transaction cost economics assumes exchange between risk-neutral principals and agents, while agency theories assume a risk-averse agent (Mahoney and McNally, 2004).

Kim and Mahoney, 2005) with the central notion that adopted organizational forms minimize transaction costs. As these 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 (specialized tools or equipment), human (firm-specific knowledge), or site (e.g., co-location of a coal-fired electric plant and a coal mine). Investments in these assets have lower (salvage) value outside of the relationship, and the difference in value, a *quasi-rent*, is subject to threat of appropriation via superior bargaining power if not properly safeguarded (Klein, Crawford, and Alchian, 1978). Long-term contracts can 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 cost studies (e.g., Mahoney, 1992; David and Han, 2004) reveal that most types of uncertainty encourage tighter coordination of marketing channels. Contracts and vertical ownership of the marketing channel may limit exposure to environmental uncertainty (i.e., supply, demand, price, and revenue uncertainty) and may counteract behavioral uncertainty (i.e., *performance ambiguity* in positive agency theory) by facilitating performance evaluation (Mahoney, 1992). When outcome measurement is difficult, agents' actions may be monitored if task programmability is high, meaning that managers can specify the steps of the contracted task in advance (Alchian and Demsetz, 1972).

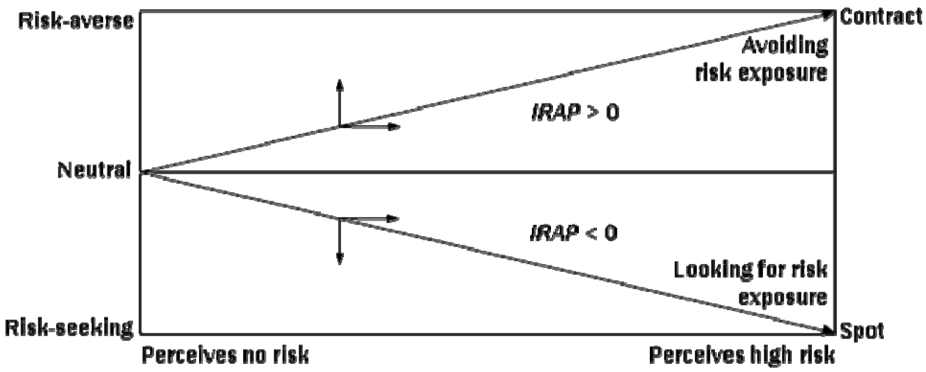
The above discussion reveals that market governance is efficient only under sufficiently low uncertainty and asset specificity (Mahoney, 1992; Mahoney and McNally, 2004). The following hypotheses relate the transaction attributes to the organizational forms investigated here, long-term marketing contracts and spot markets:

- H_1. Greater uncertainty is associated with greater use of contracts and less use of spot markets.
- H_2. Greater asset specificity is associated with greater use of contracts and less use of spot markets.

While uncertainty contributes to marketing arrangements in the above-reviewed theories, these theories do not explicitly address individuals' awareness (i.e., perceptions) of and attitudes toward risk. Pennings, Wansink, and Meulenberg (2002) show that the Pratt (1964) and Arrow (1971) framework implies risk management is a function of the interaction between risk attitude and risk perception (*IRAP*). Based on this finding, in a marketing channel context, Pennings and Wansink (2004, p. 699) conjecture:

> We do not expect risk attitude and risk perception to individually have a direct impact on the contract strategies employed by channel members. Instead … 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.

In this framework (figure 1), *IRAP* is positive when market participants perceive risk and are risk averse, negative when they perceive risk and are risk seeking, and zero when they either don't perceive any risk or are risk neutral. We offer the following hypothesis.



Note: Adapted from Pennings and Wansink (2004).

Figure 1. Influence of the interaction of risk attitude and risk perception on adoption of marketing arrangements

- H_3 . Greater *IRAP* values are associated with greater use of contracts and less use of spot markets.

Viewing price risk as environmental uncertainty, hypothesis H_3 is a refinement of transaction cost hypothesis H_1 with uncertainty replaced by *IRAP*.[3] This perspective offers a more complete treatment of managerial choice by explicitly incorporating risk preferences. Replacing hypothesis H_1 in the transaction cost framework by hypothesis H_3 yields a more unified framework that may offer more comprehensive understanding of marketing arrangements.[4]

Review of Hog Industry Research

Research on the U.S. hog industry has offered limited empirical evidence for risk reduction and transaction costs explanations of marketing arrangements. Cozzarin and Westgren (2000) and Reimer (2006) simulated marketing arrangements, while Key and McBride (2003), Davis and Gillespie (2007), and Zheng, Vukina, and Shin (2008) examined producer behavior using survey data. Simulation results did not support positive agency theory but were consistent with property rights theory providing indirect evidence that transaction costs matter.

