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CONTRACT CHOICE IN MODERN AGRICULTURE: CASH RENT VERSUS CROPSHARE*

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I. Introduction

Economists have expended enormous effort examining the rationale for various contractual arrangements in agriculture, particularly sharecropping. While economists have made considerable theoretical efforts to understand agricultural contracts, few empirical studies have been undertaken. The dearth of empirical analyses of agricultural contracts is particularly striking for modern Western agriculture.[1] This is an important omission, not only because the existing empirical work tends to focus on the question of efficiency, but also because the theoretical models tend to examine contracts that bear little resemblance to those found in the United States today.

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[1] Keijiro Otsuka & Yujiro Hayami, Theories of Share Tenancy: A Critical Survey, 37 Econ. Dev. & Cultural Change 31 (1988), found empirical work done only for the Third World, medieval Europe, and the postbellum South. To our knowledge, the only empirical study of modern Western agricultural contracts is the rather short article by D. J. Brown & J. H. Atkinson, Cash and Share Renting: An Empirical Test of the Link between Entrepreneurial Ability and Contractual Choice, 12 Bell J. Econ. 296 (1981).

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The model of landowner-farmer contracting that we develop is consistent with the actual organization of modern farms in the American Midwest, and we test its implications against individual contract data from Nebraska and South Dakota. We begin by detailing the kinds of contracts found in modern Midwestern agriculture. Then we develop a model that stresses the differential incentives associated with various contracts and use this model to explain the choice between cropshare contracts and cash-rent contracts.[2] Implications about contract choice are then tested against contract data from Nebraska and South Dakota for the 1986 crop season.

II. Farming in the Midwest

In the Midwest, landowners who lease their land for cash rent or cropshare tend to be farmers themselves (or they were once). They usually own some farmland, they nearly always own valuable equipment, they necessarily own specialized human capital, and they make nearly all of the farming decisions. In fact, the demographic distinction between landowner and farmer is not always clear. During any given year, a "farmer" may cultivate his own land and lease the land of another landowner; a "landowner" may farm some of his own land and lease the rest of his land to another farmer. In fact, in 1982, only 59 percent of all American farms were operated by individuals who owned all their farmland, and only 39 percent of all American farm acreage was cultivated by farmers who owned all of their land.[3]

Economists have focused on the choice among fixed-rent (cash-rent), fixed-wage, and share (cropshare) contracts as possible ways of combining land and labor through contracts.[4] In the American Midwest, how-

[2] "Cropshare" and "cash rent" are terms used by farmers and landowners; we will use them throughout the article.

[3] See U.S. Department of Agriculture, Agricultural Statistics 1986, tables 536, 537 (1987) (hereinafter USDA).

[4] See, for instance, Franklin Allen, On the Fixed Nature of Sharecropping Contracts, 95 Econ. J. 30 (1985); Lee J. Alston, Samar Datta, & Jeffrey Nugent, Tenancy Choice in a Competitive Framework with Transaction Costs, 92 J. Pol. Econ. 1121 (1984); Steven N. S. Cheung, The Theory of Share Tenancy (1969); Mukesh Eswaran & Ashok Kotwal, A Theory of Contractual Structure in Agriculture, 75 Am. Econ. Rev. 352 (1985); and David Newberry & Joseph Stiglitz, Sharecropping, Risk Sharing, and the Importance of Imperfect Information, in Risk, Uncertainty and Agricultural Development (James A. Roumasset, Jean-Marc Boussard, & Inderjit Singh eds. 1979). Lee J. Alston & Robert Higgs, Contractual Mix in Southern Agriculture since the Civil War: Facts, Hypotheses, and Tests, 42 J. Econ. Hist. 327 (1982), made a distinction between "sharecroppers" and "sharetenants." Croppers are farm laborers without capital who are paid with a share of the crop. Tenants are farmers who own capital and lease land by paying a share of the crop. By their definition, we consider only sharetenants.

ever, the relevant choice of farmland contracts is between cash rent and cropshare. The fixed-wage contract is not a contract between a farmer and a landowner but rather a contract between a farmer and an unskilled laborer.[5] Pure wage contracts between a farmer and a landowner simply do not exist in the Midwest. In this article, we consider only the choice between cash-rent and cropshare contracts as methods of coordinating the resources of landowners and farmers.

