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An Empirical Investigation of the Linkages between Government Payments and Farmland Leasing Arrangements

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This article investigates the impacts of decoupled and coupled program payments on farmland rental contract choices for a subset of U.S. crop farms using a principal-agent model. We consider cash and share contracts as well as hybrid contracts, which represent an increasingly prominent feature of U.S. agriculture. The conceptual framework suggests that restrictions on payments between contracting parties are ineffective and induce an offsetting contractual rearrangement. Empirical results from a multinomial logit model confirm that government support programs have large, significant effects on contract choices and that these effects vary by types of programs.

Key words: benefit distribution, contractual rearrangement, hybrid contract, leasing arrangements, program payments

Introduction

In 1999, approximately 45% of United States farmland was operated by a tenant (U.S. Department of Agriculture, National Agricultural Statistics Service, 2001). Historically, contractual arrangements between landlords and tenants mostly included either cash payments or sharecropping. More recently, a third form of leasing arrangement involving both forms of payments, which we designate as a "hybrid" contract, has gained popularity. The National Agricultural Statistics Services (U.S. Department of Agriculture, National Agricultural Statistics Service, 2001) defines a hybrid contract (also called a cash/share contract) as one under which the tenant pays part of the rent in cash and part as a share of crops or livestock products.[1]

The use of hybrid contracts is increasing in the U.S. farmland leasing market. In 1999, about 11% of all U.S. leased farmland was under hybrid contracts, compared to only 3% in 1988. Hybrid contract use was highest in the Corn Belt and the Northern Plains (U.S. Department of Agriculture, National Agricultural Statistics Service, 2001). These two regions are mainly comprised of crop farms, which are also the primary beneficiaries of commodity and conservation program payments. In 1999, 26% of leased farmland in Indiana was rented under hybrid contracts, as compared to less than 2% in 1988. Similar situations can be observed in other important agricultural states, including Illinois, Ohio, Kansas, Nebraska, Missouri, and Iowa.

The literature on farmland contract choice is considerable. Marshall (1890) laid out the early foundations of the analysis of sharecropping and illustrated the source of inefficiency associated with sharecropping (in relation to a cash or wage contracts). Sharecropping discourages the tenant's own

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[1] In what follows, we use a relatively narrower definition of the hybrid contract as one that consists of a predetermined share percentage plus a fixed cash payment.

input use because he/she receives only part of the marginal product. A number of studies challenged Marshall's conclusion. Cheung (1969) argued that sharecropping could be as efficient as other types of contracts if monitoring is costless. Stiglitz (1974), and Newbery and Stiglitz (1979) introduced land tenure choices into a principal-agent framework. The standard agency model suggests that contracts are designed to achieve a balance between efficient risk-sharing and appropriate incentives to discourage moral hazard.

Allen and Lueck (1992, 2002) argued that in developed countries, where insurance markets are well developed, risk-sharing should not be the primary determinant of contract choices. They maintained that the benefit of a sharecropping contract is that it curbs the tenant's incentive to overuse inputs (e.g., soil moisture and nutrients) supplied by the landlord. However, sharecropping requires the output to be divided between the landlord and the tenant and thus generates additional transactions and monitoring costs for the landlord.

More recently, Huffman and Just (2004) introduced a principal-agent model that allows for heterogeneity in the characteristics of principals and agents and relaxes the risk-neutrality assumption for landlords. They argued that the parameters of sharecropping vary across tenants and landlords because of tenants' heterogeneity (e.g., the agent-specific effort productivity). Huffman and Fukunaga (2008) and Fukunaga and Huffman (2009) provided recent empirical evidence on the determinants of contract arrangements using a model in which agents choose between a share and cash-rent contract. They found that both risk sharing and transaction cost incentives are important determinants of the contract type. They also emphasized the role of the landlords' attributes in determining the optimal landlord-tenant contract choice.

The literature has neglected two main issues related to farm leasing arrangements. First, previous studies have largely ignored the existence of hybrid contracts, instead focusing on a binary decision rule that involves cash rentals versus share contracts (e.g., Allen and Lueck, 2002; Fukunaga and Huffman, 2009). As argued above, hybrid contracts capture a growing share of leasing arrangements. Second, most studies have ignored the impacts of government support on contract choices.[2] Government support programs are especially important in U.S. agriculture: from 2000 to 2009, more than 40% of U.S. farms received program payments annually. The average annual commodity and conservation program payments under the 2002 Farm Bill were $15.0 billion; corresponding support payments are projected to be $10.9 billion per fiscal year under the 2008 Farm Bill Monke and Johnson (2010). Previous studies have demonstrated that the optimal contract choice depends on farming risk, tenant and landlord risk preferences, and expected returns from rented land. Income and price support programs will affect the landlord-tenant contract choice because they may impact expected returns and income variability as well as individuals' degree of risk aversion.

The contribution of this study is twofold. First, we examine the effects of government programs on farmland rental contract choices. In an empirical model, we break down aggregate government support into five different program types and investigate to what extent each impacts the probabilities of selecting a given contract type. Second, we introduce hybrid contracts as a third alternative in the contract set available to landlords and tenants in order to investigate the determinants of an increasingly popular form of rental arrangement in U.S. agriculture. Individual contract-level data collected in the 1999 Agricultural and Economics Landlord Owner Survey (AELOS) and the 1999 Agricultural Resource Management Survey (ARMS) are combined to carry out the analysis.

[2] Bierlen et al. (2000) offer a notable exception, though it is not closely connected to our analysis. The authors used a 1997 survey of Arkansas farm operators and investigated the impacts of the 1996 FAIR Act on leasing arrangements. They investigated whether operators terminated or added farmland leases due to the FAIR Act. Their results indicate that the probability of adding leases due to the FAIR Act increased as operators' experience declined, financial position strengthened, and managerial independence increased.

