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Evidence from Modern U.S. Agriculture

Eugene Canjels (New School for Social Research)

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Center for Economic Policy Analysis
New School for Social Research
80 Fifth Avenue, Fifth Floor, New York, NY 10011-8002
Tel. 212.229.5901 • Fax 212.229.5903
http://www.newschool.edu/cepa

Risk and Incentives in Sharecropping – Evidence from Modern U.S. Agriculture

Eugene Canjels

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Abstract

A new data set shows the extensive use of sharecropping in modern U.S. agriculture particularly in wheat, rice, corn, soybeans, and cotton. For these five crops, I investigate the importance of risk and three types of incentive problems that are commonly regarded to 'cause' sharecropping. A direct measure of risk from county level weather data is constructed and this measure is a major explanation in the choice between cash and share

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contracts. The potential for exploitation of the land by the tenant is also an important determinant of tenancy choice. Finally, for three inputs, fertilizer, petroleum products, and herbicides & pesticides, incentive problems in the provision of inputs by the tenant are shown to exist. For these inputs, I show that sharecroppers use less than cash renters, but this difference is eliminated when the costs of these inputs are also shared.

"So you say that the laborer as such should be an element to be studied and used as a guide in the choice of agricultural methods." Anna Karenina, Leo Tolstoy.

1 Introduction

Sharecropping is a form of an agricultural land lease contract that has puzzled economists for centuries. Instead of paying a predetermined amount of rent the tenant agrees to give the landlord a share of the output. Similar contracts are found in many other sectors, e.g., the fishing industry (Plateau and Nugent 1984) and the franchising of fast food restaurants (Lafontaine 1994). The rise of the agency literature has greatly improved our understanding of contract choice, although some of the issues involved were realized long before. Marshall (1890) formalized the incentive problem in sharecropping, while Higgs (1892) proposed the risk sharing advantages.

For several reasons sharecropping is an ideal candidate to test the usefulness of the theoretical agency literature and suggest directions for future research. From a theoretical point of view, sharecropping is very close to the simplest of all agency models, the classical principal agent problem. The contract is between one principal (the landlord), one agent (the tenant), and no other players are involved. The environment is risky since profits are greatly affected by climatic and price uncertainty, and diversifying the risk is difficult. Effort is hard to observe, and possibly even harder to enforce (firing the tenant is not really an option, although one can refuse to renew the contract). Finally, the opportunity for a repeated game solution is limited, because it takes a full year for one 'game' to finish. [1] From an empirical point of view the large number of similar observations makes an econometric analysis more powerful.

While there is an abundance of empirical studies on sharecropping, which have provided valuable information, three issues motivate the current research. First, almost all other research has looked at current developing economies or historical cases in the U.S. and Europe.[2] In contrast, I will examine sharecropping in modern agriculture. The data set that makes this possible is the 1988 Agricultural Economics and Land Ownership Survey (AELOS), which is a special survey related to the 1987 Census of Agriculture. A detailed description of the data is given in Canjels (1996). Second, previous empirical research has focussed mainly on the incentive problem: is sharecropping inefficient (in a production sense) compared to fixed rent or ownership? This research takes a broader perspective and asks why share contracts are being used and what are the effects of this.

The analysis looks at the determinants of the choice between fixed rent and

[1] Since on average contracts are repeated 10 to 15 years depending on the region, repeated games seem to provide a partial solution.

[2] To my knowledge, the sole exception is Allen and Lueck (1992a, 1992b, 1993).

sharecropping.[3] A unique feature is the inclusion of a measure of climatic risk, which is shown to be an important factor in this choice. I also look at the effect of the choice of contract on the use of certain inputs. While this has been explored in a large number of papers, previous empirical research has neglected to take the use of cost sharing arrangements into consideration. I show that while there is an incentive problem in sharecropping, this can be easily resolved by the use of cost sharing. Some explanations are suggested for why cost sharing is not always used.

A final result is that this paper is the first to present direct quantified evidence that sharecropping landlords are more involved in the production process than cash landlords. Whether the involvement of share landlords should be interpreted as an input that is subject to moral hazard problems, or as monitoring, is still unresolved.

The paper is laid out as follows. First, I briefly review the issues which are suggested in the theoretical literature and that have received the most support among economists. I move on to a description of the characteristics of tenancy and sharecropping in modern U.S. agriculture, which is necessary to put the results in proper perspective. Section 4 presents the results of the empirical analysis, and section 5 concludes.

Before continuing, it is usefull to discuss the terminology used in this paper.

[3] The wage contract is not considered, since it is rarely used in agriculture for managerial labor. The alternative of ownership is left for future research.

First, the term sharecropping describes a land lease contract in which the rent paid depends on the output produced.[4] This conforms to the use of the term in development economics. In American agricultural economics a distinction is made between sharecropping and crop-share (and livestock-share) contracts. The former refers to the complete system of labor management mainly in cotton in the post-bellum South. The latter is closer to the meaning of the word sharecropping as defined here. Cash or fixed rent contracts stand in contrast to sharecropping. The term cash-rent is more popular in American agricultural economics, while development economists and information theorists tend to use the term fixed rent. Both terms are used here interchangeably.

An operator or farmer is the person who makes the day-to-day management decisions. He can be a owner operator meaning that he owns all the land he tills, a pure tenant meaning he does not own the land he tills, or a tenant meaning that he leases some of the land but might also own some of the land. Tenants can be grouped into sharecroppers and cash renters. Similarly, landlords are grouped into share landlords and cash landlords. Since the majority of operators are male they are referred to he. The majority of landlords, however, are female and will therefore be referred to as she.

[4] Although for the empirical analysis cash leases which can be adjusted in the case of unusual circumstances are counted as fixed rent contracts.

2 Theoretical Background

I look in this paper at three issues which have found the most support among economists.[5] First of all, the tenant and landlord are risk averse. Sharecropping has an obvious advantage over fixed rent contracts in this regard. However, this advantage is small if the tenant has other means to stabilize his consumption over time, in particular saving and dissaving, and diversification. Previous empirical research has been unsuccessful in showing that risk aversion affects tenancy choice.

The second issue is moral hazard problems in the provision of inputs by the tenant and the landlord. The tenant of course provides labor and effort, but also seed, fertilizer, etc. Not every landlord is able to judge what the optimum amount is, and even if she could, it would be hard to enforce. When the amount used is observed but the optimal amount is unknown to the landlord, the moral hazard problem can be resolved by sharing the cost in the same way as the output. As I will show later cost sharing is widely used in the U.S. for certain inputs. Like the tenant the landlord also often provides valuable inputs, in particular managerial expertise, capital equipment, and credit.

The last issue has been proposed more recently and is about land exploitation. Land is a long-term asset. The tenant has the opportunity to exploit the land to increase the current production or profit at the expense of the long run productivity

[5] Three good reviews are Jaynes (1984), Singh (1989), and Otsuka, Chuma and Hayami (1992).

of the land. The major concerns are the nutrient content, the water content, and soil erosion.

In the most general model with all three issues entering, testable hypothesis are hard to obtain. Hart and Holmstrom (1987, 88) argue that "the main predictive content of the basic agency model is in the sufficient statistic result, which tells what information should enter into a contract in the first place". This means that all information which helps to predict the outcome should enter in the contract.[6] In Canjels (1996) a model is presented with strong functional form restrictions and no interaction between the different issues. This model provides the following results.

- Risk aversion.
  - Plots located in more risky regions are more likely to be sharecropped.[7]
- Moral hazard on the tenant's side.
  - If monitoring is more costly the probability of cash rent increases.