Key and McBride (2003) used USDA Agricultural Resource Management Survey (ARMS) data to gain insight on factors affecting actual contract use. Their findings were consistent with processors minimizing transaction costs by contracting with fewer and larger farms. However, they found no support for the notion that production contracts enhance producers' ability to obtain debt financing. Since inputs are provided under these contracts, they argued that producers' costs are lower, and their resources can be used to finance expansion. Also using ARMS data, Zheng, Vukina, and Shin (2008) showed that producers using

[3] Knight's (1921) distinction between risk (randomness with knowable probabilities) versus uncertainty (randomness with unknowable probabilities) parallels transaction cost theory's distinction between uncertainty versus uncertainty plus complexity compounded by bounded rationality.

[4] As is common in transaction cost and risk behavior analyses (cf., Mahoney, 1992; Pennings and Wansink, 2004), we control for business characteristics such as size and leverage and the age and education of management in the empirical analysis, but do not formalize their influences in the conceptual model. Such steps are beyond the scope of combining transaction cost and risk behavior paradigms, which only entails simultaneous consideration of the efficiency implications of specific investments and the behavioral implications of heterogeneous risk preferences.

production contracts are more risk averse than a category of producers using marketing contracts or spot sales and quantified their welfare loss under a hypothetical regulatory ban of production contracts. Using a national survey, Davis and Gillespie (2007) explained use of spot markets, cooperatives, and flat-fee and incentive-based production contracts. Results were consistent with independent producers managing risk via diversified agricultural production and smaller producers reducing risk with flat-fee contracts. They argued that the counterintuitive negative relationship between size and contract use is plausible if contracts are mostly between farmers when the grower has empty facilities and the contractor wishes to expand. Davis and Gillespie also examined whether marketing arrangements can be explained by producer specialization in the stages of hog production, which they argued reflects task programmability in positive agency theory, but found no empirical support. Likewise, their measure of risk attitude lacked statistical significance for any marketing arrangement.

Consistent with Zheng, Vukina, and Shin's (2008) findings for the United States, studies of the Dutch hog industry also suggest risk preferences matter. Pennings and Smidts (2000) found that use of futures contracts and average price sales through cooperatives were significantly more likely as Dutch hog producers became risk averse. Both alternatives entail less risk than spot market sales. 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 the interaction of risk attitudes and risk perception (*IRAP*), their bargaining power, and market structure. Market participants 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. Market participants 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

To examine the proposed relationships, a unique data set was assembled by surveying a sample of hog producers, for which annual accounting and production records are maintained through the University of Illinois Farm Business Farm Management (FBFM) Extension program. FBFM is a cooperative educational service available to all agricultural producers in the state of Illinois for a fee (Lattz, Cagley, and Raab, 2005). Presently, about one out of five Illinois commercial farms with over 500 acres or over $100,000 total farm sales participate. The program is designed to assist producers with management decisions by providing business analysis through computer-assisted processing of records for income tax management. Secondary production and accounting data are collected annually by 58 full-time field staff specialists serving nine FBFM associations or regions. The resulting data set provides extensive information on the cost and debt structure of the farm operations, as well as the source of revenues (i.e., grain or livestock production).

Contact information on all hog producers in the FBFM database was obtained from field staff. All 103 hog producers were offered a chance at one of ten $100 lottery prizes as encouragement for their participation in the 2006 survey. Four rounds of pre-tests—two with FBFM personnel and two with producers—were performed. In each case, survey items were modified, eliminated, or added based on comments. Personal interviews, averaging one hour and twenty minutes, limited the sample size but enhanced the reliability of responses. In total, 50 producers participated. The responses of two producers were not included in the analysis due to incomplete accounting data. The focus of the study is on marketing contracts which are common in traditional Midwest production regions. None of our 48 farmers use production contracts which are prevalent in regions of more recent expansion in hog production.

Consistent with prior hog contracting studies (e.g., Key and McBride, 2003; Pennings and Wansink, 2004) and with the larger empirical literature on transaction cost economics (David and Han, 2004), binary dependent variables are coded based on whether producers used primarily marketing contracts or spot transactions. *CONTRACT* equals one if greater than 50% of production is sold using long-term marketing contracts, and equals zero otherwise. *SPOT* equals one if greater than 50% of production is sold at spot prices, and equals zero otherwise—meaning that the majority of production could be sold using any combination of long- and short-term contracts. *CONTRACT* and *SPOT* are not mirror images due to the treatment of short-term contracts (i.e., futures, options, and forward contracts). Use of short-term contracts resides in the zero category of both variables. Thus, *CONTRACT* distinguishes producers using long-term contracts from others, and *SPOT* distinguishes producers exposed to spot price risk from others. This treatment allows us to assess the nature of risk reduction via short- and long-term contracts, which has not been addressed previously. Risk preferences, as measured by *IRAP*, should be more relevant for *SPOT* than for *CONTRACT*, as long-term contracts guarantee only that prices received will not fall below a specified level while short-term contracts lock in a price or basis.

