# The Role of Risk and Risk-Aversion in Adoption of Alternative Marketing Arrangements by the U.S. Farmers

Wu-Yueh Hu*, Tomislav Vukina, Xiaoyong Zheng[1]

**Abstract**

The objective of this paper is to analyze the relationship between farmers' risk-aversions and the riskiness of various agricultural enterprises to see which marketing arrangements would typically emerge. Relying on the basic agency theory model we hypothesize the prevalence of alternative marketing arrangements (AMAs) in situations with high-risk averse farmers and high-risk enterprises and the prevalence of spot (cash) markets for low risk-averse participants and less risky enterprises. Our empirical tests are carried out using the 2004 Agricultural Resource Management Survey (ARMS). The empirical results are largely supportive of the agency theory of contract choice.

**Keywords:** Agency theory, Risk, Contract choice.

**JEL Classifications**: Q12; Q13; L14

[1] : Hu, Wu-Yueh; The Corresponding Author. National Chung Hsing University, Applied Economics, 250 Kuo Kuang Rd., Taichung 402, Taiwan. Email: wyhu@nchu.edu.tw

Vukina, Tomislav; North Carolina State University, Agricultural and Resource Economics, Raleigh, USA

Zheng, Xiaoyong; North Carolina State University, Agricultural and Resource Economics, Raleigh USA

## 1. Introduction

One of the most important characteristics of modern agriculture in the U.S. is the increasing use of various alternative marketing arrangements (AMAs). AMAs refer to formal contractual arrangements in agriculture that serve as alternatives to the cash or spot market. Two main types of AMAs are marketing contracts and production contracts. The main characteristic of both of them is that they are reached prior to harvest or before the animals are finished for slaughter. AMAs covered 39% of the value of U.S. agricultural production in 2008, compared with 41% in 2005, 28% in 1991 and only 11% in 1969 (MacDonald and Korb, 2011). The inter-year decline in the use of contracts after 2005 is largely attributable to the change in the composition of agricultural production as prices and revenues for commodities less reliant on contracts rose sharply.

The use of AMAs can be understood and analyzed from either side of the contractual relation: the firm (packer, integrator, and processor) side or the farm (grower, producer) side. The use of contracts by firms is well understood in the context of a rather large literature on the natural boundaries of firms (the so called "make or buy problem").[2] When it comes to vertical organization of food supply chains, the literature mainly followed the transaction cost paradigm. The transaction cost or rent-seeking theory of firm adopted the definition of integration as the unification of control rights, with the key variables characterizing the situation under which transactions take place being the degree of asset specificity and the amount of uncertainty in the market (Coase 1937, Williamson 1985). For example, den Ouden et al. (1996) identify growing quality and credence attributes requirements by consumers (such as animal welfare, food safety, traceability, environmental

[2] For an excellent overview and exposition of different theories of the firm see Gibbons (2004).

stewardship, etc.) as the major driving forces for more contracts and vertical integration. According to Hobbs et al. (2002), various food crises such as mad cow disease are another reason for quality uncertainty becoming the major concern in agribusiness. Generally speaking, information externalities arising from uncertainties in detecting food quality may be reasons why vertical coordination is used to circumvent the market place (Hennesy, 1996). Organizing the information flow along the supply chain for transmitting the changing customer demands to the farm stages is considered more transaction cost efficient under contracts and in vertically integrated systems than in the spot markets.

In this paper, we study the motivations and incentives of farmers to rely on the AMAs to market their products. The literature in this area is divided between the agency theory and the transaction cost camps. In the core of the agency theory is the principal agent model (Grossman and Hart, 1983) which provides the solution for the optimal contract that strikes a balance between the provision of incentives and insurance for the risk-averse agents. The shape of the optimal contract should depend inversely on the agent's risk aversion and the riskiness of the contracted task. Hence, more risk-averse agents always face lower powered incentive schemes (those that provide more income insurance) and less risk-averse agents should face higher powered schemes (less income insurance). Most of the empirical literature that relies on this framework used the data for one product or commodity. For example, Knoeber and Thurman (1995) have shown that broiler industry contracts shift 97% of the total risk from growers to the integrator. Martin (1997) has shown that swine industry production contracts eliminate about 94% of the total income variability of the spot market. Zheng, Vukina and Shin (2008) showed that more risk-averse hog producers are more likely to use production contracts and less risk-averse producers are more likely to use marketing contracts or the spot market.

Extending the transaction cost theory of the firm to the farm, some authors (e.g., Allen and Lueck 1992, 1993, 1995, 1999) explained the use of contracts in agriculture by the incentives of contracting parties to reduce transaction costs and found either a positive relationship between risk and incentives or the unimportance of risk and risk-aversion for contract choice. However, Ackerberg and Botticini (2002) showed that the result claiming the positive relationship between risk-aversion and incentives is very likely the consequence of econometric problems. They argued that in the presence of endogenous matching between principals and agents where the agent's risk aversion or the riskiness of the task is unobservable, one could end up with a spuriously positive relationship between risk aversion and the power of incentives. This could be the case if, for example, agents with low risk-aversion sorted themselves into highly risky tasks and ended up signing low powered incentive contracts. Fukunaga and Huffman (2009) found support for both the transaction cost well as the agency theory framework in explaining the use of crop-sharing contracts.