[6] On this account the theories fail since information other than output, such as weather and production on the neighbors plot, hardly ever enters the contract. The decision to renew the contract probably does depend on additional information.

[7] In theory the effect of risk can go either way. For instance if there is only a moral hazard problem on the landlord's side, more risk increases the probability of cash rent. If the moral hazard problem is only on the tenant's side then more risk increases the probability of sharecropping. Since we only observe share and cash contracts and no wage contracts it is likely that the second case is more relevant.

  - Sharecroppers who don't use cost sharing use less inputs than cash renters.
  - Sharecroppers who do use cost sharing use the same amount of inputs as cash renters.

- Moral hazard on the landlord's side.
  - Share landlords provide more inputs than cash landlords
  - Landlords with less capital or less agricultural knowledge are more likely to chose cash rent.
  - Tenants with more capital or more agricultural knowledge are more likely to chose cash rent.

- Land exploitation.
  - Erodible land is more likely to be sharecropped.
  - If monitoring is more costly the probability of share rent increases.
  - If input use is positively correlated with land exploitation, cash renters use the most inputs since they will exploit the land the most; owner operators use the least inputs.

While these results all are very reasonable we have to keep in mind that they are only indicative, and cannot be proven in a general model with interaction among the different factors. The hypotheses above will be tested in the empirical section, but first I will describe the environment in which sharecropping is currently practiced.

3 Sharecropping in the United States

It is well known that sharecropping was widely used in the cotton production in the South after the Civil War. Less known is that in the same period share contracts were prevalent in most other crops and regions. Sharecropping continued to be a common form for lease contracts until about 1960. After this, a steady decline set in (e.g., Reid 1979) of which the exact reasons are unclear. While sharecropping is still declining, it has far from disappeared. In 1988, 32.6 percent of all acres leased were sharecropped. (Leasing, including share and cash rents, accounted for 45.9 percent of all agricultural land.) Table 1 and 2 show that sharecropping is particular common in the Midwest and for five crops: wheat, rice, corn, soybeans, and cotton.

The analysis in the rest of the paper is limited to these five crops for the following reasons. First, as shown above sharecropping is common in these five crops. Second, they account for about half of all sharecropping in the U.S. Third, these crops are reasonably homogeneous. Finally, the number of observations for these crops is large enough to carry out a meaningful crop specific analysis.

Table 1: Contract Choice by Region

		% of land		
	N	Cash	Share	Other
New England	3,017	83.1	8.8	8.1
Middle Atlantic	1,449	88.6	3.2	8.1
East North Central	5,383	50.9	47.9	1.3
West North Central	9,606	58.9	39.2	1.9
South Atlantic	9,152	86.5	10.6	2.8
East South Central	2,680	79.8	17.8	2.4
West South Central	5,589	66.1	31.8	2.1
Mountain	5,729	74.4	21.6	4.0
Pacific	4,527	69.4	30.1	0.5
U.S.	47,132	65.2	32.6	2.2

Notes: Unless indicated otherwise, all tables are based on calculations by the author using the AE-LOS data.

Table 2: Contract Choice for 5 Crops

		% of land		
	N	Cash	Share	Other
Wheat	1,905	48.8	50.2	1.0
Rice	644	39.7	57.8	2.5
Corn	2,686	50.2	47.9	1.9
Soybeans	2,353	46.7	52.2	1.1
Cotton	2,600	45.8	53.6	0.6

While sharecroppers are often thought off as impoverished, exploited tenants, this picture is far from the reality in modern agriculture. Canjels (1996) shows that sharecroppers are very similar to cash renters in terms of income, wealth, education, farm size, etc. They are also not 'bonded' to one landlord: 39 percent of the sharecroppers have three or more landlords.

The landlords can be grouped in three categories: active farmers (7.1%), retired farmers (39.6%) and non-farmers (65.3%).[8] The last group contains heirs of land (roughly half) and investors. Given the issues presented in the previous section, especially the incentive problems, one predicts a large difference between those three groups of landlords in their preferences for share contracts. As can be seen

[8]Public landlords and food corporations are a very small fraction of all landlords in these five crops.

in table 3, active farming landlords are more likely than retired farmers and non farmers to choose share contracts. For instance, in wheat production 65.6 percent of all landlords who are active farmers choose a share contract, while 56.8 percent of all retired farmers, and 52.6 percent of all non-farming landlords do so.

The theoretical models of contract choice predict that every share contract should be a complicated function of the characteristics of the landlord, the tenant, and the environment. In contrast to the theoretical prediction, share contracts in reality are surprisingly simple and generally uniform within regions. Moreover, they are similar to contracts used in other countries and under other circumstances.[9] In particular, the rent is usually a fixed share of output with no additional cash payments. The share is normally a simple fraction, with 1/2, 2/3, 3/4, or 3/5 of the output going to the tenant. Contracts within a region generally use the same fraction except when the land is exceptionally good or bad. Besides sharing the output, the costs of certain inputs (e.g., seed, fertilizer, herbicides, and pesticides) are also often shared between landlord and tenant in the same ratio as the output (Allen and Lueck 1991). Cost sharing will be investigated further in the empirical section.

[9]Bardhan and Rudra (1980) give a very detailed description of the form of sharecropping in India. The information presented here about the U.S. draws on the AELOS, Allen and Lueck (1992a, 1992b, 1993) and several surveys conducted by Cooperative Extension Services of the various states.

Table 3: Contract Choice by Occupation of Landlord

			% of all contracts		
	Occupation	N	Cash	Share	Other
wheat	farmer	155	30.92	65.58	3.50
	retired farmer	306	40.93	56.80	2.27
	not a farmer	653	44.06	52.57	3.36
rice	farmer	20	17.39	82.61	0.00
	retired farmer	81	40.83	54.86	4.32
	not a farmer	199	41.50	58.01	0.49
corn	farmer	127	39.80	53.00	7.20
	retired farmer	467	56.15	40.36	3.49
	not a farmer	1123	54.07	39.24	6.69
soybeans	farmer	100	43.70	55.12	1.18
	retired farmer	361	43.18	52.90	3.92
	not a farmer	947	50.42	45.80	3.78
cotton	farmer	137	40.99	58.74	0.27
	retired farmer	352	48.89	47.06	4.05
	not a farmer	944	40.78	56.80	2.42

4 Empirical Results

4.1 The Estimation of Risk

A major component of total profit-risk is yield-risk due to weather variation. I construct a direct measure of climatic risk using panel data on yields and weather.[10] The National Climatic Data Center maintains monthly data on precipitation, temperature, and Palmer Drought Severity Index for the last 100 years by climatic division. The U.S. Department of Agriculture has yield statistics by county for 23 years. Yield data is not available for all counties for all years. The yield statistics are available by crop and distinguish between irrigated and not irrigated land.[11] The yield data is aggregated by climatic division to match the climatic data set.

This panel data makes it possible to estimate the weather effect on yield. The model is written as:

$$y_{it} = X_{it}\gamma + \lambda_i + \mu_t + \epsilon_{it}$$

where y_{it} is the yield, X_{it} is a vector of weather variables, λ_i is a division fixed effect, μ_t is a time fixed effect, and ϵ_{it} is the error term. The measure of risk for each division is the standard deviation of $X_{it}\hat{\gamma}$ using 100 years of division weather

[10] Wolpin (1982) and Paxson (1992) use weather and climate data to look at permanent and transitory income.