Conceptual Framework

The model below builds upon earlier efforts of Huffman and Just (2004) and Huffman and Fukunaga (2008). We expand their work by introducing agricultural program payments into the model. We begin by addressing the role of decoupled payments (also known as direct payments) in leasing arrangements. Decoupled payments were introduced in the 1996 Farm Bill and renewed in the 2002 and 2008 Farm Bills. They are annual lump-sum income transfers that are designed to be independent of current production and market prices. Decoupled payments are based on base acreage and historical yields, and the producer is not obligated to be currently growing any specific crops on the land. He/she may plant any crop (with the exception of fruits and vegetables) without losing benefits. Under the current legislation, decoupled payments are the largest payout among commodity programs. In the Congressional Budget Office (CBO) March 2010 baseline projection for FY2011-FY2020, decoupled payments total $49 billion (or $4.9 billion annually), which account for 77% of the total commodity payments under Title I (Monke and Johnson, 2010). There are also restrictions on the distribution of decoupled payments. Legislation requires that the payments be shared among tenant farm operators and landlords subject to the contract on a fair and equitable basis. Under a cash rental arrangement, 100% of the decoupled payments are allocated to the farm operator. Under a share contract, the government distributes payments to both the landlord and the tenant operator according to the share terms of lease.

For simplicity, we assume that each landlord contracts with only one tenant. The principal is the landlord and the agent is the tenant operator.[3] Following Huffman and Just (2004), we allow heterogeneity in risk preferences of agents and principals. We also allow heterogeneity in the productivity of effort, cost of effort, and reservation utility.

A Principal-Agent Model with Decoupled Payments

The output of tenant operator i on one unit of leased land (or net revenue with appropriate normalization) is defined as:

$$y_i(e_i) = a_i e_i + \varepsilon_i, \tag{1}$$

where e_i is tenant i's effort/labor input and a_i is the tenant-specific productivity of labor. Differences in productivity may be related to human capital in the form of farming experience (Huffman and Just 2004). Output is also function of a stochastic term, ε_i, which is assumed to have zero mean and variance σ_i^2.

Following Huffman and Fukunaga (2008), we assume the landlord offers a linear incentive contract to the tenant operator. The tenant operator's compensation is:

$$I_i(e_i) = \alpha_i + \beta_i(a_i e_i + \varepsilon_i + g_d) - 0.5 k_i e_i^2, \tag{2}$$

where k_i is the tenant-specific effort cost parameter. A high (low) value of k_i indicates a steep (flat) marginal cost curve. The variable g_d represents decoupled government payments. The parameter α_i is the tenant-specific cash payment of the contract. A positive α_i represents the cash wage paid by the landlord to the tenant; a negative value for α_i means that cash rent payments are made to the landlord. The parameter $\beta_i (0 \leq \beta_i \leq 1)$ is an incentive rate representing a share of output. Hence, when $\beta_i = 1$ and $\alpha_i < 0$, the leasing arrangement is a cash contract as opposed to $0 < \beta_i < 1$ and $\alpha_i = 0$, which indicates a share contract. More importantly in the context of this paper, $0 < \beta_i < 1$ and $\alpha_i < 0$, indicate that the leasing arrangement is a hybrid type contract.

Assume that the tenant has well-defined preferences over income summarized by the utility function $U_i(I_i)$. Expected income of the ith tenant operator is $E(I_i) = \alpha_i + \beta_i(a_i e_i + g_d) - 0.5 k_i e_i^2$.

[3] Tenant operators include pure-tenant operators, who rent all of the farmland from others; and part-owner operators, who own part of the farmland and rent part of the land from others.

The variance of the tenant's income is $V(I_i) = \beta_i^2\sigma_i^2$. Let $RP_i \equiv 0.5r_iV(I_i)$ denote the risk premium where $r_i \equiv -U_i''/U_i'$ is the tenant's Arrow-Pratt coefficient of absolute risk aversion. Under the expected utility model, $EU_i(I_i) = U[E(I_i) - RP_i]$. Given that $U_i(I_i)$ is an increasing function of income, maximizing $EU_i(I_i)$ is equivalent to maximizing the expression $[E(I_i) - RP_i]$ (Chavas, 2004). Therefore, the tenant operator's optimal effort is determined by maximizing his/her certainty equivalent $CE_i = E(I_i) - RP_i$:

$$\max_{e_i} CE_i = \max_{e_i}[E(I_i) - 0.5r_iV(I_i)] = \max_{e_i}[\alpha_i + \beta_i(a_ie_i + g_d) - 0.5k_ie_i^2 - 0.5r_i\beta_i^2\sigma_i^2]. \tag{3}$$

The optimization problem defined in equation (3) solves the optimal effort $e_i^* = \beta_i a_i/k_i$.

Similarly, the lth landlord's expected return from ownership of the rented land equals $E(\pi_l) = E[(1-\beta_i)(y_i + g_d) - \alpha_i]$ and its variance is $V(\pi_l) = (1-\beta_i)^2\sigma_i^2$. As in the case of the tenant operator, we write the landlord's optimization problem in terms of the certainty equivalent return:

$$\max_{\beta_i} CE_l = \max_{\beta_i}[E(\pi_l) - 0.5r_lV(\pi_l)] = \max_{\beta_i}[(1-\beta_i)(a_ie_i^* + g_d) - \alpha_i - 0.5r_l(1-\beta_i)^2\sigma_i^2]. \tag{4}$$

subject to the participation and incentive compatibility constraints: $\alpha_i + \beta_i(a_ie_i^* + g_d) - 0.5k_ie_i^{*2} - 0.5r_i\beta_i^2\sigma_i^2 \geq \mu_i$ and $e_i^* = \arg\max_{e_i}[\alpha_i + \beta_i(a_ie_i + g_d) - 0.5k_ie_i^2 - 0.5r_i\beta_i^2\sigma_i^2]$, where r_l is the Arrow-Pratt measure of the landlord's absolute risk aversion, and μ_i is tenant i's reservation utility.