The main objective of this paper is to cast some new light into the importance of risk and risk aversion for contract choice as perceived by farmers. In particular we are interested in understanding and explaining the use of contracts (AMAs) against the reliance on the spot (cash) markets. Unlike many previous studies that focused on one commodity or enterprise (hogs or chickens) we use the data from a wide range of agricultural activities covering both crops and livestock enterprises. Because we are dealing with multiple agricultural markets, our objective is to analyze the established matching patterns between the farmers' risk-aversions and the riskiness of various agricultural enterprises to see which market arrangements emerge. Relying on the basic principal-agent model we hypothesize the prevalence of AMAs in situations with high-risk averse farmers and high-risk enterprises and the prevalence of spot markets for low risk-averse participants and less risky enterprises. Our empirical tests are carried out using the 2004 Agricultural Resource Management Survey (ARMS). The empirical results are largely supportive of the agency theory of contract choice.

## 2. Definitions, Institutions and Data

A recently completed survey of producers of live hogs indicated a number of different economic incentives associated with using the AMAs (see Cates et al., 2007). As the three most important reasons for using the AMAs the survey respondents indicated: the reduction in risk exposure (76% of respondents); the reduction in price variability (44%); and the improvement in securing a buyer (39%). Obviously, not all AMAs provide equal protection against various types of risks, so it is important to highlight the major differences between them.

A marketing contract is a verbal or written agreement to market a commodity before the completion of a production cycle (e.g., before the crop is harvested or before the animals reach the market weight). The agreement usually includes the price, or an arrangement to determine the price at the time of delivery, or a commitment by the contractor to purchase the product from the farmer/operator with the price negotiated later. Prices may often vary with the quantity and the attributes of the product. Most marketing contracts will specify the base price or price formula such that the price variation will be less than it is in the spot market. With this arrangement, the operator supplies and finances all or most of the inputs used in production, makes all production decisions, owns the product until delivery, and therefore, often bears all production risks. Marketing contracts are used for both crops and livestock but are more common for crops.

A production contract is an agreement reached before the production begins which details the farmer's and contractor's responsibilities for providing inputs and specifies the payment mechanism which will be used to compensate farmers for the provision of their inputs. The contractor remains the residual claimant on the realized profits. The contractor usually owns animals or crops, provides most of the variable inputs (feed, seed, fertilizer, chemical, transportation and technical assistance) and makes major production and marketing decisions. The farmers supply labor, management services and some of the fixed inputs (land, buildings, etc.). Production contracts often set firm guidelines regarding production practices, and farmer/grower compensation schemes frequently depend on how effectively the contractor supplied inputs have been utilized. In the production contract, the farmer/grower payment will typically not depend on either input or output prices, which makes growers completely insulated from the price risk. For example, under poultry production contracts, contract growers are required to tend the company owned chickens or turkeys until the birds are ready for slaughter. The contractor normally provides young chicks, feed, medical care and transportation and the contract operator provides chicken houses and equipment, supplies his labor and management attention and pays for utilities and some other small inputs. In return for his services, the grower gets paid a variable piece rate per pound of live poultry delivered where the variability in the piece rate is determined in a tournament setting where the individual performance is compared against the group average performance. For above average performance (below average cost) the grower receives a bonus, and for the below average performance (above average cost), the grower receives a penalty (for details see Vukina 2003). Production contracts are mainly used in the production of hogs, poultry and a limited number of crops.

Based on the description above, the riskiness (price, production and market access risks) of the three marketing arrangements can be ranked. The spot market is the most risky marketing arrangements since farmers selling their products in the spot market bear all of the price, production and market access risks. Marketing contracts are less risky than the spot market since they eliminate the market access risk and some of the price risk but they do not help in reducing the production risk. Production contracts are the least risky marketing arrangement among the three since they eliminate both price and market access risks and reduce the production risk. The summary of basic characteristics of the three marketing arrangements is given in Table 1. It shows the degree of business autonomy, price risk, production risk and market access risk for the three different marketing arrangements. Table 1 also briefly describes the timing of the agreement reached, how the farmer gets paid and the ownership of the product before the delivery.

The main data set used in this study is the 2004 Agricultural Resource Management Survey (ARMS). ARMS are the nationally representative farm level data which provide detailed information on the financial condition, production practices, resource use, and economic well-being of the U.S. farm households. The survey asks farmers about the use of AMAs (production or marketing contracts) and the volume of production and receipts for each commodity under contracts. We focused on the targeted group of commodities consisting of eight crops (corn, soybeans, wheat, oats, alfalfa, cotton, peanuts, and tobacco) and five livestock products (cattle, hogs, broilers, turkeys and milk). They have been chosen based on their production value in U.S. agriculture and their significance with respect to the AMA use. The original data set contains 20,579 observations (farms). Because of the missing values or because farms did not produce our target commodities, the data set used for the empirical analyses shrunk to 14,492 observations.[3]

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[3] All our results are based on the raw data. A special feature of the ARMS survey design is that all samples are probability-weighted. Each sample in the data has a weight (expansion factor), which is to be used to obtain the population estimates. During our data cleaning procedures, a significant

In Table 2 we show the pattern of use of various marketing arrangements by U.S. farmers by commodity. There are seven possible combinations of three marketing arrangements: cash market (C), marketing contract (M) and production contract (P). The percentage of farms using the specific marketing arrangement is the sum of all combinations. For example, the percentage of farmers using the spot market is the sum of the percentages under C, CM, CP and CMP. As seen from Table 2, the spot (cash) market is still the dominant marketing outlet with close to 100% of oats and alfalfa farmers relying on them and very high percentage of corn, soybean and wheat farmers. Marketing contracts are commonly used by various crops and milk farmers but rarely by livestock producers. Production contracts are common in livestock but rare in crops (0.56% for corn, 0.51% for soybeans and 0.12% for wheat). Marketing contracts and production contracts are rarely used together by the same commodity farmers (only 0.13% for corn, 0.22% for soybean and 0.06% for hog producers).[4]

Heavy reliance on spot markets is detectable by all program commodities (wheat, corn, sorghum, barley, oats, upland cotton, rice, soybeans and other oilseeds) which we include in the analysis because of the availability of various support programs. The Food, Conservation and Energy Act (FCEA) of 2008 commodity support programs provides a 5-piece safety net for famers: direct payments, counter-cyclical payments, and marketing assistance loans and loan deficiency payments from the

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number of observations were excluded due to the missing or unreasonable values of some variables. Hence, using weights would complicate the analysis. In their study of marketing contract decisions by farmers, Katchova and Miranda (2004) showed that there is no qualitative difference between results obtained with ARMS data with or without weights.