[11] Note that rice is always irrigated. For wheat I used data for winter wheat which accounts for 85 percent of all wheat. The other 15 percent is spring wheat which has a very different timing of seasons.

data.[12]

The specification of the vector X_{it} follows parametrically specified parsimonious models in the agronomy literature.[13] These models break up the season into different stages of plant development and allow for quadratic effects of precipitation and temperature (and other climatic variables when available). Following Mostek and Walsh (1981), an interaction effect between precipitation and temperature within a month (or season) is included. While most models measure water content at the start of the new season using the precipitation in the months between growing seasons, I use the Palmer Drought Severity Index which is a more direct measure of water content.

For the various crops, table 4 shows the main statistics of interest including the correlation between $\left(y_{it} - \hat{\lambda}_i - \hat{\mu}_t\right)$ and $X_{it}\hat{\gamma}$, which is called $\tilde{r}$. (More detailed results are available in Canjels 1996). This correlation estimates how much of the variance in the yield can be explained by the weather variables after taking out the division and time fixed effects.

The $\tilde{r}$ shows that this simple specification is quite powerful in explaining divi-

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[12] This estimate of risk by division is consistent in T, so that asymptotically as $T \to \infty$, the standard errors on this variable in a cross section regression analysis are correct. Including the variance in λ is not necessary since this increases the risk for each division by an equal amount.

[13] Specifically, the following articles are used to specify the regression. For corn: Thompson (1969a), Nelson and Dale (1978) Thompson (1986). Wheat: Thompson (1969b), Haun (1974), Feyerherm and Paulsen (1986). Soybeans: Thompson (1970), Hill (1979). Rice: Huda (1975), Murata (1975). Cotton: Lomas (1977).

Table 4: Main Statistics for the Estimation of Risk

Crop	Growing Season	N	Divisions	$\tilde{r}$
Corn: Irrigated	June – August	1129	85	0.71
Corn: Not Irrigated	June – August	836	62	0.79
Soybeans: Irrigated	June – August	480	32	0.58
Soybeans: Not Irrigated	June – August	541	32	0.89
Wheat: Irrigated	April – June	1973	98	0.34
Wheat: Not Irrigated	April – June	2583	119	0.42
Cotton: Irrigated	May – October	678	41	0.63
Cotton: Not Irrigated	May – October	793	46	0.71
Rice: All	June – October	441	22	0.61

sion yields. For corn the $\tilde{r}$ is .71 and .79 for respectively irrigated and non-irrigated crops. The irrigated soybeans are less successfully explained with $\tilde{r} = .58$, but non-irrigated soybeans did very well with $\tilde{r} = .89$. Irrigated and non-irrigated cotton has a $\tilde{r} = .63$ and $\tilde{r} = .71$ respectively, while rice has a $\tilde{r} = .61$. The least successful are the regressions for irrigated and non-irrigated wheat with $\tilde{r} = .34$ and .42 respectively. While risk is higher for unirrigated than for irrigated crops, the fact that this additional risk is well explained by the weather variables makes the estimation more successful for unirrigated crops.

4.2 A Probit Analysis of Contract Choice

The theoretical section identified several factors that might affect contract choice. Among these are risk, the cost of monitoring, and the opportunity of land exploitation. In this section a qualitative response model is estimated to evaluate the empirical relevance of the different theories. Table 6 presents the average slope coefficients (that is, the average effect of a unit change in the explanatory variable on the probability of choosing a share contract) while table 5 provides the sample means and standard deviations of the explanatory variables. (See the appendix for the exact definition of the variables.) The model is estimated separately for each crop, which allows the coefficients and intercepts to vary across crops.[14]

[14] Other researchers have looked only at one crop at a time or allowed at most for different intercepts. The assumption of equal slopes across crops seems to be too restrictive.

Table 5: Descriptive Statistics

A. Wheat

	Share		Cash		Full	
	$N = 505$		$N = 290$		$N = 795$	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
size of household	2.935	(1.448)	2.900	(1.359)	2.922	(1.416)
age of operator	48.426	(12.447)	46.355	(13.322)	47.670	(12.804)
soil erodability	0.299	(0.042)	0.281	(0.040)	0.293	(0.042)
perc. irrigation	0.017	(0.090)	0.013	(0.083)	0.015	(0.088)
farm wealth	0.205	(0.513)	0.289	(0.500)	0.236	(0.510)
debt-asset ratio	0.302	(0.321)	0.316	(0.287)	0.307	(0.309)
distance $<$ 50 m.	0.465	(0.499)	0.552	(0.498)	0.497	(0.500)
dist. 50 to 150 m.	0.129	(0.335)	0.097	(0.296)	0.117	(0.322)
distance $>$ 150 m.	0.406	(0.492)	0.352	(0.478)	0.386	(0.487)
education $<$ 12	0.050	(0.217)	0.062	(0.242)	0.054	(0.226)
education 12 to 14	0.556	(0.497)	0.634	(0.482)	0.585	(0.493)
education $>$ 15	0.394	(0.489)	0.303	(0.461)	0.361	(0.481)
landlord retired	0.535	(0.499)	0.486	(0.501)	0.517	(0.500)
landlord farmer	0.368	(0.483)	0.355	(0.479)	0.364	(0.481)
percentage owned	0.252	(0.276)	0.324	(0.282)	0.278	(0.280)
risk	0.042	(1.067)	-0.074	(0.835)	0.000	(0.990)

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Table 5 — *continued*

B. Rice						
	Share		Cash		Full	
	$N = 131$		$N = 47$		$N = 178$	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
size of household	3.748	(1.595)	3.213	(1.082)	3.607	(1.493)
age of operator	42.947	(11.780)	45.340	(12.739)	43.579	(12.050)
soil erodability	0.367	(0.045)	0.372	(0.043)	0.368	(0.045)
perc. irrigation	0.438	(0.203)	0.466	(0.227)	0.446	(0.209)
farm wealth	0.061	(0.201)	0.142	(0.295)	0.082	(0.232)
debt-asset ratio	0.478	(0.463)	0.682	(0.485)	0.532	(0.476)
distance < 50 m.	0.718	(0.452)	0.702	(0.462)	0.713	(0.453)
dist. 50 to 150 m.	0.137	(0.346)	0.128	(0.337)	0.135	(0.343)
distance > 150 m.	0.145	(0.353)	0.170	(0.380)	0.152	(0.360)
education < 12	0.115	(0.320)	0.064	(0.247)	0.101	(0.302)
education 12 to 14	0.511	(0.502)	0.702	(0.462)	0.562	(0.498)
education > 15	0.374	(0.486)	0.234	(0.428)	0.337	(0.474)
landlord retired	0.527	(0.501)	0.489	(0.505)	0.517	(0.501)
landlord farmer	0.229	(0.422)	0.170	(0.380)	0.213	(0.411)
percentage owned	0.075	(0.112)	0.105	(0.202)	0.083	(0.142)
risk	0.044	(1.138)	-0.124	(0.407)	0.000	(1.000)

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Table 5 — *continued*

C. Corn						
	Share		Cash		Full	
	$N = 449$		$N = 513$		$N = 962$	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
size of household	3.539	(1.983)	3.351	(1.691)	3.439	(1.835)
age of operator	44.929	(11.602)	44.413	(12.361)	44.654	(12.010)
soil erodability	0.281	(0.051)	0.262	(0.058)	0.271	(0.056)
perc. irrigation	0.206	(0.303)	0.121	(0.259)	0.161	(0.283)
farm wealth	0.207	(0.449)	0.205	(0.471)	0.206	(0.461)
debt-asset ratio	0.387	(0.336)	0.356	(0.304)	0.370	(0.319)
distance $<$ 50 m.	0.655	(0.476)	0.713	(0.453)	0.686	(0.464)
dist. 50 to 150 m.	0.091	(0.288)	0.103	(0.305)	0.098	(0.297)
distance $>$ 150 m.	0.254	(0.436)	0.183	(0.387)	0.216	(0.412)
education $<$ 12	0.071	(0.258)	0.103	(0.305)	0.088	(0.284)
education 12 to 14	0.690	(0.463)	0.669	(0.471)	0.679	(0.467)
education $>$ 15	0.238	(0.427)	0.228	(0.420)	0.233	(0.423)
landlord retired	0.532	(0.500)	0.511	(0.500)	0.521	(0.500)
landlord farmer	0.345	(0.476)	0.302	(0.460)	0.322	(0.468)
percentage owned	0.216	(0.215)	0.214	(0.225)	0.215	(0.220)
risk	0.305	(0.937)	-0.160	(0.975)	0.057	(0.985)