The landlord's optimal choice of α_i will be determined by the binding participation constraint. Substituting e_i^* and α_i into equation (4) and optimizing over β_i yields the optimal incentive rate offered to the ith tenant operator:

$$\beta_i^* = \frac{c_i + r_l\sigma_i^2}{c_i + (r_i + r_l)\sigma_i^2} = 1 - \frac{r_i\sigma_i^2}{c_i + (r_i + r_l)\sigma_i^2}, \tag{5}$$

where $c_i \equiv a_i^2/k_i$ is an index of tenant-specific effort productivity. Substitute the optimal share rate into the participation condition to obtain the optimal cash component of the contract:

$$\alpha_i^* = \mu_i - 0.5(\beta_i^*)^2(c_i - r_i\sigma_i^2) - \beta_i^* g_d. \tag{6}$$

The optimal share rate, β_i^*, in equation (5) emphasizes the role of the landlord's and the tenant operator's degree of risk aversion. If a tenant operator is risk neutral $(r_i = 0)$, the optimal share rate equals one and a cash contract is the optimal outcome. Similarly, the optimal share increases towards one as the landlord's coefficient of risk aversion goes to infinity (i.e., $r_l \to \infty$). Risk, represented by the variance of income, is negatively correlated with the optimal share rate. The higher is the variance of income, the smaller is the optimal share rate. Therefore, an increase in income volatility can have a negative impact on the choice of a cash contract, *ceteris paribus*. However, an increase in risk has an indeterminate impact on the optimal cash payments.

A quick look at equation (5) suggests that decoupled payments do not have a direct impact on the share rate. However, these payments may affect the contract choice indirectly, through their impact on the degree of risk aversion. If an individual has constant absolute risk aversion (CARA) preferences, decoupled payments will not have an impact on the solution in equation (5). However, if his/her risk preferences entail decreasing absolute risk aversion (DARA), decoupled payments will reduce the degree of risk aversion through their impact on wealth.

However, decoupled payments do have a direct effect on the optimal cash component, α_i^*, of the contract. It reflects a pass-through of program benefits from the tenant operator to the landlord. From equation (6), the optimal cash component with no decoupled payments (i.e., $g_d = 0$) is $\mu_i - 0.5(\beta_i^*)^2(c_i - r_i\sigma_i^2)$, which is greater than that with positive decoupled payments. The

difference is $\beta_i^* g_d$, which equals the share of decoupled payments going to the tenant operator under the current legislative environment for U.S. farm programs. Hence, the landlord captures the benefits that go to the tenant by charging an extra cash amount of size $\beta_i^* g_d$ and restores the equilibrium that would have been attained under no governmental restriction, *ceteris paribus*.[4] Under the optimal leasing arrangement, the landlord is able to capture all of the benefits distributed to the tenant operator, given the conditions that payments are decoupled and the wealth effect is negligible. A governmental restriction on payment distribution does not influence the actual benefit distribution between landlords and tenant operators in the end. It merely results in offsetting contractual rearrangements.[5] This is consistent with Lence and Mishra (2003) and Goodwin, Mishra, and Ortalo-Magné (2010), who have found evidence that landlords capture 62-86% of the benefits of decoupled payments by raising cash rents.

When referring to the equilibrium leasing arrangement, it is interesting to look at the comparison between the equilibrium contract choice with decoupled payments and the choice without the payments under three general circumstances. Assume both parties have CARA preferences and define β_{i0}^* and α_{i0}^* as the optimal share rate and cash component of the contract under no decoupled payments. First, if a share contract is optimal (i.e., $0 < \beta_{i0}^* < 1$ and $\alpha_{i0}^* = 0$) the introduction of decoupled payments will change the equilibrium to a hybrid contract, increasing the cash payment to the landlord and keeping unchanged the share rate ($0 < \beta_{i0}^* < 1$ is constant and $\alpha_{i0}^* = 0 - \beta_i^* g_d < 0$). In a second case, if the equilibrium contract with no decoupled payments is a cash contract ($\beta_{i0}^* = 1$ and $\alpha_{i0}^* < 0$), the introduction of decoupled payments would leave the share rate constant and the cash payment to the landlord would increase ($\beta_{i0}^* = 1$ and $\alpha_i^* = \alpha_{i0}^* - \beta_i^* g_d < 0$). Therefore, the equilibrium contract choice will still be a cash contract, but the cash rent will increase. Finally, if the optimal leasing arrangement is a hybrid contract without decoupled payments, decoupled payments will not change the equilibrium contract type. The cash payments to the landlord will simply increase. In summary, under the CARA assumption, the introduction of decoupled payments increases the use of hybrid contracts and decreases the use of share contracts. Decoupled payments have no effect on the choice of cash contracts.

On the other hand, if both parties have DARA preferences, decoupled payments will lower the degree of risk aversion. From the solutions in equations (5) and (6), a cash contract will emerge in the case where the landlord's degree of risk aversion goes to infinity. Under more general conditions, the direct and indirect effects of decoupled payments on the cash component of the contract, α_i, can go in different directions. The net effect depends on the risk preferences of both contracting parties. Table 1 summarizes the effects of decoupled payments on optimal leasing arrangements by risk preferences. The ambiguous causal effect of decoupled payments on leasing arrangement can only be resolved empirically. However, we examine the effects of coupled payments on contract choices before considering the empirical investigation.

A Principal-Agent Model with Coupled Payments

Coupled payments are based on current production and/or market price. Many forms of coupled programs exist in the United States. These include price and/or yield support mechanisms and disaster relief programs. For simplicity, we investigate a per-unit production subsidy. As before, the landlord and the tenant share the program payments in the same proportion as they share output. The per-unit production subsidy rate is $\phi > 0$ and coupled support equals $g_c = \phi y_i$. The tenant operator and the landlord's payments are $\beta_i \phi y_i$ and $(1 - \beta_i \phi y_i)$, respectively. Maximizing the objective function defined in equation (4) accounting for coupled support yields the optimal effort level $e_i^* = (1 + \phi)\beta_i a_i / k_i$. The optimal share rate and the cash payment that maximize the landlord's objective function are:

[4] We assume that transaction costs for renegotiating contracts are zero.

