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The Role of Risk in Farmland Contract Choices

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Understanding the role of risk in farmland leasing contract choices is important to assess the welfare consequences of farm policies or environmental changes that affect production risk. We use a unique dataset of landowners and tenants in Kansas to examine the role of risk in their farmland leasing contract choices. We find that greater production risk and more risk-averse landowners encourage fixed cash rent contracts. As many variables can potentially affect contract choices, we use a penalized regression to show that the inclusion of relationship variables leads to little change in the main results.

Key words: adaptive lasso, farmland leasing, landowner–tenant relationships

Introduction

Over the past 50 years, the national share of farmland that is operated by landowners has remained relatively stable at approximately 60% of US farmland. Of the 911 million acres of farmland in the contiguous United States, almost 40% is under a land-leasing contract, with approximately 50% of all cropland under a land-leasing contract (Bigelow, Borchers, and Hubbs, 2016). Producers and landowners have two major farmland leasing contract choices for agricultural production: fixed cash rent and crop-share. Fixed rent contracts are straightforward in that the tenant pays a single payment for the use of the land during the growing season.

Approximately 74% of farmland contracts in the Midwest regions are fixed rent contracts, while crop share contracts make up another 15% of the contracts (US Department of Agriculture, 2017). With crop share contracts, the producer pays a certain share of the harvest to the landowner at the end of the season. Farmland leasing contract choice is an integral part of risk management decisions because contracts dictate how risks are shared between landowners and tenants. Understanding these choices for tenants and landowners is crucial to assessing how various farm policies or environmental changes that affect production and price risks affect managerial decisions, productivity, and their capitalization into land values. In this paper, we examine how production risk and the risk attitudes of producers and landowners interact with their farmland leasing contract choices. However, flex leases only account for a small portion of leases in Kansas;[1] therefore, this study focuses on the two most commonly used farmland lease types: crop share and fixed cash.

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[1] A third farmland leasing contract choice is the flex, or flexible cash rental, contract. Created to ease the difficulty in setting cash rents and offering a solution to the lagged nature of rents, the flex lease alters a fixed cash lease by allowing the final rent payment to vary based on the economic conditions for that specific crop year. While flex leases are growing in popularity across the Midwest, only 6% of landowners in Kansas currently operate under a flex lease (Bigelow, Borchers, and Hubbs, 2016). In the empirical analysis, we define the outcome variable as the probability of participating in a fixed cash rent contract, crop share leases being the group with the dependent variable equal to 0. Flex lease contracts are removed from the data for empirical analysis.

The literature related to farmland contract choice often focuses on identifying the role of risk in each contract choice, typically from the perspective of either the landowners or the tenants. Empirically, this literature provides mixed evidence on the role of risk and risk preferences. We, however, contribute to the literature by providing a new set of empirical results and add to the empirical literature on classical risk-sharing approaches by using variables that measure production risk and direct measures of risk attitudes among both tenants and landowners as matched pairs.

Understanding the role of risk in the farmland leasing contract choice is particularly important when the "riskiness" of farming changes. The degree of risk in farming can change due to various factors (e.g., national or local farm policies, climate or environmental changes, or other market-level changes). Each new farm bill or legislation passed brings potential change for a producer and their production decisions because they must decide how the legislation will affect their operation. Often landowners and tenants operate under a risk-sharing approach to distribute the associated risk between both parties. Under risk-sharing theory (e.g., Huffman and Just, 2004), agents (in this case landowners) expect to increase their expected utility (or returns) by reducing or redistributing associated risk. Also under risk-sharing theory, a situation (or tenant) that is higher in associated risk will lead to choosing a contract that is associated with less overall risk. Both landowners and producers must consider the risk–return trade-offs of each farmland leasing contract choice under new regulations because they can affect the riskiness of farming. Therefore, understanding how the changes in risk affect contract choices is essential to the discussion of welfare consequences of various farm policies and the distributional effects of these policies across tenants and owners.

An example of an external environmental change can be found in Kansas, where producers in 18 western counties face possible limitations on their irrigation practices due to recent state regulations of the Ogallala Aquifer (Gollehon and Winston, 2013; Kansas Department of Agriculture, 2018). Limiting irrigation for production increases the uncertainty and risk associated with yield and revenue and, in turn, can affect the farmland leasing contract choice for a producer who leases the land they produce on. If irrigation practices are restricted and production variability increases, the greater risk exposure to tenants may alter negotiations of leasing arrangements between tenants and landowners.[2]

Thus, this study investigates how production risk affects farmland leasing contract choice using a unique dataset from a survey of tenants in Kansas and their landowners. These data have detailed information on the characteristics of tenants, landowners, and their leases. We estimate the relationship among the choices, the degree of risk in farming, and the risk attitudes of the tenants and owners. Consistent with risk-sharing theory, we find that (i) greater risk in farming leads to fixed cash rent contracts and (ii) the more risk averse the owner is, the more likely a fixed cash rent contract is chosen. Our results are robust with respect to different data subsamples and model specifications.

