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Customs and Incentives in Contracts

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by Douglas W. Allen and Dean Lueck*

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ABSTRACT

This paper examines customary practices in the context of an incentive model. In particular it examines discreteness in agricultural contracts, and focuses on the distinction between simple cropshare fractions and continuous payments in cash rent contracts. We suggest that the pattern of customary shares is best explained as a response to moral hazard problems spread over large numbers of inputs. A contracting model explains the pattern of shares, the difference in flexibility with cash rent contracts, and the lower bound on shares. Empirical analysis using micro data on over 3,000 contracts are used to test implications of the model. A wide range of support is found for a model based on moral hazard and measurement costs.

JEL: D86, L20, Q10

Key Words: Contracts, Custom, Incentives, Cropshare

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Custom: "a usage or practice common to many or to a particular place or class"

[Webster's Dictionary]

1. Introduction

The use of "custom" or "tradition" as a theory of common practices has had a long hold on social scientists generally and among economists in particular because there are many observations in life that seem rigid, and impervious to changes in economic fundamentals. The allure of custom explanations has been especially prevalent in agriculture where it has been used to explain farming practices, contracts, and organizations that have remained the same for centuries. Most notably, custom has been the standard explanation for the determination of specific shares between farmers and landowners. For example, J.S. Mill observed:

> The relations, more especially, between the landowner and the cultivator, and the payments made by the former to the latter, are, in all states of society but the most modern, determined by the usage of the country. ... But whether the proportion is two-thirds or one-half, it is a fixed proportion; not variable from farm to farm, or from tenant to tenant. The custom of the country is the universal rule; nobody thinks of raising or lowering rents, of letting land on other than the customary conditions. Competition, as a regulator or rent, has no existence.
>
> [1871, pp.306-310]

The customary shares which Mill and others noticed in the 19th century still persist today. Across North America landowners and farmers use simple fractions (such as, 1/2, 2/3, 3/4 ...) to divide their crops, and these shares are seemingly resilient to changes in underlying economic forces, such as differences in land and labor quality. The use of custom explanations may have began with Mill, but are also found among early agricultural economists such as Heady,[1] and contemporary

[1] Writing in the middle of the twentieth century, Heady states:

> Longstanding customs have grown up in the rental market, with different shares paid by the tenant for different crops. Customary share rents over a large area of the corn belt include one-half of the corn and soybeans and two-fifths of the small grains. ... These variations in share rentals can be found in other regions of the United States and their bases are hard to determine. A possible hypothesis

theorists such as Young and Burke (2001).[2] In contrast to the traditional literature, however, Young and Burke develop a model in which custom is an *observation* that requires explaining, and for them it serves to reduce bargaining costs by providing focal points for important contract terms. Like them, we develop a model to explain the existence of rigid customs, as opposed to using custom as the key explanation of rigidity.

Our explanation of customary practices within share contracts relies on contractual incentives.[3] Although our focus is on contracts in agriculture, our incentive approach is general enough to be applied to other sharing situations where the same rigidity is found. Contractual rigidity has been noted outside of farmland leases by a number of economists, in areas such as real estate, oil and gas, and franchising. For example, Hsieh and Moretti (2003) note that it real estate brokers typically charge 6-7% of the sales prices of a home, regardless of the value of the home. Moreover, they find that just one or these rates dominates in a specific market (for example, 88% of real estate contracts in Los Angeles in 1978-79 gave a 6% commission to agents). In the oil and gas industry it is routine for landowners to get a royalty payment of 12.5%; while in franchising the "royalty rates" (which are shares of revenue) typically range from 4 - 10%, most are between 3-6% with a mode of 5%, and some as high as 25%.[4] Because we model the sharing rule explicitly, our paper has

> is that variations between crops are designed to give the tenant somewhat equal returns from resources devoted to different crops. ... Customs, regardless of their original foundation, are evidently of great importance in freezing share rentals in fixed proportions between crops.
>
> [pp. 605–608, 1952].

[2] Young and Burke examine share contracts in modern Illinois and state up front that "we shall argue that custom is a real force in setting contract terms, even in modern economies." (p. 560, 2001).

[3] Our model is an extension of that found in Allen and Lueck (2002), which in turn is based on earlier work by Barzel (1991) and Holmstrom and Milgrom (1992).

[4] See Blair and Lafontaine (2005). These rates often have a minimum annual fee. They also often decline with sales volume (but some increase with sales).

implications for other contracts, like cash renting, and more implications regarding the details of sharing. We use data from several sources on thousands of contracts to test the implications of our model.

Understanding the determinants of sharing rules begins with examining some of the facts. Examining various subsamples of crops, shares from different regions, and different contracts generates an appreciation for the detail that requires explanation. To begin, consider that in areas where shares are used for specific crops, there are also concomitant continuous cash rent values existing for the same crops within the same area. As is well known, farmland contracts are found in two dominant forms: cropshare and cash rent. In fact, most leases across the United States are cash rent (57% of leases), but this varies considerably across the country.[5] In cash rent contracts farmers pay landowners a per-acre rental whose rates are relatively continuous and sometimes determined at an auction. Unlike cropshare contracts, cash rent contracts take on many values. Table 1 shows data from our four surveys on the number of different per acre cash rent values for all crops, the modal frequency and values, and the percent of cash rent contracts.[6] Several features of this table are worth emphasizing. First, there can be hundreds of different cash rents per acre within a sample of contracts. Second, the modal frequencies for all of the data sets tend to be less than 10%; only in the Louisiana sample is the frequency larger and this is just 11.6%. A frequency distribution of cash rents almost looks rectangular.

The contrast with cropsharing is dramatic, and is visually demonstrated in Figure 1 which shows the distribution of shares for row crops in South Dakota and Nebraska for 1986 in the top graph, and the distribution of cash rent values for the same crops in the same states and year in the bottom graph. Although the soil quality and labor market conditions vary considerably across the two states, the top

[5] *1997 Census of Agriculture*, Agricultural Economics and Land Ownership Survey(1999), Table 99.

[6] The data used in this paper, its origins, summary statistics, and other details are described in the data appendix.