In our sample, four producers have verbal commitments to deliver their hogs, and 14 producers are members of cooperatives. As is convention in transaction cost economics, we include only written, legally binding agreements in the contracting category (Masten and Saussier, 2002). Since members of a cooperative are subject to immediate spot price risk, these producers are not included in the contracting category. This treatment is consistent with Davis and Gillespie's (2007) results that independent producers significantly differ from cooperative producers only in that they are older and value autonomy more. Empirical results are reported for the full sample, but a subsample of producers using only spot markets and written marketing contracts yields similar results for the risk and transaction cost variables.

Secondary accounting data provide measures of farms' size and leverage, while primary survey data capture producers' age and education and whether they specialize in particular stages of the hog production process (table 1). Most of these measures are straightforward. While previous studies measure *LEVERAGE* by the debt-to-asset ratio, we employ the capital replacement and term debt repayment margin, which should be a better measure (cf., Farm Financial Standards Council, 1997). Higher values of this statistic indicate greater capacity to replace capital assets, repay debt, and service additional debt. Summary statistics are discussed in the empirical results section.

Measures of risk perceptions, risk attitudes, and asset specificity are computed from producers' responses to scaled survey items in table 2. Validated risk perception and risk attitude items are adopted from Pennings and Wansink (2004) and Pennings and Garcia (2001), respectively. These items are used in the construction of the *IRAP* variable. Since price risk is indicative of supply and demand uncertainty, risk perception items appropriately proxy for uncertainty in the transaction cost framework, assuming hog producers are boundedly rational and predicting hog prices is complex. Asset specificity items are designed to reflect the human, physical, and site categories identified by Williamson (1985), and the characteristics of the hog industry. These measures, many of which have been employed in prior research, correspond closely to the theoretical concepts.

Table 1. Definitions of Directly Measured Variables, 2006 Data (*N* = 48 observations)

Variables	Definition	Maximum	Minimum	Mean (Std. Dev.)
Continuous Variables:				
SIZE	Thousands of hogs sold in 2006	30.68	0.21	5.03 (5.50)
LEVERAGE	Capital replacement and term debt repayment margin ($1,000s), which at higher values indicates greater capacity to replace capital assets, repay debt, and service additional debt (Farm Financial Standards Council, 1997); *LEVERAGE* = net income from operations + total nonfarm income + depreciation expense + interest on term debt and capital leases – total income taxes – family living withdrawal	3.74×10^2	-2.29×10^3	-6.39×10^1 (3.64×10^2)
AGE	Producer's age in years	72.00	31.00	52.71 (8.57)

Binary Variables:		Frequency: Ones	Frequency: Zeroes
CONTRACT	= 1 if greater than 50% of production is sold using marketing contracts; = 0 otherwise	13	35
SPOT	= 1 if greater than 50% of production is sold at spot prices; = 0 otherwise	31	17
EDUCATION	= 1 if the producer has completed four or more years of college; = 0 otherwise	18	30
STAGE	= 1 if the producer operates only one of the three stages of hog production; = 0 otherwise	5	43

An aspect of using specific investments that could be viewed as a serious issue is an apparent fixed relationship with contract use. For instance, if contract terms specify equipment or genetics, then contract use will mirror asset use perfectly. In this context, item *Physical*5, which reflects producer investments in specific hog genetics, appears particularly problematic as specific hog genetics are a fundamental dimension of production contracts in other regions. However, our interviews suggest a different dynamic for the marketing contracts commonly used in the Midwest. Desired breeds (basically white hogs), which can be a prerequisite for contracting, are raised not only by contract producers but also by several independent producers as a means of increasing their current and subsequent marketing options. Use of specific genetics (e.g., particular boar semen) is not typically written into a contract, but does appear to emerge after a contract has been initiated. At this point, producers are more willing to "heed" the advice of buyers. Furthermore, producers with verbal agreements (who are not formally classified as contracting in this study) also at times follow the advice of buyers on which boars to use. Hence, the relationship between specific genetics and marketing contracts is more fluid and less fixed than for production contracts that are more common in other regions.

Table 2. Risk Perception, Risk Attitude, and Asset Specificity Survey Items

Risk Perception Items:	
*RP*1	How risky do you consider market prices for hogs?
*RP*2	How risky do you consider selling your hogs in cash markets?
*RP*3	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 *not* risky at all.
Risk Attitude Items:	
*RA*1	I usually like "playing it safe" (for instance, "locking in a price") instead of taking risks for market prices for (weaner, feader, finished) hogs.
*RA*2	When selling/marketing my hogs, I prefer financial certainty to financial uncertainty.
*RA*3	When selling/marketing my hogs, I am willing to take higher financial risks in order to realize higher average returns.
*RA*4	I like taking financial risks with my hog farm business.
*RA*5	I accept more risk in my hog farm than other hog farmers.
*RA*6	With respect to the conduct of business, I dislike risk.
Asset Specificity Items:	
*Human*1	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.
*Human*2	The relationship with my primary buyer has become valuable in terms of the experience/knowledge that we share regarding each other's practices and needs.
*Human*3	Experience (information) regarding each other's practices and needs is an aspect of the relationship with my primary buyer that I value.
*Human*4	Experience (information) regarding each other's practices and needs is an aspect of our relationship that my primary buyer likely values.
*Human*5	My primary buyer considers my understanding of its input needs and/or operating/trade procedures key to our relationship.
*Physical*1	I could not recover the full value of my investments in specialized equipment and/or facilities if the relationship with my primary buyer ended.
*Physical*2	My production system has been tailored to meet the requirements of dealing with my primary buyer.
*Physical*3	I've made significant investments in equipment and/or facilities dedicated to the relationship with my primary buyer.
*Physical*4	I own equipment and/or facilities that were required by my primary buyer.
*Physical*5	My primary buyer requires me to use specific genetics or blood lines.
*Site*1	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	The number of nearby buyers impacts my choice of a primary buyer.