[5] Cheung (1969, chapter 5) reaches a similar conclusion.

Table 1. Effects of Decoupled Program Payments on Contract Choices

Program payments	Risk preference	Effect	Optimal share rate β_i^*	Optimal cash-part payments α_i^*	Effects on Contract Choice		
No program payments			$1-\frac{r_i\sigma_i^2}{c_i+(r_i+r_l)\sigma_i^2}$	$\mu_i-\frac{1}{2}\beta_i^{*2}(c_i-r_i\sigma_i^2)$			
			$1-\frac{r_i\sigma_i^2}{c_i+(r_i+r_l)\sigma_i^2}$	$\mu_i-\frac{1}{2}\beta_i^{*2}(c_i-r_i\sigma_i^2)-\beta_i^* g_d$	Cash $\beta_i^*=1$ $\alpha_i^*<0$	Hybrid $0<\beta_i^*<1$ $\alpha_i^*<0$	Share $0<\beta_i^*<1$ $\alpha_i^*=0$
Decoupled payments	Both CARA	direct	NO	-	NO	+	-
		indirect	NO	NO	NO	NO	NO
	Both DARA	direct	NO	-	NO	+	-
		indirect	+/-	+/-	+/-	+/-	+/-
	TO CARA LL DARA	direct	NO	-	NO	+	-
		indirect	-	+	-	+/-	+/-
	TO DARA LL CARA	direct	NO	-	NO	+	-
		indirect	+	-	+/-	+	-

Notes: TO refers to the tenant operator and LL refers to the landlord.

$$\beta_i^* = \frac{(1+\phi)^2 c_i + r_l(1+\phi)^2\sigma_i^2}{(1+\phi)^2 c_i + (r_i+r_l)(1+\phi)^2\sigma_i^2} = 1 - \frac{r_i\sigma_i^2}{c_i+(r_i+r_l)\sigma_i^2}; \tag{7}$$

$$\alpha_i^* = \mu_i - 0.5(1+\phi)^2\beta_i^{*2}(c_i - r_i\sigma_i^2). \tag{8}$$

The per-unit production subsidy has a direct impact on income variability and the marginal productivity of effort. However, these two effects cancel each other when determining the optimal share rate, which remains constant if no wealth effects are present. Turning our attention to potential wealth effects, coupled payments have an ambiguous impact on the share rate. The effect depends on both the landlord and tenant's risk aversion. As discussed in the previous section, the optimal share increases towards one as the landlord's risk aversion increases to infinity. However, coupled support may decrease the landlord's risk aversion coefficient, which could entail a switch from a cash rental type to hybrid or sharecropping.

Production subsidy payments have a direct impact on optimal cash payments. If $\beta_{i0}^* = \beta_i^*$, cash payments decrease from $\mu - 0.5(\beta_i^2)^2(c_i - r_i\sigma_i^2)$ to $\mu_i - 0.5(1+\phi)^2(\beta_i^*)^2[c_i - r_i\sigma_i^2]$, which suggests that cash payments increase as per-unit production payments increase. Note that a decrease in cash payments is possible if the wealth effect decreases the landlord's coefficient of absolute risk aversion.

The impacts of coupled payments on contract choice can differ substantially according to the support types. Coupled payments influence the optimal share rate and cash payments through one or more of the following factors: increases in expected returns, changes in income variability, changes in the (value of) marginal productivity of effort, and impacts on the contracting parties' degree of risk aversion. Programs that decrease income variability and/or decrease a tenant's effort decrease the optimal share rate, thus have a positive effect on the choice of a cash contract. While the types of programs have not been explicitly modeled, we use insights from this section to state the hypotheses related to the causal relationship between U.S. coupled farm payments and leasing arrangements.

Modeling Framework

Data and Empirical Model

The data used in this study come from five sources: the 1999 Agricultural Economics and Land Ownership Survey (AELOS), the 1999 Agricultural Resource Management Survey (ARMS), the Regional Economic Information Systems (REIS) dataset for the 1990-1999 period, the county level farm program payment data from the Farm Service Agency (FSA) of the USDA over the 1996-1999 period, and the county level farmland data from the 1997 Census of Agriculture. In contrast to other studies that only use one source of data (e.g., Huffman and Fukunaga, 2008; Fukunaga and Huffman, 2009), we combine the above datasets in an effort to increase the explanatory power of the empirical model. The AELOS is an integrated survey of farm finance and land ownership. It includes comprehensive information collected from both tenants and landlords. Each observation in this dataset represents a unique contractual relationship between a landlord and a tenant operator.

The ARMS is a national survey that provides observations of farm-level production practices, economic attributes, and operator household characteristics. We use this dataset to obtain individual farm-level program payments as well as additional farm and operator characteristics that may impact the leasing arrangements. The REIS contains economic data and annual estimates of personal income for the residents of the entire nation as well as states, metropolitan areas, and counties. We obtain county-level gross cash farm income (cash receipts from marketing and government payments) data from REIS and FSA, and county-level farmland acres from the 1997 Agricultural Census.

We refine the combined dataset following these steps. First, we focus on the landlords who have only one renter. This accounts for about 90% of the entire dataset. Second, some outliers (less than 2% of the available sample) are excluded from the analysis because they represent atypical situations (for example, landlords reporting land rent exceeding $2,000 per acre). Third, because crop farm producers are the main recipients of farm program payments, farms that reported livestock product sales that exceeded of 50% of their farm sales are excluded. Farms for which more than 50% of total sales were nursery products, fruits, or vegetables are also dropped from the sample. After this selection procedure, a total of 15,457 observations remain for the analysis. In the AELOS dataset, each landlord/operator observation has a different weight to represent their weight in the underlying population, as if a complete census had been carried out(For more information about the calculation of these weights, see U.S. Department of Agriculture, National Agricultural Statistics Service, 1999).