[4] Somewhat different patterns of use are revealed based on the production volumes with newer data. For example, in 2008, AMAs covered 90% of poultry production, 68% of hog production and 90% of the sugar beet and tobacco production. Of course, AMAs were much less prevalent in corn (26% of production), soybeans (25%) and wheat (23%), although the use of AMAs in each of those field crops grew by at least 10 percentage points between 2001 and 2008 (MacDonald and Korb, 2011).

2002 Farm Bill plus the new Average Crop Revenue Election (ACRE) and the Supplemental Revenue Assistance (SURE) programs (Dumler and Lubben, 2008). Each of those 5 programs works differently and is calculated on a different base such that their degree of decoupling from production and prices varies. Marketing loans are tied to specific production each year, whereas direct and countercyclical payments are tied to a historical acreage base and payment yields that do not change year to year. ACRE payments are made on crop planted acres while SURE payments are made at the farm level. Regardless of the specifics of each program, all of them diminish, to a certain degree, the incentives to rely on AMAs as risk management devices.

When it comes to most important grains, 30.69% of corn producers, 24.62% of soybean producers and 15.32% of wheat producers use marketing contracts. Corn, soybean and wheat producers who use marketing contracts tend to be larger producers who use those instruments to cover a substantial share of their production. For those producers, marketing contracts are used to manage price and market access risks in combination with cash sales, financial hedges and storage options. Only 3.62% of the corn producers, 3.15% of the soybean producers and 2.25% of the wheat producers use only marketing contracts to sell their entire output.

The main industrial crops exhibit different patterns of AMAs adoption: 45.55% of cotton producers, 81.8% of peanuts producers and 42.61% tobacco producers rely at least partially (usually in combination with cash marketing) on the marketing contracts. In 2002 and 2004 respectively, the change in policy abolished the decades-long marketing quota system for peanuts and tobacco such that the quota-related price support programs ended.[5] After the quota buyouts, farmers started to face more price and market access risks than before and the percentage of

[5] The 2002 Farm Act and the Fair and Equitable Tobacco Reform Act of 2004.

peanut and tobacco farms using marketing contracts increased significantly (Dohlman, Foreman, Da Pra, 2010).

The importance of AMAs in total livestock marketing is much larger than in crops. Whereas crop producer who use AMAs rely almost exclusively on marketing contracts, the favorite alternative marketing arrangement for livestock producers is the production contract. This trend reflects the fact that the production risk is higher for livestock than crops. The percentage of farms which rely exclusively on production contracts is 36.31% for hogs, 79.49% for turkeys and 96.57% for broilers. Cattle producers still rely almost entirely (97.44% of farms) on the spot markets only. The fact that the percentage of hog production under contracts (60.6% in 2004) is higher than the percentage of farmers using AMAs (42%), implies that AMAs are mainly used by large-scale hog producers whereas smaller farmers tend to use the cash market.

## 3. Theoretical Framework

The origins of systematic inquiry into the reasons and motives for the use of contracts by farmers can be traced back to the large research program on land and labor contracts in agrarian economies (see Hayami and Otsuka, 1993) with its dominant theoretical kernel - the agency theory (Grossman and Hart, 1983). Agency (principal-agent) theory is concerned with designing an optimum contract between a risk-neutral principal (processor, integrator) and a risk-averse agent (farmer) to produce some output (crop or livestock). The contract is specified by the division of responsibilities for providing inputs and the rules for determining the division of proceeds between the two parties. It is typically assumed that the agent receives a compensation for his inputs whereas the principal remains the residual claimant on the realized profits.

For simplicity consider a production function given by $y_{\{p,a\}} = e_a + \epsilon_p$ where $e_a$ represents agent's effort and $\epsilon_p \sim N(0, \sigma_p^2)$ is the *i.i.d.* productivity shock. The choice of subscripts {a,p}, subsequently dropped to avoid notational clutter, specifies the distribution of inputs in the production function such that the agent supplies effort and the principal supplies only the productivity shock which can be thought of as the riskiness of the enterprise. The agent's cost of effort is given by $C = \frac{c}{2}e^2$ and she is assumed to have constant absolute risk-aversion (CARA) preferences with the utility function given by $V = 1 - \exp\left[-\lambda\left(w - \frac{c}{2}e^2\right)\right]$ where *w* represents the compensation and λ is the Arrow-Pratt measure of the agent's absolute risk aversion. The principal's profit (utility) function is simply: $\pi = y - w$. Both players have zero reservation utilities.