Notes: Risk perception items 1–3 scaled as follows: 1 = "not at all risky" and 9 = "very risky." Risk perception items 4–7, risk attitude items, and asset specificity items scaled as follows: 1 = "strongly disagree" and 9 = "strongly agree." Risk perception and risk attitude items adopted from Pennings and Wansink (2004) and Pennings and Garcia (2001), respectively. Human asset specificity items reflect Anderson's (1985, 1988) focus on the value of experience with trade partners. Physical asset specificity items 2 and 3 adopted from Heide and John (1992). All other items were developed specifically for this study.

Empirical Methods

Measures for risk behavior and transaction cost variables are constructed from survey items using factor analysis, since these theoretical concepts are observable only indirectly (Hair et al., 1995). Relationships between relevant survey items are summarized as a smaller set of more parsimonious variables (eigenvectors called factors) that conserve degrees of freedom and improve power against type II errors in subsequent logit analyses (Thompson, 2004). Factor analysis is performed in SPSS and AMOS. All other analyses are performed in STATA.

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 more dichotomous questions (e.g., $y = 1$ if contract; $y = 0$ otherwise). Binomial logit procedures estimate the probability $\Pr(y = 1 \mid \mathbf{x}) = (e^{\mathbf{x}'\boldsymbol{\beta}}) / (1 + e^{\mathbf{x}'\boldsymbol{\beta}}) = F(\mathbf{x}'\boldsymbol{\beta})$, where $\mathbf{x}$ and $\boldsymbol{\beta}$ are vectors of explanatory variables and coefficients, respectively, and $F(\cdot)$ is the logistic cumulative distribution function. Both Sykuta (2005) and Hoetker (2007) summarize best practices for logit models which are followed here.

While 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 (Hoetker, 2007). Unless particular values are of interest, marginal effects are often computed at the mean. We report the average of marginal effects computed for each observation, since no observation is likely to have mean values for all variables. These average marginal effects can differ from those computed at the mean by a factor of three (Hoetker) 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 (cf., 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 pseudo-R^2 measures exist for logit models, none of which equate directly 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 50% correctly. Hence, McFadden's (1974) pseudo-R^2 and the proportion correctly predicted by the naïve model also are reported for comparison with each model's proportion of correct predictions in our analysis. Additionally, nonnested J-tests are performed to gain insight into the relative performance of the models (cf., Davidson and MacKinnon, 1981).

Empirical Results

Factor Analysis

Following the conventional "K1" rule, we identify notable factors possessing characteristic roots (eigenvalues) greater than one (Thompson, 2004). Such factors consist of survey items with high factor loadings and explain the majority of common variance. Our measures are reliable, as indicated by Cronbach's (1951) alphas greater than 0.70 (table 3), and we find little difference between using original and standardized items (zero mean, unit variance). Hence, the factors employed in logit regressions are computed from the original items.

Table 3. Construct Reliability and Summary Statistics, 2006 Data (*N* = 48 observations)

Bootstrapped Factors	Survey Items	Cronbach's Alpha	Maximum	Minimum	Mean (Std.Dev.)
RISK PERCEPTION	*RP*1–*RP*5, *RP*7	0.777	8.40	2.62	5.70 (1.34)
RISK ATTITUDE	*RA*1–*RA*6	0.785	3.73	−3.88	0.27 (1.73)
IRAP	—	—	24.32	−30.84	1.65 (11.28)
HUMAN ASSET SPECIFICITY	*HU*1–*HU*5	0.897	4.17	0.69	2.67 (1.06)
SITE ASSET SPECIFICITY	*SI*1–*SI*5	0.845	6.06	0.73	3.77 (1.36)
PHYSICAL ASSET SPECIFICITY	*PH*1–*PH*4	0.902	7.27	0.90	2.19 (1.31)
SPECIFIC GENETICS	*PH*5	—	9.00	1.00	3.28 (2.64)