Related Literature

Optimal contract choice under risk in agriculture has been extensively studied. Holmström's (1979) seminal work investigates and establishes the role of imperfect information and moral hazard on optimal farmland leasing contract choices. In the context of land rental contracts, At and Thomas's (2019) recent study derives optimal contracts between a monopoly landlord and tenant when the tenant's revenue is affected by both moral hazard and adverse selection. They conclude that the level of a tenant's protection and the outside option of the tenant are crucial in choosing an optimal contract.

[2] Rejesus et al. (2013) find that farmers are likely to diversify crops, buy crop insurance, modify lease arrangements, and exit farming in response to extreme weather caused by climate change. This suggests that external factors that affect the riskiness of farming may have an impact on leasing arrangements and contract choice. Similarly, Zhang, Mu, and McCarl (2018) investigate the use of cash leases by wheat farmers in the Pacific Northwest and found that increases in precipitation variability reduce the prevalence of cash-rent leases.

Similar to Holmström's approach, Huffman and Just (2004) develop a conceptual model to derive a set of stylized facts for contracts between landowners and tenants. They present a principal–agent model with risk-averse agents and explore how optimal contracts change given landowners' and tenants' risk aversion, and tenants' characteristics. They highlight that the heterogeneity in landowner and tenant attributes (e.g., riskiness of land, tenants' productivity, and risk attitudes of landowners and tenants) are important for understanding the patterns of farmland leasing contract choices.

There have also been attempts to empirically estimate the determinants of land rental contract choices. Using data from over 3,000 contracts in the Midwest, Allen and Lueck (1992) find no empirical evidence that contract choices are based on avoiding risk and that, in effect, risk sharing is unlikely to be motivation for contract choice. In contrast, Fukunaga and Huffman (2009) and Qiu, Goodwin, and Gervais (2011) present empirical evidence showing that risk and risk preferences matter. Using the 1999 Agricultural Economics and Land Ownership Survey (AELOS), Fukunaga and Huffman find that tenants' and landowners' behaviors were consistently risk averse, with landowners appearing to be more risk averse than tenants. Their results support transaction cost and risk-sharing incentive motives in contracting, much like Huffman and Just's (2004) theoretical framework. Qiu, Goodwin, and Gervais also show that risk does have a significant impact on contract choice, as it has a negative effect on a fixed cash contract being chosen.

Interpersonal relationships, such as how the landowner and tenant know each other, are also a crucial aspect of understanding optimal farmland leasing contract choice. Every relationship between the landowner and tenant may have different associated risk factors based on personal experiences. This interaction between landowners and tenants shapes how much risk is associated with a particular contract choice given that there is, or is not, an already established relationship. While some studies (e.g., Allen and Lueck, 1992) include a singular relational variable describing the landowner and tenant, Bryan, Deaton, and Weersink (2015) heavily emphasize the inclusion of relationship variables in their model. They find that the relationship between landowner and tenant affects the type of contract chosen. They also find that those with longstanding relationships are less likely to engage in a fixed cash contract (Bryan, Deaton, and Weersink, 2015).

We add to the empirical literature on classical risk-sharing approaches by using variables that measure production risk as well as direct measures of risk attitudes for both tenants and landowners. Our survey design generates matched data for tenants and landowners, which allows us to analyze how relative risk preferences affect leasing contract choices. Matching landowners to tenants is rare in agricultural economic studies within the United States. However, studies utilizing matched pairs do appear more commonly when analyzing informal farmland rental markets (e.g., Ricker-Gilbert et al., 2019). This is important to note because it further underlines our contribution to the literature. Further, we also utilize a penalized regression approach to examine whether a set of relational variables, which are similar to those of Bryan, Deaton, and Weersink (2015), influences the contract choices or not.

Conceptual Framework

We present a conceptual model and derive stylized facts to describe the relationships among the optimal rental contract choices, risk, and risk attitudes. These stylized facts further motivate the empirical framework. We assume that there exist two types of farmland rental contracts: (i) fixed cash rent with a rate denoted by F and (ii) crop share contract represented by a share to the owner, s. For simplicity, we further assume that contract choice is the only choice variable of each agent. More specifically, the tenant chooses whether they take fixed cash rent or crop share contracts for a given menu described by F or s. The owner chooses the specifics of fixed cash rent and crop share contracts by choosing F and s. Similar to Huffman and Just (2004), we assume that the preferences of the tenant and the owner are represented by a mean–variance utility function:

$$U(\tilde{\pi}) = E\tilde{\pi} - 0.5kV(\tilde{\pi}), \tag{1}$$

where $\tilde{\pi}$ is the stochastic profit and k is the Arrow–Pratt constant risk aversion coefficient.