In many cases, economists have argued that share contracts tend to wither away as economies develop.[6] But share contracts have flourished in American agriculture throughout this century and continue to be widespread.[7] In fact, in Nebraska, South Dakota, and the entire Midwest—among the most developed agricultural economies—the cropshare contract is pervasive. This article utilizes a 1986 survey of landowner-farmer contracts in Nebraska and South Dakota that found that over 75 percent of all landowner-farmer contracts in Nebraska and over 62 percent of all contracts in South Dakota were cropshare agreements.[8] Some economists have argued that landowners meticulously monitor their cropshare farmers. But our experience and evidence is to the contrary. Landowners seldom monitor farmers and even then only in the most casual fashion—directly measuring farmer efforts are unheard of. The fact that many

[5] In a fixed-wage contract, a farmer (who controls the land through outright title, cash rent, or cropshare) hires a "hand" to help with farming chores. This hand typically has little human or physical capital and rarely plays a decision-making role on the farm. We define farmers as those who own both physical and human capital specialized to agriculture. Because we are focusing on landowner-farmer contracts, we do not consider fixed-wage contracts. We speculate that the reason that true "farmers" tend not to be hired on a fixed-wage basis is because of the severe incentive problem that would arise if the farmer's wealth did not depend directly on the value of the harvested crop.

[6] The idea that share contracts are a primitive form of organization in agriculture is found in Eswaran & Kotwal, *supra* note 4; Newberry & Stiglitz, *supra* note 4; and Otsaka & Hayami, *supra* note 1. Eswaran & Kotwal, *supra* note 4, at 360, argued: "As markets develop . . . sharecropping will give way to fixed rental contracts. . . . Sharecropping would dominate when markets are either absent or undeveloped and the class structure is polarized." The popular wisdom of the extinction of the cropshare contract probably stems from Richard H. Day, The Economics of Technological Change and the Demise of the Sharecropper, 51 Am. Econ. Rev. 427 (1967), who presented evidence from the Mississippi Delta cotton belt. Day's study, however, was of sharecroppers who owned little capital and lived on the landowner's farm; they were ultimately replaced by seasonal wage laborers.

[7] L. C. Gray *et al.*, Farm Ownership and Tenancy, Yearbook of the Department of Agriculture 1923 (1924), noted that, in 1920, cropshare contracts were more common than cash rent in most states. Also, D. Gale Johnson, Resource Allocation under Share Contracts, 58 J. Pol. Econ. 111 (1950), stated that "three-fourths of all rented agricultural land is leased under share contracts."

[8] Bruce Johnson *et al.*, Agricultural Land Leasing and Rental Market Characteristics: A Case Study of South Dakota and Nebraska (1988), found that 1,592 out of 2,101 contracts in Nebraska, and 834 out of 1,334 contracts in South Dakota, were sharing agreements.

landowners are absentee, living outside the county or state in which the rented land is located, supports our contention that monitoring by landowners is rare. In Nebraska and South Dakota, over half of the landlords live in a different county from their leased farmland. Of these, close to half live in a different state. In our model, we assume that monitoring effort is zero; instead, resources are allocated by the incentives created by the two types of contracts.

Some economists have argued that cropshare contracts necessarily divide the output between farmer and landowner equally.[9] The truth, however, is that cropshare contracts vary widely and are more likely not to be 50-50 agreements. For modern agriculture, the farmer usually receives more than half of the harvested crop and, to our knowledge, rarely less than that. For example, in our data set, only 4 percent of the cropshare contracts gave the farmer less than half the crop, while 66 percent gave the farmer more than half.

Modern agriculture is a complex business in which farmers use a combination of land, skilled and unskilled labor, expensive machinery, genetically engineered seed, chemical pesticides, and sophisticated cultivation and harvest techniques to produce a crop. In this study, we examine farming in Nebraska and South Dakota, where agriculture is by far the dominant industry. On the nearly 100,000 farms in these two states, an average farmer uses approximately 1,000 acres of farmland and $100,000 worth of farm equipment.[10] The average value of each farm's land and buildings is between $300,000 and $400,000. The farmers grow such crops as barley, corn, hay, soybeans, and wheat, and they sell an average of over $60,000 in agricultural products each year.[11] Aside from outright purchase, the two primary methods of gaining control of land are through short-term cash-rent and cropshare contracts with landowners.[12]

[9] Newberry & Stiglitz, *supra* note 4, forcefully argued this point and have influenced later writers, such as Allen, *supra* note 4. Eswaran & Kotwal, *supra* note 4, developed a model that explains why 50-50 sharing is common but also questioned the validity of the claim for its universality.

[10] In Nebraska, the farms tend to be smaller, averaging roughly 800 acres; in South Dakota, the farms average nearly 1,200 acres. In both states, farms tend to be larger in the western counties where the land is less valuable.

[11] All figures from USDA, *supra* note 3.