Table 1: The Frequency of Cash Rent Contract Terms Across Regions

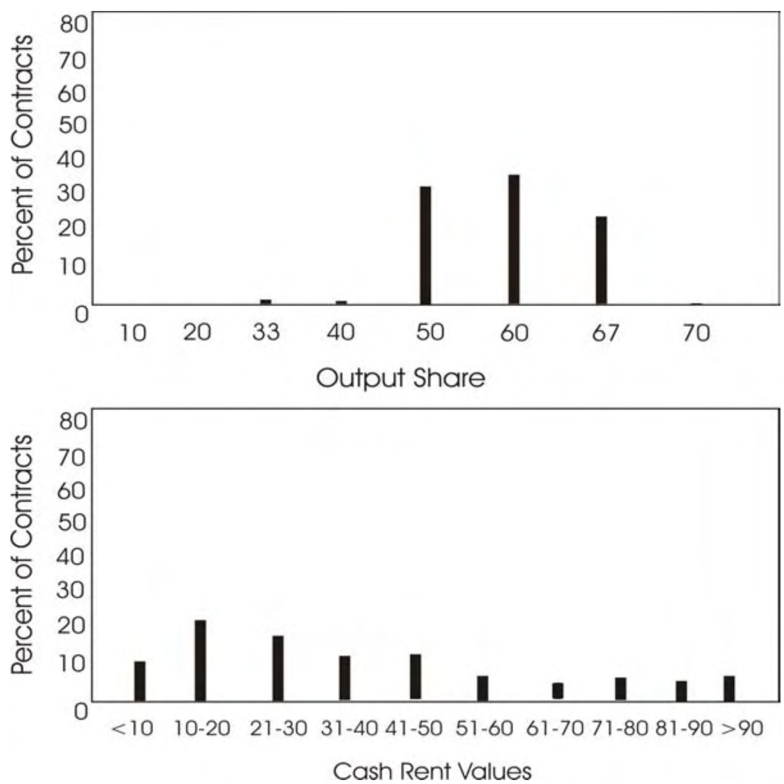
	Region (date)			
	British Columbia 1979	British Columbia 1992	Louisiana 1992	Nebraska/ South Dakota 1986
Number of Different Cash Rents	98	59	45	140
Modal Frequency	4.6%	4.8%	11.6%	8.34%
Modal value(s)per acre	$60	$50,100, & 150	$50	$15
Percent cash rent	59.1%	73.7%	36.8%	43.03%
Total contracts	592	171	513	1831

graph shows that the three major shares account for over 94% of all share values. This histogram is similar to those found in other locations and time periods.[7] The bottom graph shows the distribution of cash rent values for the same row crops in South Dakota and Nebraska in 1986. Though the crops, time period, and location are the same as the top graph, the distributions is considerably different. In fact, since Figure 2 is drawn with the cash rent values collected into groups, it distorts the continuity of the true cash rent distribution. There are over 100 different cash rent values, with $25 per acre being the modal rent at 8.56% of contracts. The next most frequent value accounts for only 6.6% of contracts. A satisfactory explanation of customary share values should also explain the non-customary cash rent values.

To further understand customary shares it is important to exploit data from different regions. In any given place the optimal share might be very specific, giving the impression that it is fixed. Indeed, this has often led to an incorrect

[7] For example, see Young and Burke (2001).

Figure 1: Distribution of Cropshare and Cash Rent Values
Row Crops, Nebraska/South Dakota, 1986



stylized fact among scholars of share contracting: namely that 50–50 sharing is the dominant sharing rule.[8] In contrast, consider the information in Table 2. Table 2 shows the frequencies of different sharing rules for all crops found in our four data sets, along with the frequencies for Illinois as reported in Young and Burke (2001), and new data from a cropshare study in Kansas. Table 2 shows that the distribution of shares (incorporating all crops) across these regions is characterized by two things. First, there are virtually no shares less than 50–50. Second, there is no single universally dominant share. Most models of cropshare values have missed the fact share values are rarely less than 50–50, often making no prediction on any lower bound for shares.

[8] See, for example: Allen (1985), Neary and Winter (1995), and Eswaran and Kotwal (1985).

Table 2: The Frequency of Farmer Shares in Cropshare Contract Terms Across Regions

	Region (date)					
Share To Farmer (%)	British Columbia (1979)	British Columbia (1992)	Louisiana (1992)	Nebraska-South Dakota (1986)	Kansas (2000)	Illinois (1995)
	(frequencies in percent)					
9/10 (90)	5	4.4	0.3	0.12	0	0
17/20 (85)	7	20	0.6	0	0	0
5/6 (83.3)	0	0	12.6	0	0 - 0.6	0
4/5 (80)	21.9	8.9	38.6	0.12	0 - 1.2	0
3/4 (75)	26	15.6	23.1	1.49	0.4 - 1.5	0
2/3 (67)	19.8	22.2	0.9	32.8	67.9 - 78.9	9.7
3/5 (60)	1.2	13.3	6.8	30.16	10.5 - 15.3	6.7
1/2 (50)	11.2	6.7	2.2	30.92	9.1 - 14.5	82.3
2/5 (40)	0	0	0	1.32	0 - 2.1	2
% of Other Miscellaneous cropshares in sample	7.9	8.9	14.9	5.9	0	1.3
Observations	242	45	324	2,424	1,449	935

Sources: For British Columbia, Louisiana, Nebraska, and South Dakota see Data Appendix. For Illinois see Young and Burke (2001). For Kansas see Tsoodle and Wilson (2000, Table 4) who have data on cropshare contracts for non-irrigated crops only. Tsoodle and Wilson only report data by region so the table show the range across these regions instead of a statewide number. The totals may not sum to 100% because there are other shares not reported.

The focus for 50–50 sharing often results from looking at a specific crop in a specific region where the 50–50 contract is simply the optimal share.[9] From Table 2 it is clear a variety of shares exist across different regions. For example, 2/3 accounts for has 32.8% of share contracts in Nebraska-South, while 4/5 has 39% in Louisiana, and no contract has more than 26% in British Columbia. In Kansas, Tsoodle and Wilson (2000) find the most common share for the farmer is 2/3 (roughly 70%) with 3/5 and 1/2 each accounting for 10 - 15% of the contracts. In each case the shares are customary in that they are rigid locally, but vary across regions.

[9] As Heady noted regarding the common practice of 50–50 sharing in the corn belt. Young and Burke (2001) also examine data from the corn belt.

Figure 2 provides an example of how the same crop can have different shares. In the mid-west states of South Dakota and Nebraska, shares for corn look similar to those found in the corn belt. In Louisiana, however, corn shares still take on a few simple fraction values, but these values are much different than in the north. In British Columbia the shares for corn are generally higher than those found on the plains, but they are also more widely distributed.[10] Figure 2 demonstrates the problem of single state data sets. Though each graph shows discrete sharing with simple fractions, the actual fractions used vary considerably.[11]

Our purpose in this paper is to explain why share contracts appear inflexible relative to cash rent contracts, why shares take on customary fractions, why these fractions vary from crop to crop and location to location, and why shares have a lower bound of 1/2. We begin by developing a model based on multiple moral hazard and measurement costs to explain the differential structure of cropshare and cash rent contracts and the rationale for customary fractions.[12] This model yields a simple customary sharing rule and four related testable propositions. In our empirical analysis we use the four data sets to test these predictions and find broad support for these implications.