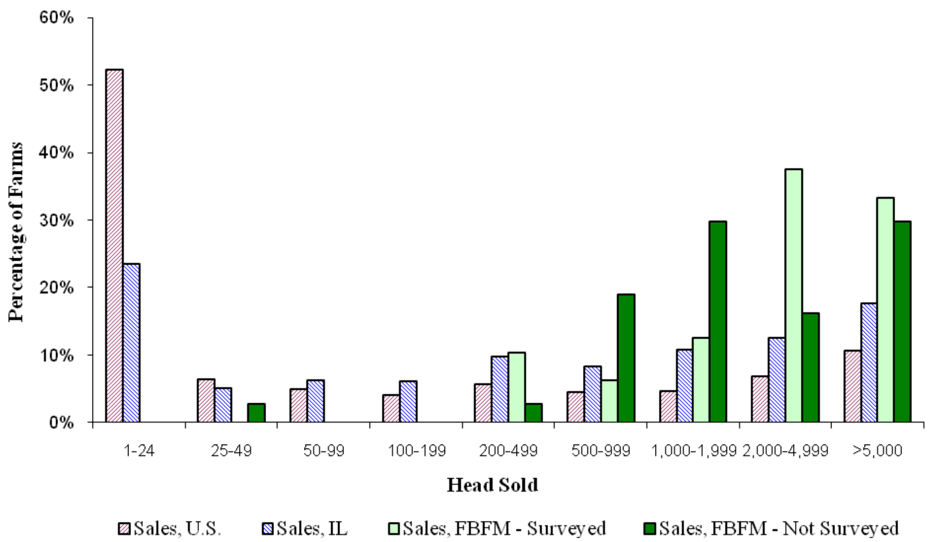
Notes: RP, *RA*, *HU*, *PH*, and *SI*, respectively, denote risk perception, risk attitude, and human, physical, and site asset specificity items identified in table 2. The items were reverse-coded when appropriate. *IRAP* is the product of *RISK PERCEPTION* and *RISK ATTITUDE* factors.

In most cases, all of the items in a particular rubric entered into the respective factors. A notable exception was the fifth physical asset specificity item (*PH*5) which reflects investments in specific hog genetics. This item loaded nearly evenly on *HUMAN* and *PHYSICAL* factors. To preserve the unidimensionality of these factors, the hog genetics item was excluded from their computations but was examined separately in the subsequent logit analysis to reflect the importance of genetics in the hog industry. *IRAP* was computed as the product of *RISK ATTITUDE* and *RISK PERCEPTION* factors.

Sample Statistics and Representativeness

With much of the growth in large hog production operations occurring outside of traditional Midwest production regions, the representativeness of our relatively small sample of Illinois hog producers must be established. Illinois ranks fourth among U.S. states in terms of total hogs and pigs on inventory, with about 4.35 million head in 2008 (USDA/NASS, "Hogs and Pigs"). According to FBFM Extension specialists, "the data from recordkeeping farms may be used with reasonable confidence, even though the recordkeeping farms as a group do not represent a cross section of all commercial farms in the state" (Lattz, Cagley, and Raab, 2005, p. 1).

The distribution of surveyed hog farms across sales is consistent with the USDA's *2007 Census of Agriculture* numbers for Illinois hog farms of 200 to 1,999 head, but underrepresents smaller farms and somewhat overrepresents larger farms (figure 2). There is little difference between FBFM producers who chose to participate in this study and those who did not. In both cases, about 33% of the producers sell more than 5,000 hogs annually. Similarly, the USDA ARMS data used in other hog marketing studies (e.g., Key and McBride, 2003) underrepresent the proportion of small hog farms in USDA Census data, which partly reflects a process of screening noncommercial production from the ARMS data set (cf., Key and



Notes: Sales data on Farm Business Farm Management (FBFM) Association members are for 2006; Illinois and U.S. data are from the USDA's *2007 Census of Agriculture*.

Figure 2. Percentage of farms by inventories and sales, 2006 and 2007

McBride, 2007).[5] Our sample is also comparable to other producers in terms of average costs of production. USDA 2006 estimates for total operating costs of \$44.73/cwt and \$41.81/cwt in the United States and the Heartland are similar to the value of \$41.89/cwt for surveyed FBFM producers.

Summary statistics also substantiate the representativeness of our sample and suggest substantial variation for the explanatory variables (tables 1 and 3). The average producer is approximately 53 years old, sells about 5,000 hogs annually, and is highly leveraged as indicated by a negative mean capital replacement and term debt repayment margin. Similarly, the average age of producers in the ARMS data set is 51 (Zheng, Vukina, and Shin, 2008). About half of the producers in the ARMS data set have completed some college. Eighteen of the surveyed FBFM producers possess a bachelor of science degree. Only five producers in our sample specialize in one stage of hog production. Such specialization is more common outside the Midwest (Davis and Gillespie, 2007). On average, FBFM producers perceive considerable environmental risk and are slightly risk averse, while they somewhat disagree with survey items stating that their investments are specialized (table 3). Producers using marketing contracts generally agree with these statements more.