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Table 5 — *continued*

D. Soybeans						
	Share		Cash		Full	
	$N = 373$		$N = 411$		$N = 784$	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
size of household	3.201	(1.289)	3.248	(1.362)	3.226	(1.327)
age of operator	48.161	(11.578)	48.640	(11.681)	48.412	(11.627)
soil erodability	0.304	(0.049)	0.271	(0.073)	0.287	(0.065)
perc. irrigation	0.026	(0.112)	0.019	(0.087)	0.023	(0.100)
farm wealth	0.104	(0.372)	0.239	(0.564)	0.174	(0.487)
debt-asset ratio	0.337	(0.335)	0.347	(0.341)	0.342	(0.338)
distance $<$ 50 m.	0.617	(0.487)	0.725	(0.447)	0.673	(0.469)
dist. 50 to 150 m.	0.121	(0.326)	0.107	(0.310)	0.114	(0.317)
distance $>$ 150 m.	0.263	(0.441)	0.168	(0.374)	0.213	(0.410)
education $<$ 12	0.113	(0.317)	0.170	(0.376)	0.143	(0.350)
education 12 to 14	0.702	(0.458)	0.625	(0.485)	0.662	(0.473)
education $>$ 15	0.185	(0.389)	0.204	(0.404)	0.195	(0.397)
landlord retired	0.531	(0.500)	0.499	(0.501)	0.514	(0.500)
landlord farmer	0.260	(0.439)	0.265	(0.442)	0.263	(0.440)
percentage owned	0.149	(0.211)	0.164	(0.368)	0.157	(0.304)
risk	0.141	(1.015)	-0.115	(0.957)	0.007	(0.993)

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Table 5 — *continued*

E. Cotton						
	Share		Cash		Full	
	$N = 366$		$N = 450$		$N = 816$	
	mean	st. dev.	mean	st. dev.	mean	st. dev.
size of household	2.973	(1.258)	3.244	(1.412)	3.123	(1.351)
age of operator	47.598	(11.894)	47.978	(12.598)	47.808	(12.281)
soil erodability	0.326	(0.064)	0.307	(0.082)	0.316	(0.075)
perc. irrigation	0.148	(0.275)	0.139	(0.271)	0.143	(0.273)
farm wealth	0.178	(0.505)	0.249	(0.745)	0.217	(0.649)
debt-asset ratio	0.545	(0.642)	0.446	(0.571)	0.491	(0.606)
distance $<$ 50 m.	0.628	(0.484)	0.678	(0.468)	0.656	(0.475)
dist. 50 to 150 m.	0.117	(0.322)	0.111	(0.315)	0.114	(0.318)
distance $>$ 150 m.	0.254	(0.436)	0.211	(0.409)	0.230	(0.421)
education $<$ 12	0.142	(0.350)	0.122	(0.328)	0.131	(0.338)
education 12 to 14	0.587	(0.493)	0.527	(0.500)	0.554	(0.497)
education $>$ 15	0.270	(0.445)	0.351	(0.478)	0.315	(0.465)
landlord retired	0.437	(0.497)	0.456	(0.499)	0.447	(0.498)
landlord farmer	0.279	(0.449)	0.276	(0.447)	0.277	(0.448)
percentage owned	0.173	(0.204)	0.206	(0.260)	0.191	(0.237)
risk	0.111	(0.858)	0.119	(0.751)	0.115	(0.801)

Table 6: Probit Analysis of Contract Choice

A. Model 1

	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
size of househ.	0.020	0.046	0.013	−0.010	** − 0.040	*10.76
	(0.015)	(0.029)	(0.010)	(0.017)	(0.019)	
age of operator	***0.006	−0.002	0.001	0.000	−0.001	*9.66
	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)	
soil erodability	***2.105	−0.002	**0.794	***1.752	**0.736	***51.36
	(0.495)	(1.000)	(0.394)	(0.355)	(0.334)	
perc. irrigation	0.285	−0.162	*0.158	0.001	0.093	6.44
	(0.255)	(0.216)	(0.082)	(0.164)	(0.097)	
farm wealth	−0.010	0.046	−0.032	* − 0.092	−0.026	3.94
	(0.051)	(0.227)	(0.060)	(0.052)	(0.039)	
debt-asset ratio	−0.009	* − 0.183	0.062	0.007	0.045	5.49
	(0.070)	(0.098)	(0.068)	(0.064)	(0.042)	
dist. 50 to 150	0.084	0.071	0.002	0.066	0.032	4.04
	(0.067)	(0.084)	(0.055)	(0.055)	(0.057)	

(continued on next page)

Table 6 — *continued*

A. Model 1 — continued						
	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
distance > 150	**0.091	0.038	**0.092	***0.139	*0.078	***23.94
	(0.036)	(0.109)	(0.040)	(0.046)	(0.045)	
education 12 to 14	0.019	−0.135	0.071	0.011	0.014	1.64
	(0.077)	(0.224)	(0.066)	(0.072)	(0.073)	
education > 15	0.087	−0.076	0.049	−0.016	−0.080	2.70
	(0.081)	(0.264)	(0.079)	(0.090)	(0.078)	
landlord retired	0.033	−0.005	0.000	0.019	−0.023	1.35
	(0.039)	(0.068)	(0.035)	(0.036)	(0.039)	
landlord farmer	0.027	0.073	*0.066	−0.002	0.016	4.17
	(0.042)	(0.094)	(0.038)	(0.044)	(0.043)	
perc. owned	** − 0.247	−0.366	0.017	−0.035	−0.090	8.87
	(0.101)	(0.253)	(0.116)	(0.083)	(0.116)	
risk	*0.037	0.064	***0.085	*0.043	0.006	***18.97
	(0.019)	(0.044)	(0.028)	(0.022)	(0.035)	

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Table 6 — *continued*

B. Model 2						
	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
size of househ.	0.021	0.044	0.012	−0.002	−0.026	8.99
	(0.014)	(0.029)	(0.009)	(0.016)	(0.016)	
age of operator	*0.003	−0.002	0.001	0.001	0.001	3.16
	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)	
soil erodability	−0.563	0.056	0.185	0.107	0.442	1.31
	(0.713)	(0.981)	(0.510)	(0.623)	(0.613)	
perc. irrigation	−0.072	−0.144	−0.026	0.289	−0.038	3.13
	(0.193)	(0.214)	(0.132)	(0.186)	(0.127)	
farm wealth	−0.059	0.047	0.023	0.053	0.015	3.08
	(0.042)	(0.228)	(0.050)	(0.064)	(0.037)	
debt-asset ratio	0.020	* − 0.179	0.000	−0.072	0.014	5.23
	(0.058)	(0.099)	(0.064)	(0.056)	(0.032)	
dist. 50 to 150	0.024	0.077	−0.016	0.073	0.022	3.40
	(0.063)	(0.085)	(0.049)	(0.050)	(0.050)	