2. A Model of Customary Contract Structure

Agricultural contracts have been modeled various ways within a vast literature, from classic principal-agent models to bargaining models. Economic models of custom, however, are relatively scarce.[13] As noted above only Young and Burke (2001)

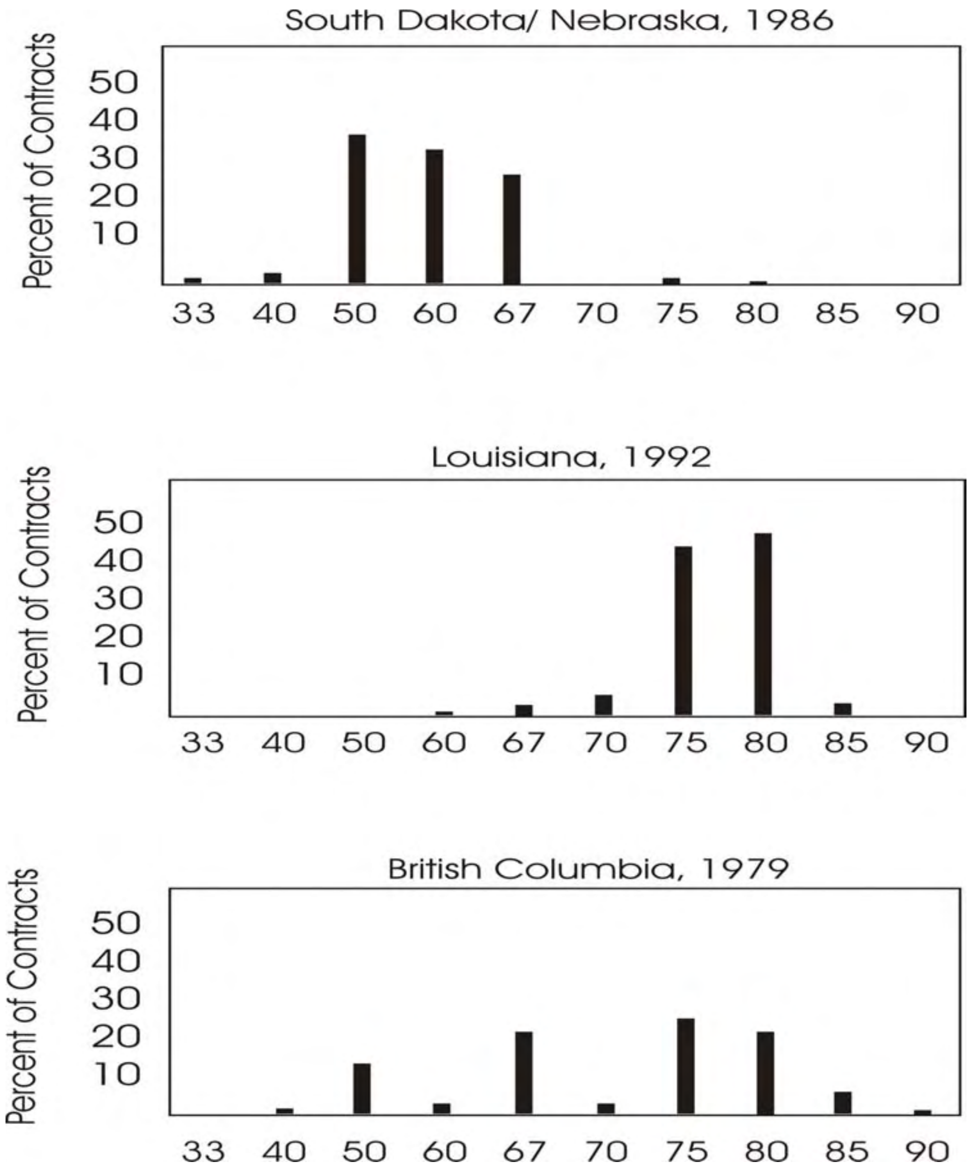
[10] We did not have enough corn share contracts in our 1992 data for British Columbia for a meaningful distribution.

[11] Burke and Young present a similar graph (Figure 1, p. 560, 2001) for Illinois (a corn state) where only three shares exist and 50–50 accounts for over 80% of all contracts.

[12] This model is derived from Allen and Lueck (2002) who examine the choice between cropshare and cash rent contracts. The intuition of the model suggests when soil exploitation is a serious problem cropshare contracts are used. When underreporting output is a serious problem, cash rent contracts are used.

[13] Ackerlof(1980) and Romer (1984) are two early studies that show how customs can arise from maximizing behavior.

Figure 2: Share Values For Corn



have attempted an explanation of customary practices in agricultural contracting relying on the idea that discrete contract terms can reduce contractual bargaining costs. Our approach, allows us to go beyond Young and Burke and derive implications about these contract terms and about the differences between cash rent and cropshare contracts.

To start assume all parties are risk neutral and farming involves a number of tasks or inputs (initially set at two). Let $Q = h(e, l) + \theta$, where Q is the harvested output (with unit price) per tract; e is a composite input of farmer inputs, including labor time and effort, equipment, and other farming materials; l is a composite input of land attributes, such as fertility and moisture content that are not specified in the contract; and $\theta \sim (0, \sigma^2)$ is a randomly distributed composite input that includes weather and pests. The opportunity cost of the farmer's input is the competitive wage rate w per unit of farmer's effort, and the opportunity cost of the unpriced land input (l) is r per unit. In a farmland contract the priced land attribute is acres, which is a sunk fixed cost to the farmer.

If contracts could be enforced without cost there would be no input distortion and no output measurement. With risk-neutral landowners and farmers, the expected profit from the farming operation is maximized, resulting in the employment of e^* and l^* units of farmer and landowner inputs. These first-best, full-information input levels are identical for the cropshare and cash rent contracts and satisfy the standard conditions that marginal products equal marginal costs for both inputs.

When contract enforcement is costly, however, the input choices will be second-best. In either contract, farmers have an incentive to exploit the land's unpriced attribute (l) because they do not face the full costs, r. In addition, farmers have an incentive to under-report the output in the cropshare contract.

2.1. **Cropshare vs. Cash Rent Contracts**

For the cash rent contract, the farmer hires a tract of farmland for a lump sum fee paid just prior to the growing season. He owns the entire crop and chooses his inputs to maximize expected profit. Because the farmer does not have indefinite tenure of the land he does not face the true opportunity cost of using the attributes of the land. If we denote the reduced costs he faces as $r/m < r$, where m $(1 \leq m \leq \infty)$ is a measure of the degree of moral hazard, the farmer's objective is:

$$\max_{e,l} \Pi^r = h(e, l) - we - (r/m)l. \tag{1}$$

then the second-best solutions e^r and l^r satisfy: $h_e(e^r) \equiv w$ and $h_l(l^r) \equiv r/m$. Assuming $h_{el} = 0$, the farmer's input level is identical to the first-best optimum; that is, $e^r = e^*$. However, since $r/m < r$, $l^r > l^*$, the land is over-worked because the farmer does not face the full cost of using the land's attributes. The rent to the landowner is $\Pi^r(e^r, l^r)$, since we assume all input markets are competitive.