The simplest case is obtained when agent's effort is observable. The symmetric information optimal contract is for the risk-neutral principal to completely insure the risk-averse agent. In this case the agent's compensation is the fixed wage independent of the result. A more realistic case is obtained where the agent's effort is unobservable which leads to a moral hazard problem. If the agent's effort is unobservable, once he signed the fixed wage contract he will exert the lowest possible effort and the principal will obtain a lower expected profit than in the symmetric information case because the agent's effort will be less than the efficient level. Can the principal make the agent interested in the consequences of his behavior by making his compensation depend on the obtained result? Yes, an obvious solution to the problem would be to introduce a franchise contract under which the agent buys the production from the principal. In this case the principal would receive a fixed payment and the agent would accept the entire risk associated with the production. However, the problem with this arrangement is the fact that the farmer is risk averse and may not be interested in signing such a contract because it exposes him to too much risk that he is ill-equipped to bear. Even if "selling the store to the agent" does not appear to be the best solution to the described problem, it makes the main characteristics of the solution to the optimal contracting under moral hazard rather intuitive: the trade-off between optimal insurance (distribution of risk) and the provisions of incentives to exert the unobservable effort.

To show this result assume that the compensation scheme is linear in output such that $w = \alpha + \beta y$ where α is the fixed salary and β is the piece rate. Utilizing the fact that ε is normal, the agent's utility function can be expressed in the mean-variance form and the agent's optimal effort becomes $e^* = \frac{\beta}{c}$. As seen, the optimal effort depends positively on the power of incentives and negatively on the cost of effort. Solving for the optimal contract parameters requires the maximization of the principal's expected profit subject to the agent's incentive compatibility and individual rationality constraints. It is straightforward to show that in this case the optimal piece rate $\beta = \frac{1}{1+c\lambda\sigma^2}$ is inversely related to agent's risk-aversion and the riskiness of the principal's enterprise. Hence, this model generates two testable hypotheses. First, there is a trade-off between incentives and the agent's risk-aversion: everything else equal, the stronger the agent's risk-aversion, the weaker the incentives. Second, there is a trade-off between incentives and the riskiness of the task. In situations where factors beyond the agent's control have a relatively large effect on output, incentives will be weaker.

The above results can be easily translated into the institutional set-up we try to analyze. First, the franchise contract or "selling the store to the agent" obviously corresponds to the spot or cash market. The spot market is the most risky marketing arrangement since farmers selling their products in the spot market bear all of the price, production and market access risks, so we should expect to see such an arrangement to be efficient for low risk-averse farmers or low risk enterprises. In terms of the parameters of the linear compensation scheme this would translate to a contract with $\alpha = -k$, where $k$ represents some franchise fee, and $\beta = 1$ parameters. The two AMAs correspond to contracts with $\alpha > 0$ and $0 < \beta < 1$ parameters. Marketing contracts are less risky than the spot market but still more risky than the production contract and the production contracts are the least risky, so $\beta_C = 1 > \beta_M > \beta_P > 0$. Therefore we expect that both AMAs (marketing and production contracts) should be adopted by more risk-averse farmers or less risky enterprises.[6]

## 4. Empirical Tests and Results

The above theoretical predictions could be tested with a simple econometric model where one would regress the contract choice variable on various measures of the farmers' (agents') risk aversion and the measures of the enterprise risk. The problem is that the structure of our data set does not have any variation in the riskiness of agricultural enterprises by farmer. In other words we only have enterprise risk measures which are common to all farmers. This is the main problem of this empirical analysis. Therefore, we embark on two approaches. We test the

6 Strictly speaking there is an issue of matching that needs to be addressed here because it is possible that low risk-averse agents will select themselves into very risky projects which will be paid based on the low incentives compensation schemes. This will generate a positive relationship between the power of incentives and risk-aversion. As shown by Kandilov and Vukina (2011), in the market setting where many principals contract with many agents, this result depends on the type of matching that can occur in equilibrium. The negative result between risk-aversion or enterprise risk and the likelihood of relying entirely on the spot market which we hypothesize still holds if the matching between the principals and agents based on their respective traits (risk and risk-aversion) is of the negative assortative type (NAM). However, if matching is of positively assortative (PAM), then there is no unique theoretical prediction for the relationship between risk-aversion (or risk) and the contract type, i.e., the relationship can be either positive or negative.

first hypothesis about the relationship between risk-aversion and contract choice by estimating simple logit regressions with the dependent variable defined as 1 if the farm uses any of the AMAs and 0 otherwise. The explanatory variables are the farm (wealth, assets, total acres farmed, number of family members and off-farm income) and the farmer characteristics (age and education) that are either proxies for risk-aversion or perhaps some measures of the cost of effort (see the theoretical expression for the slope coefficient in the linear compensation scheme). We test the second hypothesis about the relationship between enterprise risk and contract choice by computing simple correlations coefficients between various measures of enterprise risk and the AMAs usage.

### *4.1. First Hypothesis*

Since the farmer's risk aversions are not directly observable, we need to deal with the measurement issues. It is widely assumed that the best proxy for risk aversion is wealth. Decreasing absolute risk aversion (DARA) for farmers is a routine assumption in the agricultural economics literature (Pope and Just 1991). DARA implies that wealthy individuals are less risk averse and hence the likelihood of them adopting AMAs should be smaller than for less wealthy individuals. Guiso and Paiella (2008) also showed strong empirical evidence supporting the DARA generally.