The tenant, denoted by subscript T, who rents field i, maximizes

$$U_T = \max\left\{\mu_i - 0.5k_T\sigma_i^2 - F, (1-s)\mu_i - 0.5k_T(1-s)^2\sigma_i^2\right\}, \tag{2}$$

where μ_i and σ_i^2 are the mean and the variance of the profit from crop production in field i. From this problem, the fixed cash rental rate that makes the tenant indifferent between the two contracts as a function of s is

$$F^*(s) = s\mu_i - 0.5k_T\sigma_i^2\left(2s - s^2\right) \tag{3}$$

for $s < 1$. Essentially, as long as there exists an alternative contract denoted by s, the tenant would not accept a fixed cash rent contract that has the rate greater than F^*.

The owner, denoted by subscript O, who rents out field i, maximizes

$$U_O = \max\left\{F, s\mu_i - 0.5\sigma_i^2k_Os^2\right\} \tag{4}$$

From the tenant's problem, we know what the maximum fixed cash rent that the tenant will bid will be. Using this and the owner's problem, we arrive at

$$U_O = \max\left\{s\mu_i - 0.5k_T\sigma_i^2\left(2s - s^2\right), s\mu_i - 0.5\sigma_i^2k_Os^2\right\}. \tag{5}$$

Using these equations, we find an optimal s for each of the arguments of the owner's problem. For the first argument, $s\mu_i - 0.5k_T\sigma_i^2(2s - s^2)$, the solution is $s_1^* = 1 - \frac{\mu_i}{\sigma_i^2k_T}$. For the second argument, $s\mu_i - 0.5\sigma_i^2k_Os^2$, the optimal s_2 is $s_2^* = \frac{\mu_i}{\sigma_i^2k_O}$. These lead to the final optimization problem:

$$U_O = \max\left\{s_1^*\mu_i - 0.5k_T\sigma_i^2\left(2s_1^* - s_1^{*2}\right), s_2^*\mu_i - 0.5\sigma_i^2k_Os_2^{*2}\right\}, \tag{5′}$$

or simply

$$U_O = \max\left\{0.5\left(\frac{\left(\sigma_i^2k_T\right)^2 - \mu_i^2}{\sigma_i^2k_T}\right), 0.5\frac{\mu_i^2}{\sigma_i^2k_O}\right\}, \tag{5″}$$

indicating that the optimal contract is the fixed cash rent agreement only if

$$\frac{\left(\sigma_i^2k_T\right)^2 - \mu_i^2}{k_T} > \frac{\mu_i^2}{k_O}. \tag{6}$$

We obtain two stylized facts from this conceptual framework. First, an increase in the variability of profit would increase the likelihood of the optimal contract being a fixed cash rent contract, which is from the fact that an increase in σ_i^2 makes condition (6) more likely to be true. Second, as the owner becomes more risk averse, the optimal contract is more likely to be the fixed cash rent contract. This is from the fact that an increase in k_O makes condition (6) more likely to be satisfied. The role of the tenant's risk preference is ambiguous.

Table 1. Summary Statistics of the Key Variables

	Matched Pair (N = 113)		Tenants Only (N = 248)	
	Mean	SD	Mean	SD
Variables	1	2	3	4
Contract type (fixed cash = 1)	0.43	0.50	0.35	0.48
Weighted avg. CV (revenue)	0.45	0.044	0.46	0.042
Tenant's willingness to take risks	7.13	1.77	6.92	1.83
Owner's willingness to take risks	6.86	2.22	n/a	n/a
Corn share	0.32	0.23	0.33	0.21
Soybean share	0.36	0.18	0.37	0.18
Wheat share	0.26	0.27	0.25	0.25
Family	0.48	0.50	0.42	0.49
Friend	0.33	0.47	0.33	0.47
Neighbor	0.15	0.36	0.20	0.39
Acquaintance	0.12	0.32	0.09	0.29
Business only	0.12	0.33	0.14	0.35
Years leased	18.54	12.30	17.94	12.81
Main income source is on-farm income	0.54	0.50	0.62	0.49

Data

The data used for this study were compiled from a mail survey sent during the summer of 2018. Using producer information from the Kansas Farm Management Association (KFMA) database, a survey was sent to 2,000 producers in Kansas. It is worth noting that data collected from farm management associations like KFMA tend to capture larger farms and more crop than livestock producers (Kuethe et al., 2014). Producers were asked to complete and return the survey in a prepaid postage return envelope. In addition to the producer questionnaire, each survey contained a landowner questionnaire in a prepaid postage envelope. Producers were asked to send the landowner-specific survey questionnaire to the landowner from whom they leased the largest amount of land. The landowner survey packet asked recipients to complete the survey and return it using a prepaid postage return envelope included in the packet. Both surveys included questions about their leasing arrangements, the land leased, and demographic characteristics.