In a cropshare contract, the farmer has exclusive use of the plot of land without paying the landowner prior to production. At harvest time, the crop is divided between the farmer and landowner, with the farmer receiving sQ and the landowner receiving $(1-s)Q$, where $0 < s < 1$. The farmer bears all costs of the variable inputs except the differential cost of the land's unpriced attributes. The farmer's objective is:

$$\max_{e,l} \Pi^s = s[h(e,l)] - we - (r/m)l. \tag{2}$$

Now the second-best solutions e^s and l^s satisfy: $sh_e(e^s) \equiv w$ and $sh_l(l^s) \equiv r/m$. These solutions indicate the farmer supplies too few of his inputs because he must share the output with the landowner; that is $e^s < e^*$. As with cash rent, the farmer over uses the land attributes, or $l^s > l^*$; however, since $l^r > l^s > l^*$, the use of the land is *less* excessive than it is with cash rent. This means a share contract still provides the farmer with an incentive to over use the land, although this incentive is not as powerful as it is with the cash rent contract. The share to the landowner is $\Pi^s(e^s, l^s)$.

The optimal share comes from maximizing the value of the cropshare contract through the choice of share, conditional on the choice functions arising out of equation (2):

$$\max_{s} \Pi^s = h(e^s, l^s) - we^s - rl^s. \tag{3}$$

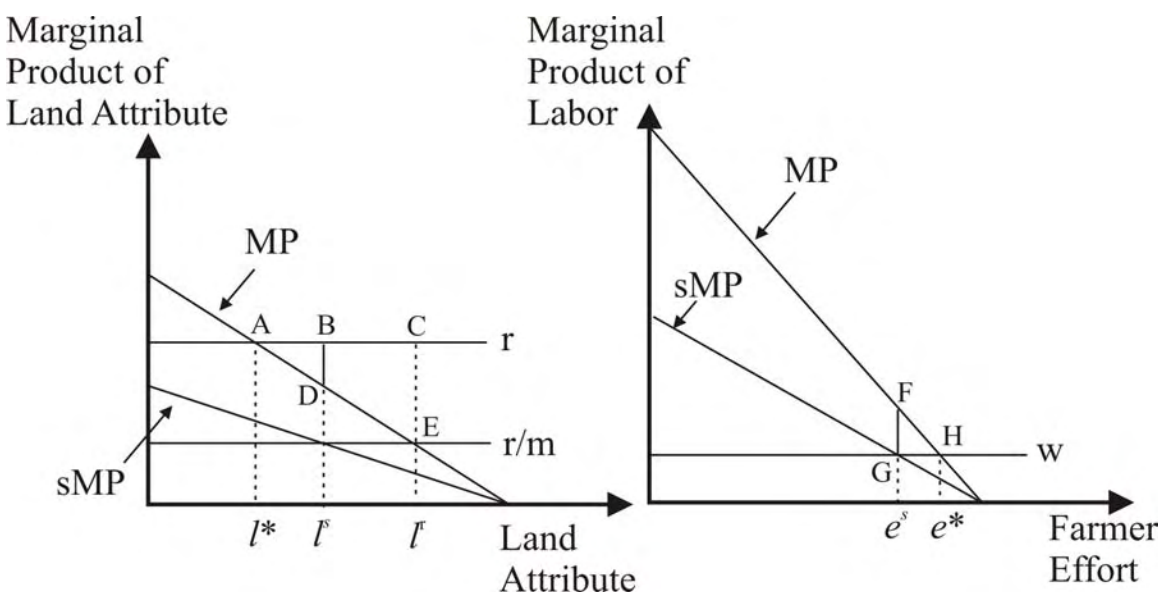
This leads to the following first order condition:

$$\frac{\partial l^s}{\partial s}[r - h_l[l^s(s)]] = \frac{\partial e^s}{\partial s}[h_e[e^s(s)] - w]. \tag{4}$$

Equation (4) states the share is chosen such that the marginal benefit of changing the share ($\partial l^s/\partial s[r - h_l[l^s(s)]]$) just equals the marginal cost ($\partial e^s/\partial s[h_e[e^s(s)] - w]$).

For example, if the share to the farmer is reduced the reduced soil exploitation is the benefit, while the reduced labor effort is the cost. Figure 3 demonstrates the equilibrium of the model under the assumption $\partial e^s/\partial s = \partial l^s/\partial s$, and also shows the first-best input levels e^* and l^*.[14] In a cash rent contract the farmer faces reduced costs of using land attributes and chooses l^r, resulting in a deadweight cost of ACE. In a share contract the perceived marginal products to the farmer are lower, and therefore, he reduces the amount of both inputs used to e^s and l^s, resulting in two deadweight costs, ABD and FGH. The equilibrium share occurs when the distances BD and FG are equal.

Figure 3: Optimal Sharing Rule



Equation (4) does not yield specific equilibrium shares, nor does it predict shares equal to simple fractions. Depending on the production function, many shares are possible. Assume, however, that the contracting parties consider the derivatives $\partial e^s/\partial s$ and $\partial l^s/\partial s$ to be parametric, such that their ratio is a number δ. That

[14] The derivative assumption is simply made to make the figure more intuitive. With this assumption the equilibrium is found where the vertical distances between the marginal products and the input prices are equal across the two figures.

is, both the farmer and the landowner assume the inputs respond to changes in the shares by some constant amount.[15] Through experience landowners have rough ideas of what a yield should be, rough ideas of how much effort, seed, fertilizer, and chemicals are being used, and rough ideas of the crop, weather, and pest conditions. It is reasonable to assume they would only approximate how an input would change with changes in the output share. With this assumption the optimal sharing rule becomes:

$$s^* = \frac{w\delta + r/m}{w\delta + r}. \tag{5}$$

If we assume the units of land attributes are normalized, such that $w\delta = r$, then we generate the first proposition.[16]

Proposition 1. *When input responses to changes in the share are assumed parametric, and input prices are normalized, the optimal share is given by:*

$$s^* = \frac{1}{2} + \frac{1}{2m}. \tag{6}$$

With two inputs the share is simply a function of the degree of moral hazard, m. If m takes on small values ($m < 2$), then sharing is unlikely and farmers and landowners cash rent (Allen and Lueck 2002). For large values of m, the optimal share asymptotically approaches 50%. Once again, if we treat m as a continuous variable, then any share between 3/4 and 1/2 is possible with two inputs. Thus, with two reasonable assumptions our model explains the existence of the 1/2 lower bound.[17]

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[15] Technically, of course, this is false. The functions $\partial e^s/\partial s$ and $\partial l^s/\partial s$ depend on the production function, the input prices, and the share. Farmers and landowners often use rules of thumb, however. For example, historically when crops were taken off fields in small wagon loads each party would take alternate loads (or every third load, etc. depending on the share). For some row crops, and when harvesting headers were small enough to take two rows at a time, farmers would harvest every other two rows, and under reporting could be inspected by a simple drive by.

[16] This assumption is reasonable. Cropshare contracts seldom have side payments. Allen (1992) has shown when side payments are absent in share contracts, there are market pressures for inputs to match with other similar inputs. Recent work by Ackerberg and Botticini (2002) suggests farmers and landowners match on risk characteristics as well. Asking whether land attributes are more costly than labor effort is like asking whether diamonds are more costly than water. For some unit of water and diamonds, the two have the same cost.