For the rest of farm/farmer characteristics we have less precise priors about their relationship to risk-aversion and hence towards the adoption of AMAs. To the extent that assets are correlated with wealth, we expect the same relationship between assets and risk-aversion as between wealth and risk-aversion. The same can be said about the farm size (total acreage farmed). The effect of education on risk aversion is likely to be positive, meaning that more educated individuals should exhibit higher levels of risk-aversion and hence should be more inclined to adopt the AMAs. The positive relationship between education level and the adoption of AMAs is also consistent with the hypothesis that education increases the level of human capital and helps farmers better understand the concept of risk management (Goodwin and Schroeder 1994; Musser, Patrick and Eckman 1996). The relationship between age and risk aversion is expected to be positive in the sense that older people tend to be more risk-averse. The relationship between the family size and risk aversion should be negative in the sense that larger families should exhibit lower levels of risk-aversion because they are better able to diversify risks than smaller households.

The estimation results for individual commodities are presented in Table 4. The parameter estimates are easy to interpret: if a parameter is positive (and significant), then, ceteris paribus, an increase in the corresponding variable will increase the probability of adoption of one of the AMAs (either marketing or production contracts). If the parameter is negative (and significant), then an increase in the given variable increases the probability of using the spot (cash) market. We start with the individual regressions first.

Wealth is defined as the net equity, which is the difference between the primary farm operator's total assets and total debt (both on-farm and off-farm). Total assets variable includes both on-farm and off-farm assets owned by the farmer. The whole sample is divided into three regions: Midwest, South and the rest of the country.[7] The summary statistics of the cleaned data are presented in Table 3. We observe that farm operators in our data set are on average 54.3 years old, rather affluent (with the average total wealth of about 1.28 million dollars) and fairly large (they farm on average 1,370 acres) and that 45% of farms are located in the Midwest and 38% in the

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[7] Midwest: WI, MI, IL, IN, OH, ND, SD, NE, KS, MN, IA, MO; South: DE, MD, DC, VA, WV, NC, SC, GA, FL, KY TN, MS, AL, OK, TX, AK, LA.

South.

First, wealth as our proxy for risk aversion has the correct (negative) sign in 10 out of 13 commodities models, half of which are significant at the standard significance level (5% or better). This means that wealthier individuals have lower risk aversions and have lower tendency towards the adoption of AMAs, i.e., they are more inclined to rely on spot markets. The coefficient has the wrong sign for peanuts, tobacco and turkeys but none of those coefficients is significant. Contrary to our expectation, the totals assets variable has the opposite sign than the wealth variable indicating that farms with more total assets tend to rely more heavily on the AMAs. Upon further reflection, it became rather obvious that this result has little to do with the farmers' risk-aversion and more to do with the farm size because farms that rely heavily on AMAs tend to be much larger. The same is also true for the total acres coefficient, except for oats, cotton, hogs, broilers and milk. This result also makes sense because the hogs, broiler or dairy farms that adopt AMAs typically do not have large acreage.

Other coefficients can be summarized as follows. Off-farm income is always insignificant and so is the family size with only two exceptions. Age of the operator is almost always negative and frequently significant, indicating that older people are less likely to use the AMAs. This is probably not reflective of their risk-aversion but simply the consequence of the fact that older people are more old-fashioned and are more likely to stick to traditional ways of doing business. The education variable is predominantly positive and significant. The exceptions are peanuts, broilers and turkeys but none of this coefficients are significant at the 5% or better. This is consistent with our hypothesis that better educated farmers better understand the concept of risk management and are more likely to adopt new business models.

Second, we look at the pooled estimates presented in Table 5. The results are quite similar to the results obtained with individual commodities regressions. Wealth as a proxy for risk aversion is negative and significant confirming our main prediction based on the agency theory that more risk-averse farmers are more likely to adopt the AMAs. Same as in the majority of individual commodities regressions the coefficient on assets is positive and significant and the total acres coefficient is positive but not significant. Both results suggest the positive relationship between the farm size and the adoption of AMAs. In line with the previous results, the off-farm income and the family size are both insignificant, education is positive and significant and age is negative and significant.

### *4.2. Second Hypothesis:*

Now to the second prediction of our theoretical model: the riskier the farm enterprise (commodity), the more likely is the adoption of AMAs. The problems associated with measuring enterprise risks are quite significant. In agriculture, it is usually assumed that the riskiness of various enterprises can be approximated with the variability of yields and prices and, consequently, revenues or profits. One of the problems with this is that yield variability is endogenous, i.e. it is influenced by farmers' actions. Farmers do various things to increase average yields but also do things to reduce the variability of yields.[8] The fact that yields are contemporaneously geographically correlated causes the negative correlations between prices and yields which serves as a natural hedge to farmers, especially those that are located in areas with a dominant influence on the formation of the market

[8] Ideally, the empirical tests should use the exogenous or natural risk measures (when agent exerts no effort in variance reduction) and not endogenous risk measures (resulting from agent's effort in variance reduction). Allen and Lueck (1999) discussed the difficulties in measuring the exogenous risk and the first attempt to deal with it theoretically is found in Araujo, Moreira and Tsuchida (2007).

price. As mentioned before, a separate factor influencing the adoption of AMAs by farmers is the market access risk, which is generally uncorrelated with price or yields risks and also hard to measure. Having said all this, the theoretically expected relationship between risk and the contract choice may be rather difficult to prove empirically.

Since the ARMS dataset is not a panel, the variations in prices, yields and revenues for individual farmers that are needed to measure risk cannot to be calculated. For this reason we use the annual data from USDA's National Agricultural Statistics Service (NASS) to calculate the coefficient of variation (CV) of prices, yields and revenues for crops and the CV of prices for livestock at the national level from 1975 to 2004.[9] The nominal prices were deflated using the CPI.[10] As seen from the first two columns in Table 6, the price variations for crops are substantially larger than yield variations. In the case of livestock, the largest price variation is recorded in turkeys and the smallest in broilers.