Correlations are presented in table 4. 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 factor and *IRAP*. *SIZE* and various measures of asset specificity exhibit moderate

[5] As a caveat, representativeness in terms of the number of farms distributed across size categories may not equate to a good representation of how the majority of hogs produced are marketed. That is, one large farm will sell as many hogs as several small farms combined. Furthermore, how our sample compares to the U.S. hog industry in the greater than 5,000 hogs sold segment is difficult to say. Our sample does not represent the large production contract operations prominent outside the Midwest. Prior research suggests Midwest farms are more diversified in terms of commodities produced, and thus less likely to use production contracts (Kliebenstein and Lawrence, 1995; Davis and Gillespie, 2007). In this respect, our sample is more representative of Midwest farms and Illinois farms in particular, as all but one of the producers in our sample also raise corn and soybeans, and 10 of the producers also raise cattle.

Table 4. Correlation Coefficients (*N* = 48 observations)

	CONTRACT	*SPOT*	*AGE*	*ED*	*SIZE*	*LEV*	*STAGE*	*HU*	*SI*	*PH*	*Physical*5	*RP*	*RA*	*IRAP*
CONTRACT	1.00													
SPOT	−0.82	1.00												
AGE	−0.18	0.36	1.00											
ED	−0.18	0.21	0.13	1.00										
SIZE	0.30	−0.30	0.05	0.05	1.00									
LEV	−0.28	0.20	−0.12	0.12	−0.56	1.00								
STAGE	0.10	−0.03	0.16	−0.12	−0.04	0.01	1.00							
HU	0.36	−0.29	0.06	−0.13	0.15	−0.30	0.11	1.00						
SI	0.06	−0.08	0.06	−0.37	0.06	−0.08	0.15	0.36	1.00					
PH	0.15	−0.09	0.01	−0.02	0.09	−0.04	0.18	0.54	0.23	1.00				
*Physical*5	0.50	−0.36	−0.01	−0.08	0.20	0.05	0.02	0.57	0.10	0.59	1.00			
RP	0.02	−0.02	0.31	0.07	0.10	0.10	0.11	0.00	0.23	−0.03	0.10	1.00		
RA	0.34	−0.42	−0.19	0.01	0.18	−0.05	0.05	0.45	0.20	0.33	0.42	0.04	1.00	
IRAP	0.31	−0.38	−0.18	0.04	0.17	−0.03	0.00	0.47	0.19	0.34	0.41	−0.06	0.98	1.00

Notes: *AGE*, *ED*, and *LEV*, respectively, denote age in years, education (= 1 if four years of college and 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. *Physical*5 similarly denotes specific investments in hog genetics (*SPECIFIC GENETICS*).

correlation with the dependent variables. The largest of these correlations is for the fifth physical asset specificity item (*Physical*5) which reflects investments in specific hog genetics. Interestingly, genetic (and human) asset specificity and *IRAP* exhibit similar levels of correlation with the dependent variables, suggesting that contract producers who make specific investments are also risk averse.

Regression Results

Logit results for transaction cost, risk behavior, and unified frameworks are presented in table 5. Here, asset specificity is represented in both the transaction cost and unified models by the survey item reflecting investments in specific hog genetics. The human asset specificity factor behaves similarly but exhibits lower (higher) statistical significance in *CONTRACT* (*SPOT*) regressions, while physical and site asset specificity factors are insignificant. In the transaction cost model, *UNCERTAINTY* is measured by the risk perception factor.

For each logit regression, 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 increases and the probability of using spot markets decreases around 2% to 3% for every additional 1,000 hogs sold. While Key and McBride find no link between production contracts and producers' access to external debt, Davis and Gillespie (2007) suggest that their own results reflect less debt borne under these input-providing contracts than under independent production. 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 expectations for age and Key and McBride's findings for experience, we find that older (more experienced) producers are more likely to use spot markets than long-term contracts. Although the sign on *EDUCATION* is consistent with results reported by Key and McBride, it is statistically significant only in the risk behavior model for *SPOT*.[6]

With regard to the question posed in our title, the findings provide direct empirical support for asset specificity and risk preferences as predictors of hog marketing arrangements adopted by producers in our sample. Since the factor measures of these latent variables are comprised of several survey items of the same scale, their marginal effects may be interpreted in the same manner as any other variable and may be readily compared across factors. However, comparing the marginal effects of factors and hard data is less straightforward, as the marginal effects of all variables change with scaling, and survey scale items cannot be readily translated to standard metrics used for hard data (e.g., number of hogs sold). Hence, the statistical significance of these factors is given more attention here than the magnitude of their influence. Though *UNCERTAINTY* as measured by the risk perception factor in the transaction cost model offers no statistically significant support for hypothesis H_1, *SPECIFIC GENETICS* provides stronger support for hypothesis H_2. Strong statistically significant support also is obtained for hypothesis H_3, as average marginal effects indicate that a unit increase in *IRAP* increases the probability of using long-term contracts and decreases the probability of using spot markets by about 1%. Consistent with Davis and Gillespie (2007),

[6] Assuming cooperative and independent producers are 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.