[17] If one is willing to make a third assumption, then the two input case can explain all discrete

2.2. **Optimal Discrete Share Contracts**

Equation (5) was derived under the assumption there were only two inputs in the production function. It is a trivial matter to increase the number of inputs to include such things as seed, fertilizer, and so on. Furthermore, an input like labor effort could be broken into specific tasks which could be considered different inputs. For example, pruning and planting are different tasks which could be considered different inputs. For example, if there is a third input k, and if the cost of the third input is c, then equation (5) becomes

$$s^* = \frac{w\delta + c\gamma + r/m}{w\delta + c\gamma + r} \tag{7}$$

where $\gamma = \partial k/\partial s/\partial l/\partial s$ and is the ratio of the parametric responsiveness of inputs k and l to changes in the share. Again assume the input prices are normalized, so that for three inputs equation (7) simply becomes $s^* = 2/3 + 1/3m$; with four inputs $s^* = 3/4 + 1/4m$. In other words, with more inputs or tasks, the lower bound on the optimal share increases. Thus we have our second proposition:

Proposition 2. *When the number of inputs increases the lower bound of the optimal share increases by discrete units, and is given by $(n-1)/n$ where n is the number of inputs or tasks.*

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shares. If farmers and landowners think of m in discrete terms (because information on production is costly or because there are cognitive difficulties with continuous decimals) equation (6) yields a set of shares remarkably similar to those found in the data. These shares are shown in Table 3.

Table 3

m	2	3	4	5	10
s	.75	.67	.625	.60	.50

The potential loss of being wrong from rounding to whole values of m is likely to be of second order smallness. This result comes from the Envelope theorem which states small deviations from an optimum lead to insignificant losses of value (See Ackerlof and Yellen (1985) For example, suppose the value of m is 2.6, but both the farmer and landowner round up to $m = 3$. The optimal share would be .69, but the farmer and landowner would contract at 2/3 or .67. This lower share would mean less effort and land attributes would be used, but at the margin these losses and gains would offset each other since in equilibrium they are equal. There would be some loss in the value of the contract, but it would be of second order smallness. Considering all of the unknowns in farming and the large role of Nature, assuming farmers and landowners think about moral hazard in discrete terms seems a minor assumption.

Generally speaking, cropshare contracts are chosen when m is large. This means the optimal share will be the lower bound. The shares we observe then (1/2, 2/3, 3/4 ...), are the optimal lower bounds when the number of unshared inputs increase.

2.3. **Input Sharing**

One often ignored aspect of cropshare contracts is input sharing, yet input sharing terms are crucial to the structure of cropshare contracts. Allen and Lueck (1993, 2002) show input sharing increases overall contract efficiency by better aligning the net returns to inputs choice, but comes at the cost of measurement and enforcement of input cost over reporting. Two features of input sharing are important for this study. First, labor effort and land attribute costs are never shared, which means there always exists a minimum of two unshared inputs. Shared inputs include things like fertilizer, seed, and fuel.[18] Second, when input costs are shared, they are always shared in the same proportion as the output.[19] When input costs are shared in this way there is no distortion created for that input, and in terms of the optimal output share, it is given by equation (4). In other words, input sharing creates a situation where it is *as if* there were only two inputs. This means the lower bound on the optimal share will become 1/2. Thus we have a third proposition:

Proposition 3. *When inputs are shared, the 50–50 contract should occur more often.*

2.4. **Flexible Cash Rent Contracts**

Cash rent contracts are more likely to occur when farmers are unable to exploit the soil (Allen and Lueck (2002)). This implies m is small, and the share is 1. The optimal cash rent is given by

$$\Pi^r = h(e^r, l^r) - we^r - (r/m)l^r. \tag{8}$$

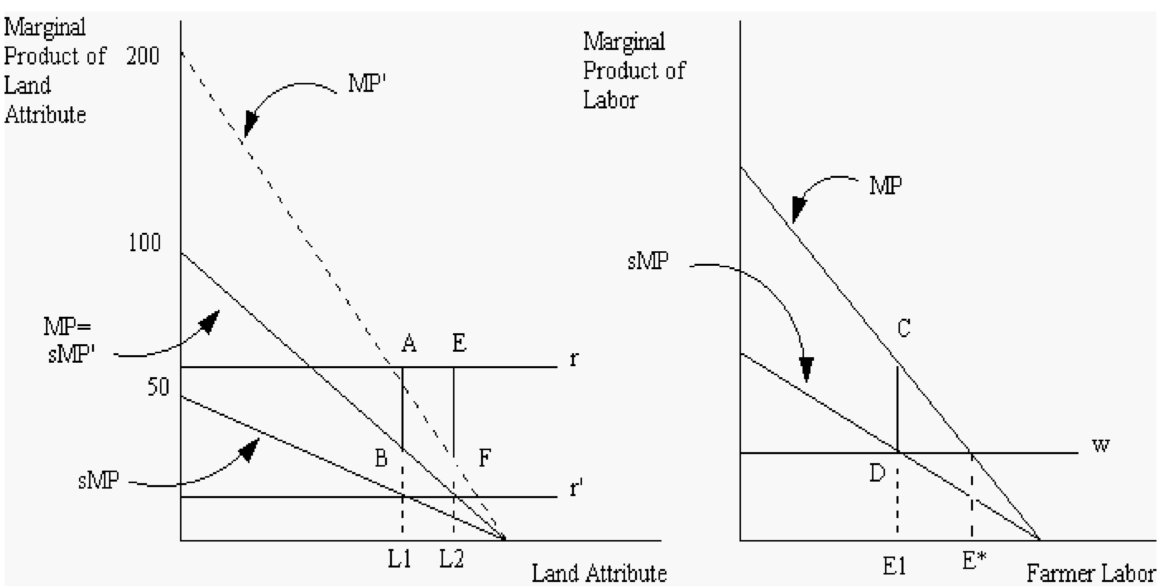
[18] In an interesting historic study, Carmona and Simpson (1999) find that when 19th century Catalan vineyard share contracts introduced input cost sharing, the farmer's share declined.

[19] See Allen and Lueck (1993, 2002) for evidence on this.

This function continuously depends on the production function, input costs, and the degree of moral hazard. There is no discreteness, and unlike the share contract, the cash rent contract has no built in adjustment to changes in prices, costs, and other economic parameters. For a given rent, any increase in land productivity accrues to the farmer as a pure rent.

Consider what happens to the optimal share when there is an increase in land productivity. Figure 2 shows a specific example, again assuming linear marginal product (MP) curves, and $\delta = 1$. The solid lines show an initial equilibrium where L1 and E1 are the equilibrium values of land attribute use and farmer effort. These are determined when distances AB and CD are equal. Now suppose the marginal product of land doubles to MP'. The first-order condition for land use before the productivity increase is $r/m \equiv sMP(L1)$. The first-order condition after the increase in productivity is $r/m \equiv sMP'(L2)$. It thus follows that $MP'(L2) \equiv MP(L1)$. This equality is independent of the share and implies there is no change in the optimal share following the change in land attribute productivity.