In addition to the three standard measures of risk, we also construct another two measures. The first is a dummy variable indicating whether the commodity is a program commodity or not. As mentioned in Section 2, program commodities receive various government program payments, reducing the riskiness of these enterprises. And the second is the number of producers, which is used as a measure particularly for the market access risk. The rationale here is that market access risk is higher in less liquid markets and an important feature of illiquid markets is there are not many market participants, both the sellers and the buyers. For example, the market for IBM stocks is very liquid as there are many buyers and sellers around the

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[9] http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp. Data for cattle, alfalfa hay, hogs, broilers and milk are shorter and started in 1991, 1989, 1988, 1988 and 1980, respectively.

[10] http://www.bls.gov/data/.

globe. On the other hand, the market for a three-bedroom house in a rural town is quite illiquid because there are only a few buyers and sellers. Assuming this is also the case for the agricultural markets we study, we can then use the number of producers as a proxy for the market liquidity and hence the market access risk.

The first test of our second prediction relies on a simple correlation coefficient between each of the five measures of enterprise risk and the percentage of farmers that are using AMAs (either the marketing or the production contract or both). These results are presented in the penultimate row of Table 6. As seen, the correlation coefficient between the market access risk (using the number of producers as a proxy) and the use of AMAs has the correct sign (negative) and is also statistically significant. The correlations between the price risk and whether the commodity is a program commodity and the use of AMAs has the correct sign (negative) but is not statistically significant. Finally, the correlations between the percent usage of AMAs and the other two measures of risk (yield and revenue) are positive but also insignificant.

Next we look at the base probability of using AMAs predicted from the logit estimation with pooled data. The logit model predicts that the probability for a farmer with characteristics $x_i$ using AMAs to market commodities as $\frac{\exp\left(x_i \hat{\beta}\right)}{1+\exp\left(x_i \hat{\beta}\right)}$, where $\hat{\beta}$ is the vector of parameter estimates from the logit estimation with pooled data. This predicted probability cannot be compared across different commodities because different commodities are produced by different farmers, who have different characteristics. To make it comparable across different commodities, we compute the predicted base probability for using AMAs for a farmer who only produces commodity $c$ using the formula $\frac{\exp\left(\hat{\beta}_0+\hat{\beta}_c\right)}{1+\exp\left(\hat{\beta}_0+\hat{\beta}_c\right)}$, where $\hat{\beta}_0$ is the estimate for the constant and $\hat{\beta}_c$ is the estimate for the coefficient for the dummy variable for commodity $c$ in the logit estimation with pooled data. As a result, the base probability does not depend on farmer characteristics.

To test our prediction, we examine the correlations between the base probabilities and the same risk measures. The results are presented in the last row of Table 6. As seen, they are virtually identical to the results obtained with the previous test. Therefore, we conclude that farmers with more risky enterprises (especially enterprises facing more market access risk) are more likely to adopt AMAs.

## 5. Conclusions

In modern agriculture, AMAs play an increasingly important role. The agency theory has been proposed to explain the incentive for farmers to use contracts in the agricultural literature and could also be used to explain the rising popularity of AMAs used by farmers. AMAs are provided as a risk management tool to reduce farmers' income uncertainty coming from the price, production and market access risks. Based on the agency theory, farmers, who are more risk averse, are more likely to use AMAs, and if the price, production and market access risks are higher for a commodity, the farmers are more likely to use AMAs to market the commodity.

In this paper, using discrete choice methods, we offer a comprehensive study of the determinants of operators' choice of marketing arrangements among possible combinations of cash, marketing contracts, and production contracts and seek evidence in support of the basic agency theory. Our empirical results are largely supportive of the agency theory of contract choice. More risk averse (using wealth as a proxy) farmers and farmers with more risky enterprises (especially enterprises facing more market access risk) are more likely to adopt AMAs.

Although we are able to conduct some empirical tests for the role of risk and degree of farmers' risk aversion in AMAs choice, the risk shifting incentives are very difficult to test in the literature. In this study, because of data limitation, we do not have measures for a farmer's risk aversion and livestock's production risk. Besides, endogenous matching might also be the problem shading the relationship between risk and AMA choices. In addition to the agency theory, the transaction cost theory can also be used to explain the incentive of using AMAs. Those are all topics for future works.

**Table 1: Summary Features of Different Marketing Arrangements**

| | Spot Market | Marketing Contract | Production Contract |
|---|---|---|---|
| Business autonomy | high | high | low |
| Price risks | high | medium | low |
| Production risks | high | high | medium |
| Market Access risks | high | low | low |
| Timing of agreement reached | transaction happens | before completion of production cycle | before beginning of production cycle |
| How is the farm operator paid | paid a price for farm output | paid a price for farm output | paid a fee for farming service |
| Ownership of the product before delivery | farm operator | farm operator | contractor |

Source: adapted from McDonald et al. (2004).