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Table 6 — *continued*

B. Model 2 — continued						
	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
distance > 150	**0.088	0.042	*0.067	**0.108	0.021	***16.06
	(0.035)	(0.107)	(0.037)	(0.044)	(0.040)	
education 12 to 14	−0.025	−0.140	0.087	−0.008	−0.010	1.85
	(0.077)	(0.224)	(0.076)	(0.066)	(0.063)	
education > 15	0.029	−0.072	0.066	−0.032	−0.070	2.01
	(0.083)	(0.264)	(0.086)	(0.080)	(0.068)	
landlord retired	0.020	−0.001	0.006	0.010	−0.027	1.04
	(0.035)	(0.068)	(0.033)	(0.034)	(0.035)	
landlord farmer	0.020	0.083	0.040	−0.033	−0.037	3.69
	(0.039)	(0.093)	(0.037)	(0.044)	(0.039)	
percentage owned	−0.052	−0.350	−0.062	*** − 0.339	−0.102	*10.93
	(0.089)	(0.249)	(0.107)	(0.126)	(0.100)	
risk	−0.021	0.026	**0.077	**0.158	***0.158	***23.39
	(0.022)	(0.101)	(0.034)	(0.071)	(0.045)	

(continued on next page)

Table 6 — *continued*

C. Model 3						
	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
size of househ.	0.008		**0.019	−0.014	** − 0.039	**13.31
	(0.014)		(0.009)	(0.016)	(0.014)	
age of operator	*0.003		0.000	0.000	−0.001	2.50
	(0.002)		(0.002)	(0.002)	(0.002)	
soil erodability	−1.153		−0.009	0.093	1.528	2.75
	(1.059)		(0.985)	(1.128)	(1.226)	
perc. irrigation	−0.262		−0.173	0.278	0.015	4.38
	(0.197)		(0.166)	(0.226)	(0.151)	
farm wealth	−0.016		0.068	−0.024	−0.032	3.46
	(0.044)		(0.044)	(0.050)	(0.038)	
debt-asset ratio	−0.031		−0.050	0.004	0.020	1.40
	(0.060)		(0.058)	(0.070)	(0.032)	
dist. 50 to 150	−0.024		−0.047	*0.099	0.023	4.91
	(0.065)		(0.046)	(0.053)	(0.047)	

(continued on next page)

Table 6 — *continued*

C. Model 3 — continued						
	Wheat	Rice	Corn	Soyb.	Cotton	χ^2
distance > 150	**0.089		0.047	*0.085	0.024	**11.72
	(0.037)		(0.035)	(0.044)	(0.038)	
education 12 to 14	−0.029		0.009	−0.023	0.006	0.27
	(0.077)		(0.070)	(0.074)	(0.058)	
education > 15	0.030		0.024	−0.053	−0.030	0.79
	(0.078)		(0.076)	(0.093)	(0.065)	
landlord retired	0.007		−0.009	−0.002	−0.036	1.25
	(0.035)		(0.031)	(0.036)	(0.034)	
landlord farmer	0.020		0.015	−0.020	−0.034	1.41
	(0.041)		(0.035)	(0.042)	(0.039)	
percentage owned	−0.119		−0.051	−0.129	0.054	3.79
	(0.100)		(0.103)	(0.095)	(0.101)	
risk	0.025		***0.117	−0.039	***0.227	***23.12
	(0.034)		(0.037)	(0.045)	(0.066)	

Notes: Reported are the average derivatives, with the standard errors in parenthesis. The last column gives the chi-square statistic testing that a coefficient is zero for all five crops, against a two-sided alternative. One, two, and three stars indicate significance at the 10%, 5%, and 1% level. The critical values for the chi-square tests are respectively 9.24, 11.07, and 15.09 for Model 1 and 2, and 7.78, 9.49, and 13.28 for Model 3 (in which rice is excluded).

The χ^2 statistic reported in the last column of table 6 tests the hypothesis that the slope for a particular variable is zero for all crops, against a two-sided alternative.

In the analysis every tenant-landlord pair is treated as one observation, so that observations with the same tenant but different landlords are dependent. This problem is treated as a random effects probit model. The model is estimated using the standard (independent) probit method. The standard errors are corrected for the dependence of observations.[15]

4.2.1 Risk

The measurement of risk by irrigated and unirrigated crops is explained in the previous section. To get a measure of risk for a contract, the unirrigated and irrigated risk are first normalized to have a mean of zero and a variance of one. The risk of a farm is a weighted average of risk on unirrigated plots and risk on irrigated plots.[16] This procedure eliminates the effect of irrigation on risk. To capture this effect a separate variable, percentage irrigated, is included.[17]

[15]Guilkey and Murphy (1993) provide Monte Carlo evidence that shows that this procedure has attractive robustness properties.

[16]Note that for cotton, risk does not have a mean of zero and a standard deviation of one. This is caused by a positive correlation between irrigation and risk on irrigated plots in the sample.

[17]An alternative approach would be to first take the weighted average and then normalize. I prefer the current approach because it is not clear that the method of estimating risk makes the measures of irrigated and unirrigated risk comparable. While the magnitude and significance of the risk variable is very similar for the two approaches, the magnitude and significance of 'percentage irrigated' is affected a great deal.

Apart from decreasing risk, in particular the adverse effects of droughts, irrigation also increases the problem of exploitation or land misuse. Irrigation is often applied with expensive equipment which is physically connected to the land and owned by the landlord. The irrigation variable therefore measures two opposing effects. First, irrigation decreases risk, which is likely to decrease the probability of sharecropping. Second, irrigation increases the opportunity of land exploitation which increases the probability of sharecropping versus fixed rent.

First look at Model 1. This model contains all variables reported in the table plus an intercept. The joint hypothesis that risk does not affect tenancy choice in any crop is strongly rejected ($\chi^2 = 17.79$). For the individual crops risk affects tenancy choice for wheat, corn, and soybeans (the t-statistics on the coefficients are respectively 1.90, 2.91 and 1.90; note that table 6 reports the standard deviation, not the t-statistic). The economic significance is also large, with average derivatives of 3.7, 8.5, and 4.3 percent. The standard deviation is approximately 1.0 for the risk measure. Thus the average derivatives give the increase in the probability of sharecropping if risk increased by one standard deviation. The effect of risk on tenancy choice in rice is of comparable magnitude with an average derivative of 6.4 percent. This is, however, statistically insignificant, partly due to having only about one fifth as many observations as the other crops. Another reason might be that the production of rice is geographically concentrated and that the climatic variation is therefore small. Finally, for cotton, risk has a small positive effect on the choice for sharecropping, but the effect is not statistically significant. The effect of irrigation is statistically insignificant for all crops except in the case of corn where the t-statistic is 1.90.

Since risk is a regional variable, it can be argued that it picks up some regional variation in contract choice that is due to other factors. The consistent positive effect of risk makes this unlikely. To check the robustness of the results, Model 2 adds state dummies in addition to the variables reported. This addition should affect the power of estimating the impact of risk a great deal, and indeed the coefficient on wheat becomes insignificant. However, the significance for corn is hardly affected, and for soybeans the significance increases. Finally the effect for cotton becomes significant and positive.[18] Jointly the risk is still significant at the 1 percent level.

The second check on the robustness of the risk results is Model 3. From the NRI all 52 (!) soil variables available plus average farm value and average farm revenue are included in addition to soil erodability. Again, the power of the estimation is obviously greatly affected. Estimation of the model for rice is no longer possible and the coefficient for soybeans changes sign and is no longer statistically significant. However, the coefficients for corn and cotton show an even larger impact of risk

[18]This reversal is caused by the East South Central and the South Atlantic regions which have less sharecropping although risk is low in those regions.

and are still statistically significant. Risk is still jointly significant at the 1 percent level. The conclusion is that the risk measure picks up climatic effects and not regional effects.