Figure 4: Optimal Shares and Land Quality



Notice, however, what does change. First, the income to the landowner increases when the marginal product of land increased. The new gross income is $\int^{l_2}(MP' - sMP')$, which is considerably larger than the old gross income $\int^{l_1}(MP - sMP)$. Second, there is more of the productive input used. This is the "built in" flexibility of a cropshare contract. Even though a farmer and landowner may approximate the exact sharing equation and use customary shares, their incomes still adjust when economic fundamentals change. On the other hand, the cash rent contract does not have this feature. Changes in any parameters have no impact on income unless the cash rent changes. In the example above, the cash rent will change as a result of the change in land productivity. Thus, these contracts are much more continuous in their contracted amounts, and leads to our final proposition.

Proposition 4. *Cash rent contracts are more flexible than share contracts.*

3. Empirical Analysis

Our moral hazard model of cropshare structure has resulted in four predictions. In particular cropshares take on the values given by equation (6) when there are two inputs; the lower bound increases with the number of inputs; 50–50 sharing is more likely with input sharing; and the distribution of cash rent contract terms is more continuous that cropshare contract terms. In this section we test these propositions using the data from British Columbia, Louisiana, and the Plains states of Nebraska and South Dakota.[20]

3.1. **Inflexible Shares versus Flexible Cash Rents**

One of the immediate implications from our model is that cropshare contracts will be inflexible with respect to economic fundamentals (proposition 4). As noted in Allen (1985), Newbery and Stiglitz (1979), Young and Burke (2001), and others,

[20] For a detailed discussion of these data, see the data appendix.

shares seem rigid and unresponsive to changes in economic fundamentals.[21] From equation (6), as long as the contracting parties assume each input parametrically responds to changes in shares, it is clear no parameters from the production function enter the share equation. In general, the cropshare contract's ability to automatically adjust incomes in light of changing fundamentals either partially or totally offsets these changes. This means the share is going to appear inflexible to changes in fundamentals.

We test proposition 4 two ways. First, in Table 4 we compare the number of different contract values, as well as the percentage of contracts included in the three most common values for major crops for which there are significant numbers of cash rent and cropshare contracts. The table divides the data into four sections — one for each of the four regions for which we have contract data. In each case there is dramatically more concentration of contract terms in cropsharing. For example, for Nebraska and South Dakota there were 76 different corn cash rent values per acre (eg., $15/acre), and the top three common values accounted for only 23.5% of all cash rent contracts. On the other hand, there were only 16 cropshare values (eg., 1/2), but the three most common accounted for 95% of all contracts. Examining all of the crops reported from the different data sets reveals this pattern is never broken. In all cases cash rent contracts are more flexible than cropshare contracts.

Our second test of proposition 4 exploits the fact that one land attribute is perfectly observable: total acres. As the size of the contracted land increases, the land becomes more valuable. With a cash rent contract we would expect the total amount of rent paid to the landowner to increase. With a share contract,

[21] For example, Young and Burke note that inflexibility allows farmers to capture landowner rents, they state that: "Indeed most of the contracts in the south give the tenant more [income] — in fact substantially more — than contracts in the north *holding soil quality fixed.*" (p. 564, emphasis in the original). They then go on to explain how this cannot be accounted for by labor mobility, contract adjustments, input sharing, or matching, and conclude custom must be the explanation. They go further and argue that farmers get as much as one-third of the landowner's rent because the 50–50 custom does not vary with soil quality. Recent work by Barry et.al.(2000), however, finds that both cash rent and cropshare contract terms in Illinois depend importantly on soil quality and does not find any evidence suggesting that one-third of the land rent goes to the farmer.

however, with its built in adjustment, we expect no change in the share. We test this hypothesis with OLS regressions to estimate the determinants of contract terms, with either the total cash rent or share as the dependent variable. These regressions are shown in Table 5. In all specifications the estimates are consistent with our prediction. In the cash rent samples the coefficient estimate for total acres is always large, positive, and significant. In the cropshare sample, the coefficients are small and statistically insignificant. For example, in the South Dakota — Nebraska sample an increase of 1000 acres in a cash rent contract leads to a large and statistically significant increase of $3104 in the total cash rent payment. However, the same change in acreage only leads to a statistically insignificant .38% change in the share.

3.2. **The Cropshare Lower Bound**

Proposition 1 states that cropshare contracts have an absolute lower bound. In the minimal case of two inputs the lower bound value is 50–50 or 1/2, and with more inputs the lower bound increases by simple fractions. In order to test the presence of the absolute lower bound found in proposition 1 we examine the frequency of cropshare contracts which provide the farmer less than 1/2 of the crops. Table 6 shows the frequencies for the four data sets and breaks them down by crop. With the exception of the data from South Dakota and Nebraska, finding shares below 1/2 is rare. In our opinion the higher numbers for Nebraska and South Dakota are likely recording errors. This was the only survey given to both landowners and farmers. Interestingly, when shares below 1/2 arise in this data they almost always are the complements to two common larger shares (eg., 1/3, 2/5), and it is likely the the respondent wrote down the share to the landowner rather than the share to the farmer. Regardless, even in the Midwest data shares below 1/2 are insignificant in number. The information in Table 6 strongly supports the proposition of a cropshare lower bound.

3.3. **Changes in the Number of Inputs**

Proposition 2 predicts that as the number of inputs increases the lower bound of the optimal share also increases. We test this proposition by 1) examining different crops which often require different amounts of inputs over the course of the production cycle; and by 2) examining the effect of input sharing on cropshare terms. When inputs are shared the number of unshared inputs falls to two, and therefore, the lower bound falls to 1/2.

Table 2 in the introduction showed that cropshare terms varied widely across regions, but it concealed the variety of crops grown in these regions. States and regions vary a great deal in the variety of crops grown.[22] Table 7 shows the distribution of shares for corn, soybeans and wheat in the Nebraska-South Dakota data, for rice and sugarcane in the Louisiana data, and for apples in the British Columbia data. The striking difference in the table is that the shares for the crops in the three columns on the right are so much higher than the shares for the crops in the first three columns. In Nebraska-South Dakota, the three shares 1/2, 3/5, and 2/3 account for over 90% of all share contracts. For the crops from Louisiana and British Columbia there are almost no 50–50 contracts, and higher shares split between 4/5, 5/6, and 17/20.