**Table 2: Marketing Arrangements Frequencies by Commodity**

| | Percentage of Farmers Using Different Marketing Arrangements | | | | | | |
|---|---|---|---|---|---|---|---|
| | C | M | P | CM | CP | MP | CMP |
| Corn | 68.75 | 3.62 | 0.20 | 27.05 | 0.25 | 0.02 | 0.11 |
| Soybean | 74.87 | 3.15 | - | 21.43 | 0.33 | 0.04 | 0.18 |
| Wheat | 84.55 | 2.25 | 0.09 | 13.07 | 0.03 | - | - |
| Oats | 98.36 | 1.31 | - | 0.33 | - | - | - |
| Alfalfa | 97.86 | 1.48 | 0.07 | 0.44 | 0.07 | 0.07 | - |
| Cotton | 54.32 | 30.89 | - | 14.66 | 0.13 | - | - |
| Peanuts | 18.20 | 59.21 | - | 22.59 | - | - | - |
| Tobacco | 57.39 | 11.52 | - | 31.09 | - | - | - |
| Cattle | 97.44 | 0.34 | 0.47 | 1.50 | 0.25 | 0.01 | - |
| Hogs | 59.00 | 1.13 | 36.31 | 2.63 | 0.88 | 0.06 | - |
| Broilers | 2.40 | 0.23 | 96.57 | - | 0.80 | - | - |
| Turkeys | 6.84 | 10.26 | 79.49 | - | 3.42 | - | - |
| Milk | 59.22 | 33.80 | - | 6.98 | - | - | - |

Legend: cash market only (C); marketing contract only (M); production contract only (P); cash and marketing contract (CM); cash and production contract (CP); marketing and production contract (MP); all three (CMP).

**Table 3: Summary Statistics**

| Variable | Description | Mean | Std Dev |
|---|---|---|---|
| Wealth | in 100 thousand dollars | 12.77 | 20.79 |
| Education | Education level: 1-5* | 2.71 | 1.01 |
| Off-farm | Income in $100 thousands | 0.53 | 1.13 |
| Assets | in 100 thousand dollars | 15.00 | 22.45 |
| Total acres | in thousand acres | 1.37 | 4.35 |
| Age | operator's age in 10 years | 5.43 | 1.23 |
| Nfamily | number of family members | 2.86 | 1.41 |
| Midwest | dummy for Midwest | 0.45 | 0.50 |
| South | dummy for South | 0.38 | 0.48 |
| Other | dummy for rest of country | 0.17 | 0.38 |

Notes: number of observations is 14,492. *): 1= less than high school; 2= high school; 3= some college; 4= BA or BS; 5=graduate school.

## Table 4: Logit Estimation Results for All Commodities

| | Corn | | Soybeans | | Wheat | | Oats | | Alfalfa Hay | | Cotton | | Peanut | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimate | t-stat | Estimate | t-stat | estimate | t-stat | estimate | t-stat | estimate | t-stat | estimate | t-stat | estimate | t-stat |
| Wealth | -0.0276 | -3.28 | -0.0171 | -2.18 | -0.0098 | -0.96 | -0.0942 | -0.76 | -0.0560 | -2.75 | -0.0196 | -1.13 | 0.0122 | 0.26 |
| Education | 0.1844 | 5.12 | 0.1960 | 5.35 | 0.2308 | 4.35 | 0.1326 | 0.24 | 0.5499 | 2.72 | 0.2470 | 3.02 | -0.0451 | -0.35 |
| off-farm | 0.0599 | 1.68 | 0.0378 | 1.13 | 0.0732 | 1.45 | -1.3884 | -0.76 | -0.3601 | -0.85 | 0.0603 | 0.64 | -0.1672 | -0.61 |
| Assets | 0.0280 | 3.61 | 0.0159 | 2.23 | 0.0131 | 1.41 | 0.1543 | 1.24 | 0.0629 | 3.23 | 0.0247 | 1.47 | -0.0152 | -0.33 |
| total acres | 0.2014 | 7.50 | 0.2294 | 8.72 | 0.0446 | 2.73 | -0.2059 | -0.60 | 0.0054 | 0.07 | -0.0256 | -0.51 | 0.0395 | 0.35 |
| Age | -0.2603 | -7.78 | -0.2192 | -6.59 | -0.1335 | -2.84 | 1.0320 | 1.88 | -0.2791 | -1.40 | -0.0586 | -0.84 | -0.1979 | -1.79 |
| Nfamily | -0.0274 | -1.02 | -0.0602 | -2.25 | 0.0650 | 1.79 | 0.4743 | 1.92 | -0.1975 | -1.21 | -0.0881 | -1.27 | 0.0320 | 0.27 |
| Midwest | 0.7658 | 3.87 | 1.3032 | 2.59 | -0.2923 | -2.60 | -2.1738 | -1.63 | -1.7647 | -3.48 | -0.3292 | -0.57 | - | - |
| South | 0.1646 | 0.76 | 1.0152 | 2.00 | -0.4127 | -2.69 | 0.7475 | 0.65 | -1.1077 | -1.05 | -0.8907 | -2.93 | - | - |
| Constant | -0.8995 | -2.84 | -1.9020 | -3.45 | -1.8526 | -4.97 | -12.0184 | -2.57 | -3.0302 | -2.14 | 0.3968 | 0.61 | 2.7013 | 2.97 |
| log likelihood | -2613.96 | | -2642.38 | | -1319.94 | | -18.3562 | | -119.8314 | | -511.90 | | -213.33 | |
| # of observations | 4451 | | 4891 | | 3159 | | 305 | | 1355 | | 764 | | 456 | |