Table 5. Marginal Effects for Logit Models of Marketing Arrangements (*N* = 48 observations)

	Transaction Cost Model		Risk Behavior Model		Unified Framework	
Marginal Effect	*CONTRACT*	*SPOT*	*CONTRACT*	*SPOT*	*CONTRACT*	*SPOT*
SIZE	0.0178	−0.0303**	0.0278**	−0.0349***	0.0185	−0.0299**
	(0.0119)	(0.0126)	(0.0127)	(0.0113)	(0.0115)	(0.0118)
LEVERAGE	−0.0007***	0.0008***	−0.0007**	0.0008***	−0.0007***	0.0007***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
AGE	−0.0141***	0.0268***	−0.0132**	0.0233***	−0.0127**	0.0228***
	(0.0055)	(0.0063)	(0.0066)	(0.0059)	(0.0053)	(0.0060)
EDUCATION	−0.1025	0.1502	−0.1426	0.1621*	−0.1108	0.1486
	(0.0983)	(0.1034)	(0.0966)	(0.1002)	(0.0981)	(0.0991)
UNCERTAINTY	0.0213	−0.0526	—	—	—	—
	(0.0508)	(0.0466)				
IRAP	—	—	0.0117**	−0.0129***	0.0059	−0.0108**
			(0.0055)	(0.0048)	(0.0059)	(0.0054)
SPECIFIC GENETICS	0.0599***	−0.0345*	—	—	0.0515***	−0.0234
	(0.0132)	(0.0177)			(0.0140)	(0.0181)
McFadden's R^2	0.4208	0.4028	0.2898	0.4158	0.4355	0.4401
% Correctly Predicted	90	81	81	88	90	85

Notes: Single, double, and triple asterisks (*, **, ***) denote statistical significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are standard errors; 73% (65%) of observations for *CONTRACT* (*SPOT*) are correctly predicted by naïve models.

STAGE provided no significant support for positive agency theory's task programmability concept in unreported results.

Notice that the moderately correlated risk and transaction cost variables (table 4) vie for significance in the unified model (table 5). Inclusion of *IRAP* in *SPOT* regressions erodes the significance of *SPECIFIC GENETICS*, relative to the results for the transaction cost model. Conversely, *IRAP* loses significance with the inclusion of *SPECIFIC GENETICS* in *CONTRACT* regressions, relative to the risk behavior model. These findings suggest that relatively risk-averse producers accept processors' contracts supporting specific investments, which contributes to the difficulty in disentangling their effects. In *SPOT* regressions, the relatively lower significance of asset specificity variables and the higher significance of *IRAP* may also reflect use of futures, options, and forward contracts, which entail no asset specificity but mitigate risk. Overall, the results support hypotheses H_2 and H_3, underscoring the importance of asset specificity and risk behavior.

In terms of both McFadden's R^2 and the proportion of observations correctly predicted, the transaction cost model outperforms the risk behavior model for *CONTRACT* regressions while the reverse is true for *SPOT* regressions. The unified framework offers the highest predictive power for *CONTRACT* (the same level as the transaction cost model) but not for *SPOT*. Closer inspection reveals that for every observation of *SPOT* where the risk behavior model outpredicts the unified framework, predicted probabilities were very close but on opposite sides of the 50% cutoff value for a prediction of one.

To assess the robustness of our findings, we also estimate the relationships using a two-limit tobit analysis of truncated continuous dependent variables characterizing the percentage

Table 6. Results of Nonnested Model Specification Tests (*N* = 48 observations)

Models w/Binary Dependent Variables		*CONTRACT*		*SPOT*	
Base Model	Alternative Model	*z*-Statistic	*p*-Value	*z*-Statistic	*p*-Value
RISK model	TCE model	2.66	0.01	0.72	0.47
TCE model	RISK model	1.07	0.29	2.43	0.015
UNIFIED model	TCE model	1.65	0.10	−0.08	0.94
TCE model	UNIFIED model	1.68	0.09	1.48	0.14
Models w/Continuous Dependent Variables		*CONTRACT*		*SPOT*	
Base Model	Alternative Model	*t*-Statistic	*p*-Value	*t*-Statistic	*p*-Value
RISK model	TCE model	2.38	0.02	2.16	0.04
TCE model	RISK model	1.12	0.27	2.70	0.01
UNIFIED model	TCE model	0.44	0.67	0.20	0.84
TCE model	UNIFIED model	1.12	0.27	2.70	0.01

Note: Statistically significant test statistics warrant rejection of the base model due to significant additional information provided by the alternative model.

of hogs sold via spot markets and marketing contracts.[7] The results (not presented here, but available from the authors on request) also support transaction cost and risk motives for contract use. For contract use, *SPECIFIC GENETICS* is significant at the 1% and 5% levels, respectively, in the transaction cost and unified models, while *IRAP* is significant at the 10% level for the risk behavior model only. For spot market use, *SPECIFIC GENETICS* is significant at the 1% and 5% levels, respectively, in the transaction cost and unified models, while *IRAP* is significant at the 1% level in both the risk behavior and unified models. The similarity in findings emerges primarily because most of the producers who use marketing contracts sell their entire production through the outlet.