Both tenants and landowners were also asked to self-identify their level of willingness to take financial risks with respect to their farm operations, with 1 being "completely unwilling to take risks" and 10 being "completely willing to take risks." This allowed the survey respondent to state their average level of risk. We can see in Table 1 that landowners were more risk averse than tenants given this 10-point scale. While it has some limitations, the use of a Likert scale to measure risk attitude is seen in literature with arguments both for and against its use. It is argued that survey respondents may report distorted levels of their risk attitude when self-reporting instead of when risk attitude is found via a choice experiment or through further questioning (Camerer and Hogarth, 1999). However, other studies have found consistency across their results when using a Likert scale of risk attitude (Caliendo, Fossen, and Kritikos, 2009; Dohmen et al., 2011; Roe, 2015). For further discussion of risk-elicitation methods, see Tack and Yu (2021).

A total of 389 landowner surveys were returned, with 179 matched tenant–landowner survey pairs. We limited the pairs to those with enough information on their lease and whose main crops are corn, soybeans, wheat, or grain sorghum. The sample criterion on the main crops is used because other crops do not have enough yield and price information to measure variability in revenues.

As a result, our final sample included 113 tenant–landowner pairs.[3] We distinguish our study from the literature by using information, especially the direct measures of risk attitudes, on both landowners and tenants from the matched pairs. Additionally, as previously mentioned, the majority of Kansas farmland leasing contracts are fixed cash or crop share, with only approximately 6% of Kansas landowners operating under a flex cash lease. We decided to only include observations for landowner–tenant matched pairs (and tenants) that operated under either a crop share lease or a fixed cash lease.

In addition, a coefficient of variation (CV) for each crop was used to measure the relative variability in crop yield. CVs were calculated using county-level yield data from the USDA National Agricultural Statistics Service for corn, soybeans, wheat, and grain sorghum for the years 2002–2017 (US Department of Agriculture, 2019). We compute the CV for each crop using the means and the standard deviations over these years. Crop price data for corn, soybeans, wheat, and grain sorghum for the years 2002–2019 were obtained from Kansas State University's Department of Agricultural Economics Grain Basis Database (Llewelyn, 2020). We also use weather variables (e.g., growing degree days, degree days above 30°C, and precipitation) from Schlenker and Roberts's (2009) dataset as potential covariates.

Table 1 provides the summary statistics of the two samples we use for the analyses: (i) a sample of the 113 matched tenant–landowner pairs and (ii) a sample of the 248 tenants who report the relevant information and meet the sample criterion based on the main crops they grow. For the matched-pair dataset, approximately 43% of producers and landowners currently operate under a fixed cash contract, whereas only 35% of producers operated under a fixed cash contract in the tenants-only sample. The dataset used in this study—and its percentages of crop share and fixed cash leases—does appear to be representative given previous studies and surveys completed in recent years (Li and Tsoodle, 2020). The variability producers face, measured as the weighted average of the coefficient variations in revenue, where the weights are based on their crop rotation, is about 46% of the average revenue and is similar across the two samples.

Producers' main crop, the crop with the largest production share, was relatively consistent between the two samples. Soybeans were produced most at 36% and 37% of producers' main crop, with corn following at 32% and 33% of the matched-pair and tenants-only samples, respectively. Note that these percentages are based on the life of the current crop rotation. As previously mentioned, respondents were asked to assess their personal willingness to take financial risks on a scale from 1 to 10, with 1 being "unwilling to take any financial risks" and 10 being "completely willing to take risks." The average tenant in both the matched-pair and tenants-only samples was slightly more risk loving than the average landowner.

In addition to risk preferences, survey respondents were asked to state the relationship that they have with their landowner or tenant, along with demographic identifiers such as the number of years they have leased together and where the landowner lives in relation to their leased land. The relationship options between landowners and tenants include family, friend, neighbor, acquaintance, or business only. Approximately 48% of those in the matched-pair data and 42% of those in the tenant-only data identified their landlords as family, while 33% identified as friends, with fewer respondents identifying as neighbors, acquaintances, and business only. For both datasets, the average number of years leased is approximately 18 years and over half reported that the majority of their household income was on-farm income.

[3] While the 113 pairs are correctly matched and provide sufficient information for our analyses, only 61 out of 113 matched landowners provide the leasing arrangement information. Note that we use the leasing information from the tenant survey; risk attitude is the only information we use from the landowner survey. In the Appendix, we provide the estimation results that uses the restricted sample of 61 pairs (Table A1) and show that the results are consistent.