That risk is important in contract choice is supported by the fact that 5.9 percent of all cash contracts contain special clauses, which adjust the rent in a particular good or bad year. The particular form of these clauses suggests a pure risk sharing arrangement.

There is an important theoretical objection against the climate measure of risk explaining contract choice. If risk is important why don't we observe any insurance contracts in which the payoff depends on the realization of weather. Since weather cannot be affected by either contract party and does affect the relevant outcome, insurance contracts of this type should be very useful. Such an insurance program was actually recently proposed by the Federal Crop Insurance Commission but was quickly dismissed by the commercial insurance providers for being too much of a 'lottery'. Instead, the FCIC went forward (well after 1988) with an alternative, the Group Risk Plan, in which the payoff depends on the actual county yields compared with normal county yields for a county. This plan also takes away part of the moral hazard problems involved with crops insurance programs. I conclude that the practical implementation of offering weather insurance contracts seems difficult, which makes sharecropping useful in providing insurance.

4.2.2 Moral Hazard Problems

The theoretical section introduced two different types of moral hazard problems on the tenant's side. In the standard moral hazard problem, the tenant has an incentive to use fewer inputs, such as labor and fertilizer, than the optimal amount. This type of moral hazard problem pushes the optimal contract toward a fixed rent contract. On the other hand, the tenant has an incentive to exploit the land. This moral hazard problem has the opposite effect: the optimal contract looks more like a wage contract. In this section I present evidence on the effect of monitoring ability which affects both types of moral hazard problems but the expected sign of the coefficient is opposite.

The ability of the tenant to 'cheat' on the landlord depends on how much land he owns. If the tenant owns a part of the land and rents another part diverting resources (such as fertilizer or labor) from the rented plot to the owned plot will be easy. Thus the moral hazard problem is more severe if the tenant owns more land compared with the amount that he rents, and one would expect to find more fixed rent contract.[19] After controlling for state effects, the coefficients on the variable 'percentage owned' are negative for all five crops but only statistically significant for soybeans. I regard this as limited evidence that this effect exists.[20] The po-

[19]This argument implies that the Bell (1977), Shaban (1987) efficiency tests are only valid for the subsample of mixed tenants and cannot be extended to pure tenants.

[20]One can argue that poor farmers without much land are credit constrained and

tential economic significance can be large with the probabilities of sharecropping decreasing as much as 7 percent (for wheat) if ownership increases by one standard deviation.

On the landlord's side three variables are included that indicate the ability of the landlord to monitor the tenant. The first is the distance from residence to plot which increases the cost of monitoring. The second is whether the landlord is retired or not which affects her opportunity cost of time (but also see the section on other factors below). The last one is whether or not she has or had a job that is farm related which affects whether she has the knowledge necessary to monitor.

An interesting result is that the probability of choosing a share contract increases with the distance of the residence of the landlord to the plot. The coefficient on living more than 150 miles away is jointly significant at the 1 percent level and this is robust against the inclusion of state effects and soil variables. If we look at the effect for corn in Model 1, the average derivative on the dummy that indicates that the landlord lives further than 150 miles from the plot, is 9.2 percent. Since this is a zero-one dummy variable, the interpretation of the average derivative is that it gives approximately the increase in the probability if every landlord moves from living closer than 50 miles to more than 150 miles from the

choose sharecropping to obtain credit from the landlord (for instance they pay the whole rent only after the season, and the landlord often shares in the costs of certain inputs). However, the regression included the variable 'farm wealth' and this variable would pick up such a credit effect. Farm wealth is statistically insignificant for all crops.

farm. Average slopes between 3.8 percent (rice) and 13.9 percent (soybeans) are of substantial economic significance. The coefficients on the other distance dummy, living between 50 and 150 miles from the plot, are also always positive but usually smaller than the dummy for 150 or more miles. Since monitoring is easier for landlords living close to the plot, these results suggest that land exploitation is important. Landlords who live closer to the plot can ensure that the land is not exploited without having to use share contracts.

The relationship between sharecropping and the provision of credit has received much attention in the literature. Because of the apparently widespread existence of this in the developing world, I considered this very seriously but was not able to find any evidence for this in modern U.S. agriculture. In the model two variables are included, farm wealth and debt-asset ratio, which are jointly never significant and individually never significant at the 5 percent level.

4.2.3 Land Exploitation

One important problem in agriculture is soil erosion. Erodible soil needs special tillage to keep erosion under control. The methods are often expensive and the direct effect is small — it only affects the long term productivity of the land. The National Resource Inventory provides measures of soil erodability by county. Model 1 show that, except for rice which has a small and insignificant coefficient, erodible soil is always more likely to be sharecropped and this is jointly significant.

The impact of soil erodability is roughly 5 to 10 percent for one standard deviation change.

Soil erodability might not be a problem if the landlord lives close but a large problem if the landlord lives far away. This interaction effect between soil erodability and distance was examined by allowing the slope on soil erodability to vary by distance category. Although the data showed that distance effects are important it could not distinguish between a change in intercept and a change in slope coefficients on soil erodability.

Again since this is a variable that varies broadly by region, it might be picking up other regional variations. None of the coefficients is significant after including state effects or all other soil characteristics. Of course this might be a problem of power but it shows that the evidence for this type of land exploitation is limited.

4.2.4 Other Factors

Besides traditional theoretical economic motivations other factors such as tax laws or agricultural price supports might affect tenancy choice. In discussions with a variety of people, the only legislation mentioned that could possibly affect tenancy choice was the Social Security legislation.[21] Having a sharecrop or fixed rent

[21] Note that to the extent that agricultural price supports or other farm policy decreases risk, it should have an impact on tenancy choice. I am controlling of course for all crop specific effects. Also note that although I do not know of any state specific legislation that might affect tenancy choice, any such effect is captured in model 2 which includes state dummies.

contract can affect whether the income of the landlord is characterized as earned income or rental income. This would have it the greatest impact on retired landlords versus non-retired landlords. The former prefer not to have their rental income counted as earned income since their Social Security benefits could be reduced. The effects for the non-retired landlords would depend on the individual situation but might go the other way if the landlord tries to have earnings so as to increase future Social Security benefits. The results show however that the dummies for the landlord being retired are not statistically significant.[22]

4.3 Input Use

4.3.1 Fertilizer, Herbicides & Pesticides, and Petroleum Products

The moral hazard story of sharecropping predicts that sharecroppers use fewer inputs than cash renters. This has been extensively tested with mixed results. The fact that cost sharing alleviates or even solves the incentive problems has received a great deal of attention in the theoretical literature but is neglected in the empirical research comparing input use.

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[22] Wells (1984) shows another way Social Security legislation might have an impact on tenancy choice. In a discussion of the California strawberry industry she argues that in the absence of legislation the farmers would employ Mexican green-carders as wage laborers. However, sharecroppers are regarded as independent contractors and are responsible for all social security payments which they often evade. So by employing its Mexican workers as sharecroppers, the farmer avoids paying social security taxes. This is not practiced in the crops I am looking at.

Cost sharing is aggressively stimulated by the Cooperative Extension Service because of the positive incentive effect, and it is very common for certain inputs. Table 7 shows how often cost sharing is used for the various inputs. It is particularly common for fertilizer and herbicides & pesticides, and much less common for hired labor and petroleum products.

Table 8 shows the analysis of the use of three inputs, fertilizer, herbicides & pesticides, and petroleum products, between various types of operators.