Clearly, the distribution of shares depends on the type of crop gown. Had different crops been selected, different distributions of shares would have emerged. Generally speaking, when corn, soybeans, or other row crops are grown 50–50 is relatively common, but when wheat and other small grains are grown the 2/3 share

[22] For example, in Illinois agriculture is very homogeneous. For the 10 crop years beginning in 1991, corn and soybeans comprised an average of 89% of the harvested cropland acreage in Illinois. (See the 2001 Illinois Annual Survey, Illinois Agricultural Statistics Service, http://www.agstats.state.il.us/annual/2001/toc-htm.htm (accessed April 12, 2002)). In fact, no other state is as homogeneous as Illinois in terms of crop production. The *1997 Census of Agriculture* shows the following percentages in corn and soybeans for the states in Table 1: Illinois 92%, Kansas 24%, Louisiana 44%, Nebraska 66%, and South Dakota 44%. British Columbia's largest crop fraction is hay at 36%. Statistics Canada (1997), Tables 4.1–4.10.

is more common. For fruit, like apples, pears, and peaches the shares are usually 4/5 or higher for the farmer. And for sugarcane, shares are at least 4/5.

Corn, soybeans, and wheat (the three crops on the left) generally involve fewer inputs/tasks than sugarcane, rice, and apples (the three crops on the right).[23] Sugarcane, due to the sensitivity of the product during harvest requires the farmer to be more involved in processing. Rice involves more tasks because of water management, and fruit requires so many tasks related to pruning and weeding the farms are seldom larger than 20 acres. Proposition 2 states that the more tasks involved the higher is the lower bound on the share equation and the higher the equilibrium shares. Table 7 is consistent with this.

Table 7 indicates that the lower bound on shares depends on the number of inputs, but it relies on using crops to proxy for the number of inputs. A better test results from proposition 3 and the impact of input sharing. None of the data presented thus far has controlled for the allocation of input costs (e.g, seed, fertilizer, pesticides) between the contracting parties. Table 8 shows frequency distributions for share terms, controlling for crops and for the allocation of input costs for corn and soybeans grown in Nebraska and South Dakota in the 1986 crop year.[24] When the inputs are shared the 50–50 contract dominates. Table 8 also shows the frequency distribution of cropshare terms for these same crops when inputs are not shared. The distinction between contracts with and without input sharing is striking. When inputs are not shared the 50–50 contract falls from the dominant type to third place after 3/5 and 2/3. In fact, barely 20% of the contracts are 50–50. In the introduction Table 3 showed the distribution of shares for Northern and Southern Illinois, found in Young and Burke, in the north input costs are likely shared while in the south they likely are not shared.[25]

[23] See Allen and Lueck (2002) for a detailed discussion of the different tasks involved in these crops.

[24] This is the only data set we have with detailed information on input sharing. In Nebraska and South Dakota, unlike Illinois, corn and soybeans are often irrigated. These contract terms are not presented in Table 7 but are almost identical to the distribution for dry land corn and soybeans.

[25] Young and Burke's data (Tables 1 and 2, p.565) suggest a correlation between input and output

3.4. **Changes in Moral Hazard**

Recent studies have indicated that some crops are more prone to moral hazard in land attributes than others.[26] For example, row crops like corn, soybeans, and sugar beets, all require cultivation which gives the farmers access to exploit the soil with various tillage techniques. Likewise, non-irrigated crops also provide more incentive and opportunities for farmers to exploit the moisture of the soil. These crops are more likely to be cropshared, and we further expect these crops to have lower shares. That is, as m increases, the optimal share given in equation 6 falls. Table 9 presents the frequency of cropshare terms for two extreme cases for opportunities for moral hazard, conditional on a cropshare contract being used. The table shows the shares for these two crops. Dryland row crops allow easy access to manipulate soils. These crops are most often cropshared. Irrigated non-row crops allow fewer opportunities for soil manipulation, and are more often cash rented. As can be seen from the table, the former have much lower shares than the latter, consistent with our model which predicts as m increases, the share to the farmer falls. Evidence from the regression estimates shown in Table 5 are also consistent with this In Table 5 the coefficients from the SHARE regressions show that row crops have lower shares for the farmer. Likewise irrigated crops are more likely to have higher cropshares.

4. Conclusion

We have explained the customary practice of simple fractions in share contracts and continuous payments in cash rent contracts by examining the incentives involved

sharing. In fact, in an unpublished companion paper (Burke and Young 2000, p.7) also note that: "In the north, over 86% of the contracts are (1/2,1/2) [that is, the output share is 1/2 and the input share is also 1/2]. In the south, about 39% of the contracts are of the form (3/5,1) or (2/3, 1); fully 79% of the contracts use either 3/5 or 2/3 as the tenant's share of output and 3/5, 2/3, or 1 as the tenant's share of input." Furthermore, we consulted the source of the Illinois data used by Young and Burke and found that the northern regions share inputs 96% of the time, while in the southern region this occurs only 33% of the time (*The 1995 Cooperative Extension Service Farm Leasing Survey* (Department of Agricultural and Consumer Economics, University of Illinois, 1996). Hence it seems that the difference reflects differences in input sharing.

[26] See Allen and Lueck (2002) for a summary of this literature.

in both contracts. Our explanation used a multiple moral hazard model, combined with one behavioral assumption: farmers and landowners treated input responses to changes in shares as parametric. We assume farmers and landowners behave this way not because they believe it is true, but because it is too costly for them to measure the true effects in an environment where nature plays an enormous role, and the costs of behaving this way results in second-order small losses.

Our model generated a sharing formula that lead to simple fractions. This theory not only explains discrete sharing with simple fractions, it also explains why cash rent contracts are not this way, why shares move from one fraction to another, and why share contracts appear inflexible. Our data from four regions and time periods strongly supported the predictions of the model. As Romer (1984, p. 727) noted: "The existence and persistence of [such] customs is perfectly consistent with maximizing behavior [and] ... we can analyze these customs using conventional economic tools." In this case we have shown that some simple modifications of contract theory can lead to a compelling explanation of customary agricultural practices that have puzzled economists for almost two centuries.

Data Appendix

1986 Nebraska and South Dakota Data

The data from Nebraska and South Dakota come from the *1986 Nebraska and South Dakota Leasing Survey*. The Leasing Survey was conducted by Professor Bruce Johnson of the University of Nebraska and Professor Larry Jannsen of South Dakota State University. The survey was funded by the Economic Research Service of the United States Department of Agriculture. A summary of the study and the survey procedures can be found in Bruce Johnson, Larry Jannsen, Michael Lundeen, and J. David Aitken, *Agricultural Land Leasing and Rental Market Characteristics: A Case Study of South Dakota and Nebraska* (report prepared for the Economic Research Service of the United States Department of Agriculture, 1988).

1979 British Columbia Contract Data

Data for the 1979 British Columbia landowner-farmer contracts come from the *British Columbia Ministry of Agriculture Lease Survey*. This survey was conducted by the Farm Management group in the Vernon, British Columbia office of the Ministry. The survey was done by telephone and included farmers from throughout the province; however, farmers in the Okanagan Region were over-sampled. The number of usable responses was 378. This survey asked few questions and thus has fewer variables.