Empirical Framework

As illustrated in the conceptual framework section, our main hypotheses are (i) greater profit variability of a field increases the likelihood of the field being contracted under a fixed cash rent contract and (ii) the fixed cash rent arrangement is more likely to occur when the landowner is more risk averse. The outcome variable is therefore whether the contract is fixed cash rent or not. We are primarily interested in the following explanatory variables: (i) variability in profit, which is measured by the weighted average of the coefficients of variation for the four crops, and (ii) the risk preferences of the tenants and the landowners.

To estimate the relationship among the farmland leasing contract choices, variability in profit, and the risk attitudes of tenants and landowners, we use both the linear probability model (LPM) and the logit regression model. The LPM is

$$\text{Prob}\,(\text{Fixed Cash Rent}_i = 1) = \beta_0 + \beta_1 CV_i + \beta_2 TR_i + \beta_3 OR_i + \boldsymbol{X}_i\boldsymbol{\Gamma} + \varepsilon_i, \tag{7}$$

where CV_i is the weighted average of the coefficients of variations for the crops that tenant i is producing, TR_i is the risk attitude of tenant i, and OR_i is the risk attitude of the owner of the land that tenant i is leasing from. Additionally, we include shares of corn, soybeans, and wheat in the crop rotation and fixed effects specific to each Kansas Farm Management Association region, which are represented as a vector, $\boldsymbol{X}_i$, and ε_i is random errors with mean 0. [4] Similarly, we specify the logit model as

$$\text{Prob}\,(\text{Fixed Cash Rent}_i = 1) = \frac{1}{1 + \exp\left(-\left(\beta_0 + \beta_1 CV_i + \beta_2 TR_i + \beta_3 OR_i + \boldsymbol{X}_i\boldsymbol{\Gamma}\right)\right)}. \tag{8}$$

We cluster standard errors by crop-reporting district to control for potential within-district correlations since the crop prices we use are reported at the level of the crop-reporting district.

Based on the stylized facts derived from the conceptual framework, we expect variability in output to be negatively correlated with the probability of fixed cash rent contract in place, holding risk preferences constant. We also expect that the more that the tenant is willing to take risks, the more likely a fixed cash rent contract will be chosen (positive sign), while the more the owner is willing to take risks, the less likely the fixed cash rent will be selected (negative sign).

Given that Bryan, Deaton, and Weersink (2015) document the importance of the relationship variables, we also examine the role of relationship variables in explaining farmland leasing contract choices and whether the inclusion of these variables affects the estimated coefficients of our variables of interest. Ideally, one can include all possible relationship variables that are relevant to the outcome variable. However, if the number of these candidate control variables is relatively large compared to the sample size, including all of these candidate variables will lead to poor prediction accuracy with nonzero coefficients for all of the variables (Tibshirani, 1996).

Penalized regressions have been proposed as an alternative (e.g., Tibshirani, 1996; Zou, 2006). A common and reliable penalized regression is the adaptive lasso (Zou, 2006). An adaptive lasso model is

$$\widehat{\boldsymbol{B}},\widehat{\boldsymbol{\Delta}} = \arg\min \left\| Y - DB - X\Gamma - \sum_{j=1}^{p} \delta_j Z_j \right\|^2 + \lambda \sum_{j=1}^{p} \widehat{w_j} \left|\delta_j\right|, \tag{9}$$

where $\boldsymbol{B} = \{\beta_1, \beta_2, \beta_3\}$, $\boldsymbol{D} = \{CV, TR, OR\}$, and Z_j is the jth variable among candidate variables over which we perform the variable selection estimation. Thus, $\widehat{\boldsymbol{\Delta}}$ is the vector of the estimated coefficients of the selected variables. Finally, λ and $\widehat{w}_J$ are tuning parameters. These parameters

[4] A common critique on estimating the linear probability model using the ordinary least squares is the inefficiency of the estimates due to the heteroskedasticity (Maddala, 1986; Cameron and Trivedi, 2005). Similar to Angrist, Bettinger, and Kremer (2006), we employ heteroskedasticity-consistent robust standard errors to deal with the heteroskedasticity.

control the magnitude of the penalty and minimizes overfitting. When $\lambda = 0$, no penalty is imposed, but as λ increases, parameters shrink toward 0. The second tuning parameter, $\widehat{w}_J$, is importance weights for each jth parameter. Normally, λ is determined by a cross-validation procedure and $\widehat{w}_J$ is defined as $1/\left|\hat{\delta}_{j,OLS}\right|$, where $\hat{\delta}_{j,OLS}$ is the estimated coefficient from the ordinary least squares estimation with all variables included. Zou (2006) shows that the adaptive lasso approach can consistently select relevant variables. Also note that we perform the variable selection over the additional candidate variables, Z_j, while keeping the initial key variables in each specification.