[12] Farmers pursue purchase less often than leasing. The reason for this is unclear. In general, the contracts are very simple. Douglas W. Allen & Dean Lueck, The Back-Forty on a Handshake: Specific Assets, Reputations, and the Structure of Farmland Contracts, 8 J. L. Econ. & Org. 366 (1991), examine the details in these contracts and find that most of the contracts are for one year, with very few of the multiyear contracts longer than three years.

III. A Model of Contract Choice

Steven Cheung demonstrated that, when transaction costs are zero, contract choice will not influence the outcome; cash-rent and cropshare contracts are equally efficient methods of coordinating landowners and farmers.[13] Since Cheung, many economists have relied on transaction-cost theories to explain contract choice.[14] We follow this tradition and use our knowledge of modern farming to identify the important costs associated with using cash-rent and cropshare contracts. In the model that follows, we assume that a given tract of land is to be leased—owner cultivation is not an option—and the important choice is between a cash-rent and cropshare contract. Further, risk-sharing arguments are ignored; both landowners and farmers are assumed to be risk neutral. We assume risk neutrality in order to focus on the incentives generated by each contract. In addition, it seems plausible to treat all parties symmetrically given the demographic similarities between farmers and landowners. Despite our modeling assumption, we do test some common risk-based hypotheses in Section V.

In a cash-rent contract, the farmer pays a fixed annual amount per acre of land and owns the entire crop. As a result, he supplies the optimal amount of his own inputs but overutilizes any inputs supplied by the landowner. For example, farmers can increase their wealth by not planting crops in a "proper" rotation, overusing chemicals and fertilizers that erode the soil, and tilling in ways that increase current crop output but reduce the moisture content of the soil. Even such subtle issues as the "timing" of seed, fertilizer, and harvest—especially with respect to weather—can enhance the farmer's return at the expense of the landowner's—for example, if a hail or rainstorm is expected, a farmer may harvest his own crop before a shared crop. In a cropshare contract, the farmer shares the harvested crop with the landowner. Because the farmer receives less than the full amount of the crop, he uses fewer inputs and

[13] Cheung, *supra* note 4.

[14] Other studies in this tradition include Alston, Datta, & Nugent, *supra* note 4; Yoram Barzel, Economic Analysis of Property Rights (1989); Eswaran & Kotwal, *supra* note 4; Robert E. B. Lucas, Sharing, Monitoring, and Incentives: Marshallian Misallocation Reassessed, 87 J. Pol. Econ. 501 (1979); and Joseph D. Reid, The Theory of Share Tenancy Revisited—Again, 85 J. Pol. Econ. 403 (1977). There are also the screening theories of Allen, *supra* note 4, and William Hallagan, Self Selection by Contractual Choice and the Theory of Share-cropping, 9 Bell J. Econ. 344 (1978), and the risk-aversion theories of both Joseph Stiglitz, Incentives and Risk Sharing in Sharecropping, 41 Rev. Econ. Stud. 219 (1974), and Newberry & Stiglitz, *supra* note 4. Cheung, *supra* note 4, has elements of both transaction costs and risk aversion in his theory of share tenancy. See Otsuka & Hayami, *supra* note 1, for other references.

thus reduces the overall distortion from suboptimal input choices.[15] Hence, the benefit of the share contract is that it curbs the farmer's incentive to exploit the inputs supplied by the landowner, such as soil moisture and nutrients.

In principle, the landowner could also undersupply attributes of the land used by the farmer, but our discussions with Midwestern farmers and landowners indicate that this is nearly impossible. A landowner might be delinquent in road maintenance and fence upkeep, but we find no evidence that these are the duties of landowners for Midwestern farming. The large fraction of absentee landowners supports the view that landowners just supply land and no other services. Because of this, we assume that only the farmer chooses the inputs in these contracts.

Even though share contracts reduce total input distortions, they entail costs that are not present for cash-rent contracts—the output has to be measured and divided.[16] For agriculture, this requires physical measurement and division of the harvested crop. As a result, the farmer has an incentive to underreport the harvest to the landowner. Underreporting may take the form of crop quality as well as quantity. For example, a farmer may keep the best hay or the wheat with the fewest weeds for himself, while not underreporting quantity at all. An extreme example is land leased for pasture. This land is cash rented because the costs of detecting quality and weight-gain underreporting for live cattle is prohibitive. A cropshare contract also implies that both the farmer and the landowner must sell their share of the crop and incur the associated costs because cropshare contracts do not specify shares of the dollar value of the crop but rather shares of the crop. The trade-off between input-distortion costs and output-division costs determines the contract choice, the joint wealth-maximizing choice being the contract that yields the highest value of output net of all costs.