Finally, the results of nonnested *J*-tests of relative model performance (cf., Davidson and MacKinnon, 1981) are presented in table 6. Statistically significant test statistics warrant rejection of the hypothesized base model due to significant additional information provided by the alternative model. As *J*-tests tend to reject the null too often, we employ the 5% level of significance as a conservative standard. Results for binary and continuous specifications of *CONTRACT* suggest that the transaction cost model outperforms the risk behavior model, but the transaction cost and unified models are not discernibly different. This finding is consistent with McFadden's R^2 and the proportion of observations correctly predicted. For *SPOT* the results are less direct, but informative. For the binary specification, the transaction cost model is rejected in favor of the risk behavior model. For the continuous specification, tests indicate both models are incomplete, and that the unified model is a superior representation. The transaction cost model is rejected at the 1% level in favor of the unified model. The unified model is also superior to the nested risk behavior model, since *SPECIFIC GENETICS* is

[7] See Hobbs (1997) and Kosarek, Garcia, and Morris (2001) for examples of two-limit tobit estimation. The procedure is appropriate for continuous dependent variables that, like our data, have many observations at extreme values (i.e., fat tails).

statistically significant in the unreported results for the unified model. Intuitively, these results suggest that a unified framework can be more informative, particularly in explaining spot market use (i.e., the non-use of both marketing contracts associated with specific investments and short-term contracts limiting exposure to price risk).

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 participating in a farm management association at the University of Illinois, and verify the relevance of risk behavior and transaction costs theories using a unified framework. Overall, our findings reveal that the unified framework performs as well as or better than separate risk behavior and transaction cost frameworks.

By incorporating a more explicit treatment of risk preferences within the transaction cost framework, we find that risk preferences and investments in assets tailored for a specific exchange relationship are significant predictors of marketing arrangements. Our findings for Pennings and Wansink's (2004) interaction of risk attitudes and risk perceptions variable (*IRAP*) suggest that, consistent with risk behavior theory (Pratt, 1964; Arrow, 1971), producers who are more averse to price risk and perceive more of it are more likely to select contracting over spot sales. Failure by Davis and Gillespie (2007) to identify a risk attitude effect likely reflects their focus on investment rather than price risk.

Consistent with transaction cost 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 marketing contracts (spot markets). However, no support was found for such investments in physical assets or site specificity. As observed by Ménard and Klein (2004), site specificity may be less important than in the poultry industry, because hogs can be transported further without losing value. The general agreement of our results with the efficiency-based predictions of transaction cost economics further supports Muth's (2007) testimony to policy makers that the livestock industry is operating efficiently.

The influences of asset specificity and risk preferences identified here fit with trends of market coordination in response to growing segments of consumers with particular tastes and dietary concerns. Coordination of production practices and genetics among hog producers helps processors source certain carcass attributes needed to serve these segments with differentiated retail pork products. In return, producers may expect a premium or price protection in the form of a long-term contract. Alternatively, coordination may be achieved and producers may be insulated from price variation through employment in vertically integrated firms. Ideally, a multinomial logit model could be used to examine the full spectrum of marketing arrangements.

Given a limited sample of 48 hog producers using marketing contracts, forward contracts, futures and options, and spot sales, we creatively offer insights for a portion of the spectrum of marketing arrangements by analyzing both contract and spot dependent variables. Thereby, we ascertain the relative importance of risk and transaction cost considerations for long- and short-term contracts, relative to spot transactions. Our results suggest that both aspects are relevant, but the transaction costs associated with specialized investments are relatively more important for long-term marketing contracts, whereas risk aversion has a greater impact on spot market use for which short-term forward contracts and futures and options are other alternatives. While both theories appear to be incomplete representations of commodity marketing, combining aspects from each offers a richer understanding.

Despite a limited sample size, we identify significant effects using a unique combination of accounting data and survey data. The use of factor analysis (Hair et al., 1995) to construct reliable measures of risk behavior and transaction costs variables from survey items contributes to this success, as does the use of complementary accounting data to accurately control for the size and leverage of each hog operation. In comparison, many previous hog marketing studies rely solely on self-reported survey data which are sometimes considered less reliable than hard data. Given our focus on the use of marketing contracts and spot sales by Illinois producers in a farm management association, future research may investigate whether the influences of risk preferences and asset specificity extend to the rest of the industry, particularly for other regions of hog production and other marketing arrangements. Our findings may be applicable to other agricultural markets as well. New asset-specific technologies and producers' perceptions and attitudes regarding market risk seem likely candidates to explain differences across commodity marketing channels. Future research using a multi-commodity context and longitudinal data may permit a clearer understanding of the factors affecting marketing arrangements and the usefulness of the unified conceptual framework presented here.

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