We therefore re-estimate equations (7) and (8) considering a set of candidate variables as potential covariates using the adaptive lasso approach. For the logit model, one can replace the first term in equation (9) with the negative of log-likelihood function of the logit model of equation (8) (Zou, 2006). The 22 candidate variables considered here are relationship variables (i.e., whether the tenant and owner are family, friend, neighbor, business-only, acquaintance, no interaction), the number of years of lease between the owner and tenant, and variables describing how the land was obtained (e.g., inherited, purchased, or unknown). Locational variables include whether the landowner lived in the same county or state as the rented farmland. Finally, agronomic variables include precipitation, growing degree days, growing degree days above 30°C, irrigation, productivity, and the sum of the share of crops in each rotation. Bryan, Deaton, and Weersink (2015) include similar relational variables for both landowners and tenants in their empirical model and are able to determine that the different relationships between tenants and landowners affect farmland leasing contract choice.

Results

Table 2 reports the estimation results of the matched-pairs dataset for both the LPM and the logit model.[5] Columns 1 and 3 contain the coefficients of the LPM and the logit model, respectively, that do not include the risk attitude variables, and columns 2 and 4 include the coefficients of the models that do include the risk attitude variables. We focus discussion on the weighted average CV for revenue and the risk attitudes of tenants and owners.

The weighted average CV for revenue, which is a measure of the riskiness of farming a field relative to the other areas, is statistically significant and positive for all four models. This is consistent with the stylized facts of the conceptual framework. The estimated coefficients indicate that a 1-percentage-point increase in the average CV leads to about a 2.2-percentage-point increase in the likelihood of that land being contracted under the fixed cash rent contract. Models that do not include the risk attitude variables, columns 1 and 3, have slightly larger coefficients than their counterparts indicating that the risk attitudes capture some positive effect of the CV. Both the LPM and the logit model yield similar marginal effects.

The coefficient on the owner's willingness-to-take-risk variable is statistically significant and negative for both the LPM and the logit model. In other words, the less risk averse the owner is, the less likely they are to have a fixed cash rent contract. This finding is consistent with the stylized facts. The coefficient on the tenant's willingness-to-take-risk variable is positive, indicating that less risk-averse tenants tend to participate in fixed cash rent contracts. As previously mentioned, the data—along with previous studies conducted in Kansas (Li and Tsoodle, 2020)—indicate that fixed cash contract are more frequent in areas of nonirrigated land, supporting the idea that risk-averse landowners are more likely to choose fixed cash contracts on nonirrigated land. Note that the conceptual framework predicts an ambiguous direction for the relationship between the likelihood of the optimal contract being fixed cash rent and the tenant's willingness to take risk. It does appear, though, that tenant and landowner risk preferences are somewhat correlated to each other in the

[5] Note that two observations are dropped from the sample of 113 pairs when estimating the logit model since one of the association region indicators that contains two observations perfectly predicts the outcome.

Table 2. Estimation Results: Matched Pairs

	Marginal Effects Prob(Fixed Cash Rent = 1)			
	Linear Probability Model (N = 113)		Logit (N = 111)	
Variables	**1**	**2**	**3**	**4**
Weighted avg. coefficient of variation (revenue)	2.27* (1.19)	2.14* (1.01)	2.39* (1.23)	2.19** (1.04)
Tenant's willingness to take risks		0.059* (0.029)		0.056** (0.026)
Owner's willingness to take risks		−0.055** (0.017)		−0.054*** (0.016)
Wheat share	0.37 (0.45)	0.35 (0.45)	0.32 (0.42)	0.28 (0.39)
Corn share	0.89* (0.43)	0.84* (0.43)	0.89** (0.41)	0.80** (0.37)
Soybean share	0.075 (0.58)	0.060 (0.59)	−0.020 (0.58)	−0.035 (0.54)
Pseudo-R^2	n/a	n/a	0.13	0.16
Association fixed effects	Yes	Yes	Yes	Yes

Notes: Robust standard errors clustered by the crop-reporting district level are in parentheses. Single, double, and triple asterisks (*, **, ***) denote p-values of less than 0.1, 0.05, and 0.01. Columns 1 and 2 are the estimated coefficients of the linear probability model (LPM) model and Columns 3 and 4 are the marginal effects evaluated at the means of the regressors using the estimated coefficients of the logit model. Columns 2 and 4 include the risk attitude of the tenants and owners as additional regressors. The R^2 of the LPM is noninformative, so we only report pseudo-R^2 for logit estimations.

matched dataset (correlation coefficient of 0.63) and may suggest that some landowners and tenants are matching on risk preferences.