In the table the cash renters are used as the base to which the others are compared. The numbers following fixed rent are sample means. The numbers following the three other types of renters are regression coefficients on the dummies for operator type. State fixed effects are included in these regressions but not reported.

The power of the tests depend on the sample sizes. For rice, I don't find any statistically significant differences between the different types of operators but this is not surprising given the very low sample sizes. Note also that samples sizes for cost sharing in petroleum products are very low.

First compare cost sharing sharecroppers versus cash renters. Out of the 15 cases, cost sharers use once statistically significantly more (at 5%) than cash renters and once significantly less (at 10%). The other cases are about equally divided between positive and negative effects. The joint hypothesis that all coefficients on

Table 7: Cost Sharing by Type of Expenditure

			Percentage Cost Sharing					
		N	Ferti-lizer	Hired Labor	Petr. Prod.	Insur. Prem.	Herb. & Pest.	Other Exp.
wheat	cash	442	6.54	0.51	2.87	12.19	1.98	8.13
	share	727	43.13	2.90	7.20	30.59	21.43	14.69
	other	55	35.24	1.96	5.14	29.78	11.29	16.85
rice	cash	101	5.39	2.52	1.75	9.66	4.93	17.72
	share	233	22.40	4.35	12.60	25.37	16.07	14.23
	other	20	57.40	0.59	37.87	46.15	39.05	47.93
corn	cash	991	13.06	2.09	5.13	21.66	11.22	11.68
	share	772	63.21	10.20	11.18	49.77	59.07	46.36
	other	78	22.32	1.98	14.93	33.02	23.94	19.56
soybeans	cash	745	13.29	4.50	6.24	22.54	10.92	14.26
	share	703	65.90	7.87	14.68	53.38	58.73	47.02
	other	72	42.11	20.34	2.99	15.76	31.09	40.54
cotton	cash	860	10.06	3.54	4.15	13.57	4.88	9.20
	share	644	37.43	2.63	4.37	19.82	25.07	12.38
	other	57	41.53	0.45	1.92	29.01	41.65	23.36

Table 8: Comparison of Input Use

A. Wheat

	fertilizer		petr. prod.		herb. & pest.		χ^2
	N	coef.	N	coef.	N	coef.	
fixed rent	70	8.12	71	4.93	70	4.61	
cost sharing	50	-3.89	13	-0.04	29	0.95	3.73
		*(2.32)		(2.01)		(0.99)	
no cost sharing	59	-5.06	96	-1.54	80	-1.21	**10.62
		**(2.10)		(1.07)		*(0.73)	
pure owners	233	-2.75	231	0.26	232	-1.05	5.82
		*(1.65)		(0.93)		*(0.61)	

B. Rice

	fertilizer		petr. prod.		herb. and pest.		χ^2
	N	coef.	N	coef.	N	coef.	
fixed rent	15	22.02	15	18.82	15	17.88	
cost sharing	9	6.98	8	0.69	10	6.66	1.59
		(7.88)		(6.92)		(7.47)	
no cost sharing	20	1.25	21	-3.03	19	-3.18	0.64
		(6.32)		(5.17)		(6.23)	
pure owners	27	-3.14	27	1.64	26	-1.26	0.37
		(6.47)		(5.39)		(6.43)	

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Table 8 — *continued*

C. Corn

		fertilizer		petr. prod.		herb. & pest.	χ^2
	N	coef.	N	coef.	N	coef.	
fixed rent	110	25.74	111	10.93	111	14.99	
cost sharing	83	-2.89	32	2.35	70	-0.16	2.60
		(2.63)		(2.00)		(1.85)	
no cost sharing	24	-7.83	77	-1.90	39	-1.32	5.76
		*(4.05)		(1.46)		(2.29)	
pure owner	292	-6.90	293	-1.21	295	-4.62	***24.47
		***(2.03)		(1.10)		***(1.35)	

D. Soybeans

		fertilizer		petr. prod.		herb. and pest.	χ^2
	N	coef.	N	coef.	N	coef.	
fixed rent	92	21.28	92	9.48	92	15.86	
cost sharing	54	1.24	17	4.97	42	-0.58	4.56
		(2.89)		**(2.39)		(2.60)	
no cost sharing	25	-8.01	62	0.46	37	-1.91	4.94
		**(3.83)		(1.55)		(2.75)	
pure owner	295	-4.78	302	-0.04	301	-3.38	**9.80
		**(2.01)		(1.10)		**(1.66)	

(continued on next page)

Table 8 — *continued*

E. Cotton

		fertilizer		petr. prod.		herb. & pest.	χ^2
	N	coef.	N	coef.	N	coef.	
fixed rent	90	24.89	93	18.30	88	35.03	
cost sharing	25	4.15	9	-1.33	19	0.53	1.00
		(4.35)		(4.70)		(6.20)	
no cost sharing	41	-5.50	56	-4.16	46	-1.50	5.85
		(3.43)		*(2.34)		(4.28)	
pure owner	145	-4.38	149	-3.12	140	-7.50	**12.07
		**(2.44)		*(1.77)		**(3.13)	

F. All Five Crops χ^2 statistics

	fertilizer	petr. prod.	herb. & pest.	χ^2
cost sharing	5.90	5.80	1.78	13.47
no cost sharing	***16.53	7.36	3.95	**27.83
pure owner	***23.44	4.49	***24.60	***52.53

Notes: The number under coef. following the category fixed rent, are the sample means of input use per acre. The numbers following cost sharing, no cost sharing, and pure owner, are regression coefficients (with standard errors) of the regression of input use per acre on a constant and the dummies for operator type. The last column reports the chi-square statistic of the test that all coefficients on the three types of inputs are zero against a two-side alternative. Under the heading 'F. All Five Crops' the chi-square statistics are reported which test that the coefficients for a particular input are zero for all five crops. Finally, the last column under this heading shows the chi-square statistics for all crops for all inputs. One, two, and three stars indicate significance at the 10%, 5%, and 1% level. The critical values for the chi-square tests are respectively 9.24, 11.07, and 15.09 for the five crop hypotheses, 6.25, 7.82, and 11.34 for the three input hypotheses, and 22.31, 25.00, and 30.58 for the 3 input and 5 crop joint hypotheses.

the cost share dummies are zero, is not significant. (χ^2 statistic is 13.47, while the 10% critical value is 22.31).

Comparing non cost sharing sharecroppers with fixed renters gives a strikingly different result. Out of the 15 cases, 13 are showing that non cost sharers use less inputs than fixed renters. Three of those are significant at the 10% levels and two at the 5% level. The joint hypothesis that non cost sharing sharecroppers use the same as fixed renters is rejected at the 5% level. The results imply that moral hazard problems in the use of inputs exist, but that these can be easily resolved by using cost sharing. The obvious question raised by these results is why cost sharing is not part of every contract.

One answer to this question is that cost sharing is only useful when the amount used is observable but the optimal is unknown. It is hard for landlords to observe if petroleum products (mainly gasoline) are used for production on the rented plot. Fertilizer and herbicides & pesticides on the other hand are much easier to monitor especially if the landlord has some knowledge of agriculture. This difference in monitoring ability between these inputs seems to explain the large difference in the use of cost sharing between petroleum products, fertilizer, herbicides and pesticides. A probit analysis of the use of cost sharing (the result of which are presented in Canjels 1996) provides a weak support of the argument above. This analysis shows that the costs of petroleum products are more often shared when the landlord is better able to check the use of the input, specifically when the landlord is a farmer. Because no such effect was found for or fertilizer and herbicides & pesticides, other factors are probably involved in the choice for cost sharing.