We address the choice of leasing arrangements using a multinomial Logit (MNL) model, appealing to the concept of random utility derived by individual n from a set of $j = 1, \ldots, J$ different alternatives (Train, 2003):

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad \forall \quad j, \tag{9}$$

where V_{nj} represents information that is known by researchers and ε_{nj} is the unobservable component of utility.

Let $\boldsymbol{x}$ be a vector of individual-specific characteristics and $\boldsymbol{\beta}$ a corresponding vector of estimated coefficients. If ε_{nj} is unknown but follows a logistic distribution, the choice probability is (Long and Freese, 2006):

$$P_{nj} = \frac{\exp(\alpha_{\mathrm{j|b}} + \boldsymbol{x}\boldsymbol{\beta}_{\mathrm{j|b}})}{\sum_{j=1}^{J} \exp(\alpha_{\mathrm{j|b}} + \boldsymbol{x}\boldsymbol{\beta}_{\mathrm{j|b}})}, \tag{10}$$

where b refers to the base alternative which is defined here as a "share contract." We normalize $\alpha_b|b = 0$ and $\beta_b|b = 0$ so that the log of the odds of an alternative compared with itself is always zero.

The log likelihood function for the MNL model is:

$$\ln L(\beta) = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} \ln P_{nj}. \tag{11}$$

The variable d_{nj} equals 1 if individual n chooses alternative j, and equals zero otherwise.

Model Specification

In the following empirical investigation, we use a generalized MNL model with an alternative-specified constant (Train, 2003). Each observation in the dataset constitutes a landlord and tenant operator pair (landlord-tenant hereafter) that is involved in a specific farmland contract. The landlord and tenant choose a contract among three alternatives: a cash contract, a share contract, or a hybrid contract. The decision is made conditional on a set of independent variables, which are specific to the landlord-tenant pair n and are included in the vector $\boldsymbol{x}_n$. This vector can be decomposed into four different parts that include farm program payments, farming risk and risk preferences, tenant operator's effort productivity, and other factors, each of dimension I_G, I_R, I_P, and I_M, respectively. Alternatives are assumed to be mutually exclusive. The utility function can be written as:

$$V_{n,i|b} = \alpha_{i|b} + \sum_{g=1}^{I_G} \beta_{g|b}^{G} GovP_{n,g} + \sum_{r=1}^{I_R} \beta_{r|b}^{R} Risk_{n,r} + \sum_{p=1}^{I_P} \beta_{p|b}^{P} EffP_{n,p} + \sum_{m=1}^{I_M} \beta_{m|b}^{M} Other_{n,m}. \tag{12}$$

The subscript i refers to either the "cash" or the "hybrid" contract. The parameter $\alpha_{i|b}$ is the ith alternative specific constant, which can be interpreted as the average effects of unobserved factors. The variables $GovP_{n,g}$ are payments (per acre) received from government program g. The variables $Risk_{n,\gamma}$ are proxies to capture farming risk and both parties' risk preferences. One potential proxy candidate for risk is the coefficient of variation (CV) for gross income at the individual farm level. However, this may raise endogeneity concern if the individual CV is correlated with unobserved farm characteristics, such as land attributes. Therefore, we use a CV of gross cash farm income per acre (which includes both cash receipts from market and government payments) in the county where the individual farm is located over the previous ten-year period. A tenant operator's risk preference is represented by farm net worth. On the landlord's side, we do not have data on net worth/wealth. We therefore use an indicator of whether the landlord purchased insurance for the farm business as a proxy to the landlord's risk preference.

The variables $EffP_{n,p}$ represent the tenant operator's productivity. We employ farming experience and the squared value of farming experience to proxy the tenant operator's effort productivity. Finally, the variables in $Other_{n,m}$ include the landlord's residence, the landlord's real estate taxes relative to his/her rent income, farm type, and the tenant operator's tenure status (whether the operator is a pure tenant or a part-owner tenant).[6]

Government program payments include six components. They are Production Flexibility Contract (PFC) payments, Market Loss Assistance (MLA) payments, Loan Deficiency Program (LDP) Payments (include marketing loan gains), Agricultural Disaster Payments (which include all market loss or disaster assistance payments, but exclude Federal Crop Insurance indemnity and other indemnity payments), Conservation Reserve Program (CRP) benefits, and a final category including all other minor program payments. As discussed in the conceptual framework section, decision makers use expectations of future payments to determine the contract type. Disaster, MLA, and LDP payments are not predetermined. Rather, they are triggered by market and production conditions. Measurement issues arise if actual reported payments are used to represent expectations,

[6] Following the suggestion of an anonymous reviewer, we investigated whether the landlord's and the tenant operator's relative real estate taxes had an impact on leasing arrangements. We found that the operator's real estate taxes were not statistically significant and thus excluded this variable from the final estimation.

as is noted in (Goodwin, Mishra, and Ortalo-Magné, 2003). To control potential errors-in-variables problems, we follow their approach and use a four-year county average of payments per acre to proxy expected program payments.[7]

Future PFC payments are decoupled and known in advance of when a contract is signed. Therefore, we use self-reported, realized farm-level payments in the empirical model. Conservation Reserve Program pays farmers annual rents to place land in reserve. In order to be eligible for the payments, land must be erodible and environmentally fragile. Such payments could quite possibly be correlated with the unobserved factors that affect the contract choice (e.g., land attributes). Therefore, although CRP payments are usually known before signing the contract, our empirical investigation uses a four-year county average as a proxy for individual farms to avoid the potential endogeneity problem.

Table 2 presents the definition of key variables and summary statistics. In our crop farm sample, 57% of farmland contracts were on a cash basis while 18% were share contracts. The remaining 25% were hybrid contracts, making the latter form of leasing arrangement more popular than pure share contracts for crop farms. From 1996 to 1999, farms received on average $14.15 PFC payments per acre annually at the county level. The corresponding MLA, LDP, and Disaster payments were $10.03, $9.80, and $2.38 per acre on average. Finally, the annual county average CRP payments were $2.32 per acre. All monetary values were adjusted by the consumer price index to represent 2004 dollars. Tenant operators had 26.3 years farming experience on average. About 55% of landlords lived in a rural area and the remaining 45% of landlords were defined as absentee landowners and lived in a non-rural area. Principle crop farms–defined as grains, oilseed, dry beans, or peas farms–account for 63% of the crop farm sample. Around 83% of tenant operators are part-owner tenants who own some of the operating land and the remaining 17% are pure-tenant operators who rent the entire farmland from others.