Included in Table 3 are the estimated coefficients for the weighted average CV of revenue variable, the tenant's risk attitude coefficient, and the crop share coefficients for both the LPM and the logit model. We also estimate the model without the owner's risk attitude variable for the main sample of the 113 matched pairs to assess whether the potential differences in the estimation results between the two sets of samples are driven by omitting the owner's risk attitude variable.

Columns 1 and 2 of Table 3 include the coefficients for the LPM and the logit model for the matched-pairs dataset, columns 3 and 4 summarize the LPM of the tenants-only dataset, and columns 5 and 6 report the estimated coefficients of the logit model for the tenants-only dataset. Across all models, the estimated coefficient on the weighted average CV coefficient is positive and statistically significant. Interestingly, the estimated coefficient is smaller for the tenants-only sample. The coefficient on the tenant's risk attitude is no longer statistically different from 0 for all six specifications, which is different from the findings reported in Table 2. This result suggests that omitting the owner's risk attitude variable causes a downward bias in estimating the coefficient for the tenant's risk attitude variable, implying that owners' and tenants' risk attitudes are correlated.

Given that the coefficients of the weighted average CV in columns 1 and 2 of Table 3 are similar to those of Table 2, the difference in the estimates is mainly from the difference in the samples rather than the fact that the owner's risk attitude variable is omitted. The primary difference between the matched-pair sample (113 observations) and the sample with the tenant-only information (248 observations) is due to the nature of the survey procedure. That is, tenants were given the opportunity to fill out their survey and then were asked to mail another survey to their landlord for them to fill out. The lack of a matched pair for 135 tenants (the difference between the 248 tenant surveys and the 113 matched-pair surveys) suggests there may be a fundamental difference in the nature of the

Table 3. Estimation Results: Comparison with the Tenants-Only Sample

	Marginal Effects Prob(Fixed Cash Rent = 1)					
	Matched Pairs		Tenants Only			
	Linear Probability Model (N = 113)	Logit (N = 111)	Linear Probability Model (N = 248)		Logit (N = 248)	
Variables	**1**	**2**	**3**	**4**	**5**	**6**
Weighted avg. coefficient of variation (revenue)	2.32*	2.46**	1.38*	1.41*	1.39**	1.41**
	(1.13)	(1.17)	(0.65)	(0.70)	(0.59)	(0.63)
Tenant's willingness to take risks	0.018	0.017		–0.0061		–0.0061
	(0.024)	(0.023)		(0.019)		(0.018)
Wheat share	0.40	0.35	0.28	0.28	0.28	0.28
	(0.45)	(0.41)	(0.29)	(0.29)	(0.30)	(0.30)
Corn share	0.93*	0.93**	0.51*	0.51*	0.51*	0.52*
	(0.42)	(0.39)	(0.27)	(0.27)	(0.30)	(0.29)
Soybean share	0.090	0.0070	–0.088	–0.081	–0.091	–0.081
	(0.57)	(0.57)	(0.31)	(0.31)	(0.32)	(0.32)
Pseudo-R^2	n/a	0.13	n/a	n/a	0.03	0.03
Association fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors clustered by the crop-reporting district level are in parentheses. Single, double, and triple asterisks (*, **, ***) denote p-values of less than 0.1, 0.05, and 0.01. Columns 1, 3, and 4 are the estimated coefficients of the linear probability model (LPM) and columns 2, 5, and 6 are the marginal effects evaluated at the means of the regressors using the estimated coefficients of the logit model. Columns 1, 2, 4, and 6 include the risk attitude of the tenants and owners as additional regressors. The R^2 of the LPM is noninformative, so we only report pseudo-R^2 for logit estimations.

relationship between tenants and landowners for the nonreporting landowners. It could be driven by tenants' unwillingness to pass along the survey or landowners' unwillingness to fill it out.

In either case, we examine the summary statistics of the demographic variables to see whether there are any possible explanations due to differences in relationship (Table 1). One difference to note is the contract type. In the matched sample (113 observations), there is a higher occurrence of fixed cash leases, whereas the larger sample of unmatched and matched tenants (248 observations) has a higher incidence of choosing crop share leases. This suggests a possible difference in the relative risk attitudes between the tenants and landowners in the two samples. It is also possible that the nature of the relationships between landowner and tenant differs between the two samples. Evidence for this comes from differences between the share of landowners that are family versus neighbor or acquaintance. There are also differences between the number of years leased to the same tenant and the share of on-farm income. It is impossible to pinpoint the exact driver of these differences, but we do observe qualitatively similar estimates for the coefficient of the riskiness variable (i.e., the weighted average CV) with respect to different model specifications or samples.