**Table 4: Continued**

| | Tobacco | | Cattle | | Hogs | | Broilers | | Turkeys | | Milk | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | estimate | t-stat | Estimate | t-stat | estimate | t-stat | estimate | t-stat | estimate | t-stat | estimate | t-stat |
| Wealth | 0.0228 | 0.52 | -0.0176 | -1.90 | -0.0956 | -5.08 | -0.2121 | -1.11 | 0.1528 | 0.85 | -0.0111 | -0.99 |
| Education | 0.0751 | 0.70 | 0.1459 | 2.17 | 0.0363 | 0.66 | -0.3918 | -1.45 | -0.6818 | -1.79 | 0.0434 | 0.68 |
| off-farm | 0.0376 | 0.17 | -0.0912 | -0.97 | -0.1796 | -1.54 | -0.2267 | -0.92 | -0.3101 | -0.47 | 0.0606 | 0.72 |
| Assets | -0.0132 | -0.31 | 0.0158 | 1.94 | 0.1015 | 5.74 | 0.3449 | 1.94 | -0.0978 | -0.64 | 0.0172 | 1.85 |
| total acres | 0.3101 | 2.23 | 0.0212 | 2.89 | -0.2576 | -3.55 | -0.9354 | -1.50 | 0.2450 | 0.30 | -0.1874 | -1.91 |
| Age | -0.0164 | -0.17 | -0.0720 | -1.13 | -0.3542 | -6.03 | 0.0204 | 0.07 | -0.2976 | -0.63 | -0.0706 | -1.19 |
| Nfamily | 0.0279 | 0.28 | -0.0172 | -0.34 | -0.0252 | -0.70 | -0.1501 | -1.21 | -0.2073 | -0.68 | 0.0058 | 0.17 |
| Midwest | 11.9415 | 0.03 | -1.1985 | -7.81 | 0.3085 | 1.44 | 1.1189 | 1.66 | -0.0225 | -0.22 | -2.5920 | -18.31 |
| South | 14.0040 | 0.03 | -1.9973 | -10.05 | 1.2573 | 5.70 | 4.8220 | 5.73 | - | - | -0.5280 | -3.26 |
| constant | -14.7092 | -0.03 | -2.5846 | -5.18 | 0.7093 | 1.56 | 0.7897 | 0.40 | 6.5257 | 2.02 | 1.0992 | 2.52 |
| log likelihood | -294.68 | | -975.06 | | -997.80 | | -53.77 | | -25.80 | | -843.54 | |
| # of observations | 460 | | 8894 | | 1600 | | 874 | | 117 | | 1633 | |

Note: Midwest and South (South) are not included in the peanut (turkeys) regression because all peanut (turkeys) producers are in the South (the South and the Midwest).

**Table 5: Joint Estimation Results**

| Variable | Estimate | t-stat |
|---|---|---|
| wealth | -0.0432 | -8.15 |
| education | 0.1110 | 4.93 |
| off-farm | -0.0403 | -1.65 |
| assets | 0.0465 | 9.36 |
| total acres | 0.0059 | 1.13 |
| age | -0.2089 | -10.05 |
| nfamily | 0.0032 | 0.20 |
| Midwest | -0.7669 | -10.91 |
| South | -0.5620 | -7.66 |
| soybeans | 1.1325 | 19.78 |
| wheat | 0.2600 | 5.14 |
| oats | -0.3186 | -2.16 |
| alfalfa hay | -0.0625 | -0.85 |
| cotton | 1.3758 | 13.25 |
| peanut | 2.9681 | 19.09 |
| tobacco | 1.0516 | 8.57 |
| cattle | -0.7199 | -14.42 |
| hogs | 1.1940 | 18.95 |
| broiler | 5.9045 | 25.28 |
| turkeys | 4.3268 | 10.71 |
| milk | 1.6760 | 24.14 |
| constant | -0.4279 | -2.51 |
| log likelihood | | -6610.12 |
| # of observations | | 14,492 |

## Table 6: Relationship between Risks and non-use of AMAs

| | CV for Prices | CV for Yield | CV for Revenue | # of Producers | Dummy for Program Commodities | % of Producers Who Use AMAs | Base Probability for Using AMAs |
|---|---|---|---|---|---|---|---|
| Corn | 0.4585 | 0.1701 | 0.3157 | 4,451 | 1 | 31.25 | 0.3946 |
| Soybean | 0.4642 | 0.1371 | 0.3486 | 4,891 | 1 | 25.13 | 0.6692 |
| Wheat | 0.4307 | 0.1077 | 0.3437 | 3,159 | 1 | 15.45 | 0.4581 |
| Oats | 0.4416 | 0.1031 | 0.3586 | 305 | 1 | 1.64 | 0.3216 |
| Alfalfa Hay | 0.0911 | 0.0893 | 0.0726 | 1,355 | 0 | 2.14 | 0.3798 |
| Cotton | 0.4341 | 0.1648 | 0.2988 | 764 | 1 | 45.68 | 0.7207 |
| Peanuts | 0.3224 | 0.1226 | 0.3143 | 456 | 0 | 81.80 | 0.9269 |
| Tobacco | 0.2351 | 0.0616 | 0.2203 | 460 | 0 | 42.61 | 0.6511 |
| Cattle | 0.1638 | | | 8,894 | 0 | 2.56 | 0.2409 |
| Hogs | 0.2366 | | | 1,600 | 0 | 41.00 | 0.6827 |
| Broilers | 0.1011 | | | 874 | 0 | 97.60 | 0.9958 |
| Turkeys | 0.3887 | | | 117 | 0 | 93.16 | 0.9801 |
| Milk | 0.2447 | | | 1,633 | 0 | 40.78 | 0.7770 |
| Correlation between Risks and % of Producers Who Use AMAs | -0.0875 (0.29) | 0.2326 (0.36) | 0.2045 (0.36) | -0.4993** (0.22) | -0.4036 (0.24) | | |
| Correlation between Risks and Base Probabilities | -0.0657 (0.29) | 0.1334 (0.37) | 0.1689 (0.37) | -0.5709*** (0.19) | -0.3819 (0.25) | | |

* significant at 10% level; ** significant at 5% level; *** significant at 1% level.

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