Expected Impacts of Key Factors on Contract Choices

The PFC payments are decoupled payments independent of current production and market price. The impacts of decoupled payments on leasing arrangements are summarized in table 1. More specifically, when wealth effects are small or negligible, the PFC payments will entice agents to move from a share contract to a hybrid contract and thus will redistribute the benefits between contracting parties. The MLA, LDP, and disaster assistance programs are coupled and are associated with current production and/or market conditions.

When wealth effects are negligible, we can expect the following impacts of program payments on the contract choice. The coupled programs (MLA, LDP, and disaster) lower income variation and have a positive effect on the optimal share lease rate. Thus, they raise the probability of selecting a cash contract. However, if a wealth effect influences the degree of risk aversion of both parties, the effects of program payments can have opposite impacts. In general, government programs can shift incentives to use a particular type of contractual arrangement and can redistribute income and risk between the landlord and tenant. The CRP is a special type of program when considering the impacts of government payments on leasing arrangements. In most cases, payments are not related to the leased land. Tenant operators receive payments from their own land. The CRP pays landowners annual rents to set their land aside under a ten to fifteen year lease agreement. Land committed to CRP must be removed from production. Because the CRP payments usually do not involve rented land, they may not affect the landlord's incentives. However, they may have an impact on the contract choice by affecting the tenant's degree of risk aversion (through wealth effects). According to the optimal share rate derived in Equation (5), risk is expected to have a negative impact on the optimal share rate. However, an increase in σ^2 generates conflicting effects on the optimal cash payments and it makes it impossible to unambiguously sign the net impact of risk on cash payments.

[7] Market Loss Assistance payments were introduced in 1998 and we use the 1998-1999 average annual payments. For other programs, we use 1996-1999 average annual payments.

Table 2. Summary Statistics (N=15,457)

Contract choice		Frequency	Percentage
Cash contract		8,806	56.97
Hybrid contract		3,834	24.80
Share contract		2,817	18.23
Variable	**Definition**	**Mean**	**Std. Dev.**
1996-1999 County average program payments ($/acre)			
PFC	Production flexibility contract payments	14.15	8.73
MLA	Market loss assistance payments	10.03	6.21
LDP	Loan deficiency payments (including marketing loan gains)	9.80	6.76
Disaster	Disaster payments	2.38	2.96
CRP	Conservation reserve program payments	2.32	2.40
Other	Other payments	0.12	0.16
Risks and risk preferences			
CV	10-year county level coefficient of variation of cash receipts from market and government payments (per acre)	0.13	0.07
NetWorth	Net Worth of the farm	183,032.70	70,011.40
Insurance_l	1 if landlord's purchase insurance for the rented farm	0.34	0.47
Tenant operator's effort productivity			
FarmingExp	Tenant operator's farming experience	26.30	11.96
$FarmingExp^2$	Tenant operator's farming experience squared	821.50	732.74
Other factors			
Rural_l	1 if landlord lives in a rural area	0.55	0.50
Ft_main	1 if the farm type is grains, oilseed, dry beans, or peas	0.63	0.48
RealTax_l	Landlord's real estate tax expenditure relative to total rent received (100%)	0.62	4.64
PartOwner	1 if the tenant is a part-owner and 0 if he or she is a pure-tenant	0.83	0.38

One concern at the empirical stage is the possibility that a particular type of principal contracts with certain types of agents, a phenomenon dubbed endogenous matching by Ackerberg and Botticini (2002). The authors argue that if: 1) there exist incentives for particular parties to contract with a specific subset of the other parties (e.g., a risk-averse tenant being more likely to contract with a risk neutral landlord); and 2) some characteristics (e.g., landlord's true risk preference) of contracting parties are not observable, explaining the outcome may involve a possible bias if the endogeneity is not addressed.

To investigate this possibility, we carried out a two-stage regression procedure that involves in the first stage, regressing the tenant operator's risk preference (represented by net worth of the farm) on the landlord's risk preference (proxied by purchase of insurance) and other exogenous factors may that may have an impact on matching (e.g., contracting parties' ages and education). We found no significant correlation between the contracting parties' risk preferences. In a second stage, we use the predicted value of the tenant operator's risk preference proxy and estimate the

multinomial logit model. The results from the second stage are quite similar to the uncorrected MNL estimation results, which do not control for endogenous matching. Intuitively, the similarity between the results is consistent with prior studies (e.g., Sherrick and Barry, 2003; Allen and Lueck, 2002) that emphasize how contracts emerge from long-run business relationships due to close ties between the landlord and the tenant. Therefore, it is not unreasonable to treat the matching of contracting parties as exogenous to the leasing arrangements in the U.S. farmland market.

A tenant operator normally contracts with several different landlords (on average, one tenant operator contracted with four landlords in 1999). Some correlation among observations from the same tenant operator may exist. Therefore, clustered robust standard errors are used and based on the tenant operator's identification number in this analysis. The logit model implicitly imposes the Independence of Irrelevant Alternatives (IIA) assumption, which states that the probability of choosing between two alternatives is unaffected by the presence of additional alternatives. We test the IIA using the Chi-Square test statistic proposed by Hausman and McFadden (1984). We are not able to reject the null hypothesis that the IIA assumption is valid at a high level of significance. Tests for combining alternatives (Long and Freese, 2006) are also computed to examine if hybrid contracts are distinguishable from share and cash contracts. The Wald tests reject the hypothesis that any two of the alternative contracts are indistinguishable at a 0.01 level.

Results

Table 3 reports the estimates of the coefficients in the three-alternative MNL model while table 4 reports the marginal or discrete changes in predicted probabilities for each alternative derived from table 3 estimates.