Finally, we perform a robustness check that focuses on the possibility of the omitted variable bias. We re-estimate equations (2) and (3) using Zou's (2006) adaptive lasso approach (equation 4). We use a five-fold cross-validation procedure to find an optimal λ. We repeat the model estimation procedure 100 times to consider model uncertainty. We find that the adaptive lasso for the LPM never selects any additional control variables from the candidate pool and thus yields the identical result as column 2 of Table 2. For the logit model, the only additional variable selected via the adaptive lasso approach is the indicator variable of whether the tenant knows how the landowner obtained the land or not. Table 4 reports the estimation result with this additional variable included. The coefficients of the key independent variables remain robust with respect to the addition of control variables.

An interesting finding of the variable selection exercise is that none of the relationship variables was selected to explain the farmland contract choices. This is especially interesting because a

Table 4. Estimation Results: Post-Selection Estimation

	Marginal Effects
	Logit (N = 111)
Variables	**Prob(Fixed Cash Rent = 1)**
Weighted avg. coefficient of variation (revenue)	2.12**
	(1.01)
Tenant's willingness to take risks	0.056**
	(0.025)
Owner's willingness to take risks	−0.059***
	(0.015)
Wheat share	0.30
	(0.37)
Corn share	0.77**
	(0.34)
Soybeans share	−0.022
	(0.51)
Does not know how the landowner obtained the land	0.39*
	(0.21)
Pseudo-R^2	0.18
Association fixed effects	Yes

Notes: Robust standard errors clustered by the crop-reporting district level are in parentheses. Single, double, and triple asterisks (*, **, ***) denote p-values of less than 0.1, 0.05, and 0.01.

majority of the respondents identified themselves as either a family member or friend to their respective landowner. This is different from the work of Bryan, Deaton, and Weersink (2015), who find that familial relationships explained farmland leasing contract choice but not contract amount.

There are limitations to this study. The data used in this study were survey-based and found to be representative of other, similar datasets in terms of descriptive statistics, but we recognize that the sample size used for this study is relatively small. Additionally, associated risk between landowners and tenants varies across the United States. As such, the conclusions drawn from this study should shed light on Kansas landowners and tenants and should only be applied to other regions with care.

Conclusion

In conclusion, this study's matched landowner–tenant dataset provides an opportunity to estimate the relationship between farmland leasing contract choice, the degree of risk in farming, and risk attitudes of the tenants and landowners. Consistent with the risk-sharing theory found in earlier studies, we confirm two stylized facts: (i) greater risk leads to the optimal contract as fixed cash rent and (ii) more risk-averse landowners make the fixed cash rent contract more likely.

These results indicate that changes in environmental factors affecting the riskiness of production (e.g., restrictions on irrigation water availability in western Kansas) will have impacts on landowner–tenant negotiations of leases. If landowners exert a preference for less risk exposure and choose not to use a crop share arrangement, tenants will see a two-fold increase in risk exposure: greater production risk from less irrigation water and greater production and marketing risk from a fixed rent contract. Therefore, the results of this study will be useful for understanding farm management decision making in the future as environmental factors like climate conditions change.

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Appendix A

Table A1. Estimation Results: Matched Pairs from the Restricted Sample

	Marginal Effects Prob(Fixed Cash Rent = 1)			
	Linear Probability Model (N = 61)		Logit (N = 60)	
Variables	**1**	**2**	**3**	**4**
Weighted avg. coefficient of variation (revenue)	1.97	1.74	1.93	1.64
	(1.56)	(1.43)	(1.23)	(1.00)
Tenant's willingness to take risks		−0.049		−0.045**
		(0.027)		(0.020)
Owner's willingness to take risks		0.050		0.047**
		(0.030)		(0.024)
Wheat share	1.76*	1.55*	1.75**	1.52
	(0.76)	(0.78)	(0.89)	(1.02)
Corn share	1.94**	1.74**	1.93**	1.67**
	(0.71)	(0.71)	(0.82)	(0.83)
Soybean share	0.66	0.60	0.71	0.67
	(0.56)	(0.59)	(0.63)	(0.74)
Pseudo-R^2	n/a	n/a	0.13	0.16
Association fixed effects	Yes	Yes	Yes	Yes

Notes: Robust standard errors clustered by the crop-reporting district level are in parentheses. Single, double, and triple asterisks (*, **, ***) denote p-values of less than 0.1, 0.05, and 0.01. Columns 1 and 2 are the estimated coefficients of the linear probability model (LPM) model and Columns 3 and 4 are the marginal effects evaluated at the means of the regressors using the estimated coefficients of the logit model. Columns 2 and 4 include the risk attitude of the tenants and owners as additional regressors. The R^2 of the LPM is noninformative, so we only report pseudo-R^2 for logit estimations.