1992 British Columbia and Louisiana Contract Data

Data for the landowner-farmer cropshare contracts come from The *1992 British Columbia Farmland Ownership and Leasing Survey*, which we conducted in January 1993. The survey was sent to a random sample of 3,000 British Columbia farm operators. The number of usable responses was 460. The data are organized so that observations are individual contracts. Data for the landowner-farmer cropshare contracts come from *The 1992 Louisiana Farmland Ownership and Leasing Survey*, which we conducted in January 1993. The survey was sent to a random sample (chosen by the parish USDA County Agents) of 5,000 Louisiana farm operators. The number of usable responses was 530. The data are organized so that observations are individual contracts. Unlike the Nebraska/South Dakota data, these data do not have detailed information on landowners or input sharing. It does have information on ownership of land and other assets. The 1,004 different farms that make up the British Columbia and Louisiana sample are often arranged in various ways to create different data sets. A data set may be organized around a farm, a plot of land, equipment, or buildings. Depending which set is used determines the sample size. All of the variables used in the book are defined in Tables A-1 and A-2.

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Table 4: The Frequency of Cash Rent and Share Values

	Cash Rent		Cropshare	
Crop	# of different rent values	% of Top 3 Values	# of different share values	% of Top 3 Values
		Nebraska/South Dakota 1986		
Corn	76	23.5	16	95.0
Wheat	56	28.26	13	93.9
Oats	30	31.56	9	95.6
Barley	24	44.78	7	91.1
Sorghum	39	27.27	11	95.2
Soy	57	27.78	13	96.3
Hay	56	31.34	11	94.9
		Louisiana, 1992		
Sugar	15	45.8	9	88.6
Rice	20	34.9	18	66.4
Cotton	22	31.5	7	94.3
Corn	17	38.4	7	86.9
		British Columbia, 1992		
Apples	54	19.0	9	59.1
Hay	22	33.3	4	92.3
Alfalfa	7	37.5	4	75.0
		British Columbia, 1979		
Apples	23	24.3	8	79.2
Hay	36	24.2	6	90.9
Pears	15	22.3	6	80.6

Sources: See Data Appendix.

Table 5: OLS Regressions
Dependent Variables: Cash Rent or Share

Variables	Data Set: Nebraska/ South Dakota (1986)		Louisiana (1992)		British Columbia (1992)	
	Cash	Share	Cash	Share	Cash	Share
ACRES (1000s)	**3104.04**	**−0.38**	**64.00**	**0.001**	**18.02**	**−0.01**
	(23.97)	(**−1.56**)	**(12.34)**	**(0.94)**	**(3.03)**	(**−0.46**)
Control Variables						
CONSTANT	−798.68	65.68	53.38	19.26	14.02	33.70
	(−2.53)	(109.18)	(2.50)	(7.18)	(0.47)	(4.51)
HAY	466.94	.11	−2.23	17.98	−7.57	−0.45
	(1.08)	(0.24)	(−0.05)	(3.13)	(−0.54)	(−0.10)
DENSITY	3.44	−0.01	−0.17	0.03		
	(2.26)	(−2.45)	(−1.16)	(0.59)		
FAMILY	−497.86	−0.28	−3.84	0.47	−3.55	−1.14
	(−1.44)	(−0.75)	(−0.36)	(0.41)	(−0.17)	(−0.28)
ROW CROP	1263.77	−4.31	−1.80	2.37	8.68	−17.43
	(2.76)	(−8.54)	(−0.19)	(1.78)	(0.29)	(−2.10)
RICE			12.76	4.49		
			(0.89)	(2.18)		
IRRIGATED	1840.35	.52	30.29	2.69	9.37	
	(4.32)	(1.14)	(2.62)	(1.31)	(0.66)	
AGE			−1.21	−0.04	−0.15	0.42
			(−3.29)	(−0.97)	(−0.27)	(0.28)
INSTITUTION			−14.72	2.02	28.79	−8.30
			(−1.03)	(1.17)	(1.79)	(−0.95)
INPUT SHARED	−7.21					
	(−17.61)					

Data Sources: See Data Appendix.

Table 6: Frequency of Cropshares Less Than 1/2

	Data Set			
Crop	Nebraska/ South Dakota (1986)	Louisiana (1992)	British Columbia (1992)	British Columbia (1979)
	(frequencies in percent)			
Barley	3.9		0.0	0.0
Oats	2.08			0.0
Wheat	3.15	0.0	0.0	0.0
Corn	3.41	0.0		0.9
Hay/Alfalfa	3.06		0.0	3.0
Apples			0.0	0.0
Pears				0.0
Peaches				0.0
Cherries				0.0
Rice		0.9		
Soy	3.1	0.6		
Cotton		0.0		
Sugar		0.0		
Milo	4.1	0.0		

Sources: See Appendix.

Table 7: The Frequency of Share to Farmer in Cropshare Contracts by Crop

	Crops (region)					
	Corn	Soybeans	Wheat	Sugarcane	Rice	Apples
Share To Farmer (%)	Nebraska/ South Dakota (1986)	Nebraska/ South Dakota (1986)	Nebraska South Dakota) (1986)	Louisiana (1992)	Louisiana (1992)	British Columbia (1992)
	(frequencies in percent)					
9/10 (90)	0.06	0	0.18	0	0	13.3
17/20 (85)	0	0	0	0	0	40.0
5/6 (83.3)	0	0	0	38.6	0	0
4/5 (80)	0.18	0	0.18	47.1	0	26.7
2/3 (67)	25.9	16.2	49.2	0	5.7	20.0
3/5 (60)	34.1	45.4	20.6	1.4	51.4	0
1/2 (50)	35.6	35.1	24.1	0	8.6	0

Sources: See Data Appendix. The shares do not some to 100% because there are other shares not reported. This is especially true of Louisiana rice where we find 35 different share terms, including 10 that have at least 2.9% of the contracts.

Table 8: Cropshare Frequencies by Crop and Input Cost Allocation

	Corn	Soybeans	Corn/ Soybeans	Corn	Soybeans	Corn/ Soybeans
	Nebraska South Dakota	Nebraska South Dakota	Illinois North Region	Nebraska South Dakota	Nebraska South Dakota	Illinois South Region
Inputs Shared?	Yes	Yes		No	No	
Share To Farmer (%)						
3/4 (75)	0	0	0	1.2	0.6	0
2/3 (67)	8.3	3.6	1.7	28.3	15.7	53.5
3/5 (60)	16.6	17.4	2.3	60.1	73.7	31
1/2 (50)	69.7	74.6	94.8	6.8	6.1	14

Sources: Data Appendix. The Nebraska and South Dakota data only show dryland crops for a better comparison with Illinois. The Illinois data are reported in Young and Burke (2001, Figure 3, p.562) and are derived from *The 1995 Cooperative Extension Service Farm Leasing Survey*, (Department of Agricultural and Consumer Economics, University of Illinois, 1996).

Table 9: Shares Based on Degree of Moral Hazard

	Frequency of Shares			
	50–50	60–40	67–33	75–25
Dryland Row Crops	33.3	34.4	26.9	.5
Irrigated Non Row Crops	17.0	5.3	51.1	18.1