Government Program Payments

Recall that program payments are measured in 2004 dollars. Not surprisingly, the change in predicted probability following a dollar increase is small. Therefore, we report the effects of a standard-deviation change in table 4. We define a standard deviation increase (centered on the mean) as one unit change when we refer to the marginal/discrete effects. Table 4 shows evidence that the PFC payments have a positive impact on the selection of hybrid contracts and a negative effect on share contracts. When a PFC payment increases by one unit ($8.73), the probability of choosing a hybrid contract increases by 1.1% and the probability of choosing a share contract decreases by 4.5%. This is consistent with the theoretical explanation that landlords are more likely to capture the program benefits through a hybrid contract. The impact of decoupled payments on choosing a cash contract is positive. Direct payments have an impact on wealth and decrease risk aversion under DARA-type preferences, and thus increase the probability to choose a cash contract.

Both the disaster payments and the loan deficiency payments encourage the choice of a cash contract by reducing the income volatility. If a tenant operator receives an additional unit ($6.76) of loan deficiency payments, the probability of choosing a cash contract increases by 2.1%. The predicted probability of choosing a cash contract is 5.0% higher following a one unit ($2.96) increase in the tenant operator's disaster payments. Meanwhile, both the LDP and the disaster payments decrease the probabilities of choosing a share contract. In contrast, the MLA payments have negative impacts on the cash contract choice. The marginal effects of the MLA payments on both the cash and share contracts are the largest among all government programs. Getting an additional unit of MLA payments decreases the probability of choosing a cash contract by 6.8%. The extent of LDP and disaster payments was determined by the 1996 Farm Bill. However, the MLA was determined outside of the Farm Bill. In 1998, the prices of many crops declined significantly. Congress authorized $2.86 billion as emergency MLA payments (trigged by low market price, but based on historic base acreages) to help farmers deal with income losses. Therefore, MLA actually

Table 3. Maximum Likelihood Estimation of MNL Models of Contract Choice (N = 13,136)

Explanatory Variable	Choice	Coefficient	Robust standard error
1996-1999 County average program payments ($/acre)			
PFC	Cash	0.02***	4.02E-3
PFC	Hybrid	0.02***	4.22E-3
MLA	Cash	−0.07***	0.01
MLA	Hybrid	−0.04**	0.02
LDP	Cash	0.03**	0.01
LDP	Hybrid	0.03**	0.01
Disaster	Cash	0.08**	0.03
Disaster	Hybrid	0.02	0.04
CRP	Cash	−0.02	0.02
CRP	Hybrid	−0.03	0.03
Other	Cash	0.20***	0.07
Other	Hybrid	0.07	0.08
Risks and risk preferences			
CV	Cash	−1.97**	0.84
CV	Hybrid	−1.76*	0.91
NetWorth	Cash	2.12E-07	1.50E-07
NetWorth	Hybrid	1.42E-07	1.66E-07
Insurance_1	Cash	−0.93***	0.09
Insurance_1	Hybrid	−0.61***	0.09
Tenant operator's effort productivity			
FarmingExp	Cash	0.01	0.02
FarmingExp	Hybrid	0.04	0.02
$FarmingExp^2$	Cash	-1.85E-04	3.05E-04
$FarmingExp^2$	Hybrid	-3.30E-04**	9.90E-05
Other potential factors			
Rural_1	Cash	0.30***	0.09
Rural_1	Hybrid	0.02	0.09
Ft_main	Cash	−0.37**	0.18
Ft_main	Hybrid	0.33	0.21
RealTax_1	Cash	0.17***	0.06
RealTax_1	Hybrid	−0.01	0.06
PartOwner	Cash	0.32*	0.16
PartOwner	Hybrid	0.36**	0.18
Constant	Cash	1.31***	0.31
Constant	Hybrid	−0.38	0.41
Log pseudo-likelihood = -863750.98			
Wald chi^2 = 294.99			
Prob > chi^2 = 0.00			

Notes: Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.

Table 4. Marginal and Discrete Changes on the Predicted Probabilities

	Unit change in the independent variable	Change in predicted probability (100%) Cash	Hybrid	Share
Receipt of program payments in 1999				
PFC	\$8.73	3.42	1.08	-4.50
		[0.64, 6.21]	[-0.97, 3.12]	[-6.61, -2.40]
MLA	\$6.21	-6.77	1.15	5.62
		[-10.43, -3.10]	[-1.66, 3.96]	[3.12, 8.12]
LDP	\$6.76	2.10	1.09	-3.19
		[-1.16, 5.35]	[-1.44, 3.62]	[-5.50, -0.87]
Disaster	\$2.96	5.01	-1.97	-3.04
		[1.44, 8.59]	[-4.91, 0.97]	[-5.85, -0.23]
CRP	\$2.40	-0.41	-0.41	0.82
		[-3.07, 2.25]	[-2.55, 1.74]	[-0.75, 2.38]
Other	\$0.16	3.93	-1.33	-2.60
		[1.27, 6.58]	[-3.35, 0.70]	[-4.67, -0.53]
Risks and risk preferences				
CV	0.07	-1.77	-0.32	2.10
		[-4.41, 0.86]	[-2.36, 1.71]	[0.49, 3.71]
NetWorth	\$70011.40	2.32	-0.21	-2.11
		[-1.91, 6.55]	[-3.50, 3.08]	[-5.07, 0.85]
Insurance_1	0→1	-15.25	0.88	14.36
		[-18.71, -11.78]	[-1.41, 3.18]	[11.39, 17.34]
Tenant operator's effort productivity				
FarmingExp	11.96	-3.85	6.28	-2.44
		[-12.79, 5.10]	[-1.36, 13.93]	[-8.83, 3.96]
$FarmingExp^2$	732.74	5.20	-9.45	4.25
		[-4.13, 14.54]	[-17.60, -1.30]	[-2.12, 10.62]
Other factors				
Rural_1	0→1	7.02	-3.47	-3.55
		[3.98, 10.06]	[-5.67, -1.27]	[-6.03, -1.07]
Ft_main	0→1	-12.59	9.61	2.98
		[-19.51, -5.67]	[4.37, 14.85]	[-1.88, 7.84]
RealTax_1	1%	4.27	-2.30	-1.97
		[1.89, 6.66]	[-3.88, -0.73]	[-3.82, -0.12]
PartOwner	0→1	3.37	2.08	-5.45
		[-3.46, 10.21]	[-2.84, 7.00]	[-10.60, -0.31]