A second answer why not everyone uses cost sharing is the following. The theory of sharecropping argued that it might be used to reduce incentives of exploiting the land. If this theory is correct, the incentives should not be restored by using cost sharing. Comparing the input use between cash renters versus owner operators can shed more light on this possibility since the former have every incentive to exploit the land while the latter have the correct incentives. Table 7 shows very strongly that owner operators do till the land much less intensive than cash renters. In 13 of the 15 cases the coefficient on owners is negative. This is 3 times significant at the 10% level, 4 times at the 5% level, and 2 times at the 1% level. The joint hypothesis tests show a difference for the inputs fertilizer and herbicides & pesticides, and the crops corn, soybeans, and cotton.[23]

Given these results on the exploitation of land by renters, the question of cost share use is turned around: Why do some contracts specify cost sharing? One possible answer is that cost sharing also provides risk sharing advantages. A second answer is that the Cooperative Extension Service has stimulated the use of cost sharing and the landlords and tenants have followed their advice. To evaluate

[23] These results are not explained by the size of the farm. The coefficients and standard errors change very little when including linear and quadratic size (acreage) effects.

better the prudence of this advice more research needs to be done to compare leased land with owner operated land.

4.3.2 Managerial Decision Making

Research about other countries and other times has shown that the landlord often supplies three inputs: credit, capital equipment, and managerial expertise. The AELOS does not provide any direct information on the provision of credit by the landlord. The probit analysis, however, suggested that credit is not a factor in contract choice. Since in the U.S. capital equipment is usually owned by the tenant, the only input provided by the landlord that is subject to the moral hazard problem is managerial expertise.

The AELOS provides unique information on managerial decision making. Table 8 reports the probability that a landlord makes certain managerial decisions, the tenant makes them, or they make them jointly. These decisions are: selection of fertilizer and chemicals, cultivation practices, selection of crop varieties, harvesting decisions, and marketing. The table contrasts these probabilities for fixed rent and share contracts. For example in corn sharecropping landlords have a 5.7% probability of making all the harvesting decisions, a 23.5% probability of making them jointly with the tenant, and a 70.8% probability of not being involved in the task. Joint decision making is more likely for sharecroppers than for cash renters for all 25 cases (5 types of decisions and 5 crops). The differences are the strongest

Table 9: Managerial Decision Making

		Wheat		Rice		Corn		Soybeans		Cotton	
		cash	sh.	cash	sh.	cash	sh.	cash	sh.	cash	sh.
	N	286	592	63	186	653	619	506	550	542	508
selection	ll	7.0	7.1	3.1	2.7	4.2	6.8	5.4	2.6	7.8	10.9
fertilizer	tt	88.7	76.5	92.7	89.9	89.9	66.7	88.1	61.4	87.5	78.8
and chem.	b.	4.3	16.4	4.2	7.3	5.9	26.6	6.5	36.0	4.7	10.3
cultivation	ll	6.1	6.7	2.9	7.0	3.9	5.6	5.2	2.7	8.0	4.2
practices	tt	85.8	73.6	94.8	83.3	88.6	69.7	84.5	70.0	82.6	88.5
	b.	8.1	19.8	2.3	9.7	7.5	24.7	10.2	27.3	9.5	7.3
selection	ll	6.2	7.2	4.9	7.0	4.0	5.8	5.6	2.6	7.8	4.3
crop	tt	91.3	79.8	93.1	81.4	90.7	67.2	87.0	65.5	88.0	87.0
varieties	b.	2.5	13.1	2.1	11.6	5.3	27.0	7.4	31.9	4.2	8.7
harvesting	ll	6.5	6.5	2.9	2.7	3.7	5.7	5.4	3.0	7.8	4.2
decisions	tt	90.8	82.7	95.1	91.1	91.8	70.8	87.7	74.9	89.1	89.4
	b.	2.7	10.9	2.0	6.1	4.5	23.5	6.9	22.1	3.1	6.4
	ll	8.0	20.3	2.9	3.4	4.4	18.0	6.3	15.8	7.8	11.4
marketing	tt	78.3	42.2	82.1	76.0	88.9	36.6	84.7	42.2	87.0	73.2
	b.	13.7	37.6	15.0	20.6	6.8	45.5	9.1	42.0	5.1	15.5

Notes: The entry gives the percentage of all contracts for which the decisions are made by the landlord (ll), the tenant (tt), or both (b).

for marketing decisions. For examples, in wheat 78.3% of cash renters versus 42.2% of sharecroppers make all marketing decisions alone. The two crops that show the largest differences are corn and soybeans.

While this is strong evidence for a difference in landlord involvement between share and cash contracts, two interpretations are possible. First, it can be interpreted as a difference in managerial inputs, supporting the landlords' moral hazard issue where in share contracts the landlord has an incentive to provide managerial expertise. Alternatively, it can be interpreted as a difference in managerial control which supports the tenants' moral hazard problem where the cash renter has the correct incentives but the sharecropper must be monitored).

5 Conclusions

Sharecropping continues to be important in modern U.S. agriculture. This paper analyzes the motivations for sharecropping for five crops in which sharecropping is most prominent: cotton, corn, wheat, rice, and soybeans.

Based on a measure of risk constructed from panel data on yields and weather, risk is an important factor in explaining contract choice. This is particularly interesting because several economists began doubting the importance of risk due to the lack of empirical support.[24]

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[24] E.g., Eswaran and Kotwal (1985) motivate their model of two-sided moral hazard

There are, however, also moral hazard problems in the provision of inputs. Cost sharing sharecroppers use an equal amount of inputs (fertilizer, petroleum products, and herbicides & pesticides) as cash renters, but sharecroppers who do not use cost sharing use fewer inputs. Previous empirical investigations ignored the impact of cost sharing on the efficiency of agricultural production under share contracts. On the landlord's side, moral hazard problems seem to exist for the provision of managerial expertise, since sharecropping landlords are more involved in the decision making than cash landlords. However, this could also be monitoring, in which case it supports the importance of moral hazard problems on the tenant's side.

This evidence supports the usefulness of agency theory. However, this research also points out some puzzles. If cost sharing solves or alleviates the incentive problems, why does not everyone use cost sharing? It is well known that cost sharing is useful only when the amount of inputs is observable but the optimum is unknown. However, this appears not to be the full story.

Three pieces of evidence suggest that cash renters exploit the land and that sharecropping (without cost sharing) is used to limit land exploitation. First, landlords who are less able to monitor the correct usage of the land because they live far away, are more likely to choose a share contract. Second, erodible land

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problems by 'the argument that risk sharing is the main motivation behind sharecropping lacks empirical support.'

is more likely to be sharecropped. Finally, owner operators use fewer inputs than cash renters. The issue of land exploitation deserves more attention than it has previously received because of the large and growing importance of cash tenancy.

6 Appendix

Description of Variables

- size of household: number of people in a household including children
- age of operator: self explanatory
- soil erodability: average K factor from National Resource Inventory
- perc. irrigation: percentage cropland irrigated
- farm wealth: total wealth operator related to the farm operation in millions
- debt-asset ratio: ratio for farm related assets and debts
- distance $<$ 50 miles: dummy for distance of residence landlord to plot less than 50 miles
- distance 50 to 150 miles: dummy for distance between 50 and 150 miles
- distance $>$ 150 miles: dummy for distance of residence landlord to plot more than 150 miles

- education less than 12: dummy highest grade completed less than 12
- education 12 to 14: dummy highest grade completed between 12 and 14
- education more than 15: dummy highest grade completed more than 15
- landlord retired: dummy indicating landlord is retired
- landlord farmer: dummy indicating landlord is or was a farmer
- percentage owned: percentage of total operation owned by the operator
- risk: explained in section 4.1

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