Notes: For continuous independent variables (program payments, CV, and farming experience), a unit change equals a standard deviation around the mean, holding other variables at their sample mean. Numbers between brackets provide 95% confidence intervals for changes in predicted probabilities following Long and Freese (2006).

targeted higher risk farms/crops. This would in turn make MLA correlated with higher risk (high CV) and thus have negative impacts on the optimal share rate (i.e., a decrease in the probability of choosing a cash contract). The impacts of CRP payments on the landlord-tenant contract choices are

found to be insignificant. The "other" payment category reveals a positive impact on the choice of a cash contract and a negative impact on a hybrid or a share contract.

In conclusion, the results indicate that decoupled payments encourage the use of cash and hybrid contracts relative to share contracts. Benefits from most of the program payments (with the exception of MLA) have positive effects on the choice of a cash contract. Also, the impacts of payments on the probability of selecting a hybrid contract are positive (except for disaster payments). The payment effects on share contracts differ depending on the specifics of the program. Most programs have negative impacts on the probability to observe a share contract, with the exception of MLA payments. The impacts of program payments on contract choices show that risk-sharing and benefit distribution are important determinants of farmland leasing arrangements.

Risk and Risk Preferences

The role of risk sharing in the determination of leasing arrangements is somewhat controversial in the literature. Some empirical studies find it an important determinant of leasing arrangements (e.g., Huffman and Fukunaga, 2008; Fukunaga and Huffman, 2009), but others disagree (e.g., Allen and Lueck, 1992, 2002). Our results provide evidence that risk has significant impacts on leasing arrangements. Risk (as proxied by the income CV variable) has a negative effect on the choice of a cash contract. A standard deviation increase in the coefficient of variation will reduce the probability of choosing a cash contract by 1.8% and increase the probability of choosing a share contract by 2.1%. The landlord's purchase of insurance is found to be a significant determinant of contract choices. The results show that if a landlord purchases insurance for the target farm business (denoting possible risk aversion), he/she is less likely to choose a cash contract. This is not consistent with the intuition summarized in table 1. We expected that a risk-averse landlord would be more likely to choose a cash contract. One possible explanation is that the purchase of insurance indicates a more risky farming activity (σ^2 is large), which deters the use of cash contracts. However, the farm's net worth is found to be insignificant.

Productivity of Effort and Other Attributes

Table 4 reports that farming experience is not a statistically significant determinant of contract choice. However, the squared value is found to be significant, and has a positive impact on the probability of selecting cash and share contracts and a negative effect on hybrid contracts. The results indicate that a landlord living in a rural area is more likely to choose a cash contract than those who live in an urban area. The evidence supports the transaction cost hypothesis proposed by (Allen and Lueck, 2002), which states that an absentee landlord is more likely to choose a share contract, under which the tenant's incentive to overuse the land is smaller than under a cash contract. It does not lend support to the alternative transaction cost hypothesis that an absentee landlord is less likely to choose a share contract since the cost of monitoring is relatively high (e.g., Cheung, 1969). The results show that farm type significantly affects contract choices as well. If the target crop farm belongs to a principle crop farm type (i.e., oilseed and grain farms), the probability of choosing a hybrid contract increases 9.6%. The landlord's ratio of real estate taxes to total rent income is found to be a statistically significant variable. The higher the ratio, the higher the probability of cash lease. The tenure status of the tenant operator is found to be a statistically significant determinant of contract choices. Tenant operators who are part-owners of the land are found to be more likely to choose cash or hybrid contracts and less likely to use share contracts.

Conclusions

This paper provides a simple conceptual model for evaluating the impacts of government programs on contract choices in agriculture. The theoretical model shows that exogenous legal restrictions on the distribution of program benefits between contracting parties–such as the restriction on the direct payments distribution between landlords and share tenants under the 1996, 2002, and 2008 Farm Bills–can cause an offsetting contractual rearrangement in order to restore the benefit distribution to the unrestricted level. The increasingly common use of hybrid contracts (and decreasing use of share contracts) on crop farms may be a form of this contractual rearrangement. We use data from a variety of sources to empirically analyze the determinants of contract choices using a multinomial logit (MNL) model with alternative specified constants. The results confirm that different policy mechanisms have different effects on the farmland contract choices. More specifically, we find that a one standard deviation increase in PFC (decoupled) payments increases the probability of using a hybrid contract by 1.1% and decreases the probability of selecting a share contract by 4.5%. Other farm programs are also found to be significant determinants of leasing arrangements; their effects vary by the types of programs. Risk-sharing incentives are important determinants of contract choices.

This study generates two important implications. First, it illustrates the potential biases that may arise when restricting the set of potential leasing arrangements to only cash and share contracts. Introducing hybrid contracts into the analysis is especially important to understanding the impact of program payments on leasing arrangements. Second, the analysis suggests that governmental and legal restrictions on benefit sharing between contracting parties are ineffective and induce offsetting contractual rearrangements. The increasing use of hybrid contracts likely reflects a redistribution of program benefits between contracting parties. Most existing empirical research analyzing the distribution of program benefits between landlords and tenants focuses on cash rental contracts (e.g., Lence and Mishra, 2003). Only a few studies examine benefit distribution under share contracts (e.g., Goodwin, Mishra, and Ortalo-Magné, 2010). Future studies may find it helpful to consider different types of contracts, especially hybrid contracts. Future research endeavors could also use panel data to investigate the impact of policy changes on leasing arrangements.

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