We model contract choice as a two-stage process.[17] First, we determine the input choices made by farmers in cash-rent and cropshare contracts. Second, given the farmer's choices, we determine the contract that maxi-

[15] Eswaran & Kotwal, *supra* note 4, at 353, also recognized this feature of cropsharing and wrote: "We view sharecropping as a partnership in which both agents have incentives to self-monitor."

[16] To our knowledge, only Edward P. Lazear, Salaries and Piece Rates, 59 J. Bus. 405 (1986), and John Umbeck, A Theory of Contract Choice and the California Gold Rush, 20 J. Law & Econ. 421 (1977), have recognized this important component of share contracts.

[17] Our formal model is similar to Yoram Barzel & Wing Suen, Moral Hazard, Monitoring Costs, and the Choice of Contracts (unpublished manuscript, Univ. Washington 1988); Russell Cooper & Thomas W. Ross, Product Warranties and Double Moral Hazard, 16 Rand J. Econ. 103 (1985); and Eswaran & Kotwal, *supra* note 4.

mizes farmer-landowner wealth by comparing the net values of the two contracts as important parameters change. We assume there are just two inputs—farmland owned by landowners and farm capital (both human and physical) owned by farmers—and that both parties are risk neutral. Actual crop output is subject to random fluctuations because of such factors as weather and pests. Because of this uncertainty and because all of the attributes of the farmer and land inputs cannot be perfectly specified in a contract, there are opportunities for the farmer to gain at the landowner's expense. Uncertainty eliminates the possibility that the landowner can calculate the input levels from the level of output. In all cases, we consider the use of a tract of farmland of fixed acreage that is contracted for use by a single farmer for a single growing season.[18]

To begin, let $Q = \epsilon h(f, l)$, where Q is the harvested output (with unit price) per tract; f 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 $\epsilon \sim (1, \sigma^2)$ is a positive, randomly distributed composite input that includes weather and pests. We assume that $h_f > 0$, $h_l > 0$, $h_{ff} < 0$, $h_{ll} < 0$, and $h_{fl} = 0$, where the subscripts denote partial derivatives. The last term implies that the inputs are independent. This specification also implies that the marginal productivity of the inputs is random and that, as the production scale increases, so does the variance of output.[19] Both implications are intuitively appealing. Assuming independent inputs simplifies the model and increases the number of testable implications.[20] 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, for our purposes, is ignored.

[18] Since we assume it is prohibitive for the landowner to measure inputs by outputs, landowners are unable to entice optimal resource allocation by using repeated contracts. Because the landowner can only rely on the incentive structure of the contract, our one-period model is justified.

[19] Richard E. Just & Rulon D. Pope, Stochastic Specification of Production Functions and Economic Implications, 7 J. Econometrics 344 (1978).

[20] Not only do we have no a priori theoretical grounds to assume which inputs are substitutes or complements, but there is empirical justification for their independence. First, were they not independent, contracts could adjust some input prices upward and others downward, in order to influence farmer behavior. This, however, is not observed. Second, Douglas W. Allen & Dean Lueck, Sharing Input Costs: Evidence from Midwestern Cropshare Contracts (unpublished manuscript, Louisiana State Univ. 1991), find that input-cost sharing in cropshare contracts exhibits an all-or-nothing dichotomy; that is, input costs are either shared in the same proportion as output or not shared at all. This result is only consistent with independent inputs.

Therefore, it is worth stressing that r is not the price of land per acre but rather the cost of the composite unpriced land input.

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 f^* 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.[21]

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 underreport the output in the cropshare contract. We examine the differential outcomes of the cash-rent and cropshare contracts by modeling these incentives. For both contracts, the farmer chooses the inputs, which depend on the type of contract. Once the input levels are determined, the net value of each contract can be calculated.

A. 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.[22] He owns the entire crop and chooses inputs to maximize expected profit. Because he does not have indefinite tenure of the land, he does not face the true opportunity cost of using the land's attributes. If we denote the reduced costs he faces as $r' < r$, then the second-best solutions f^r and l^r satisfy $h_f(f^r) \equiv w$ and $h_l(l^r) \equiv r'$. Given that $h_{fl} = 0$, we note that the farmer's input level is identical to the first-best optimum; that is, $f^r = f^*$. It is also clear, however, that, since $r' < r$, $l^r > l^*$, implying that the land is overworked because the farmer does not face the full cost of using the land's attributes.

B. Cropshare Contracts

In a cropshare contract, the farmer gains exclusive use of the plot of land without paying the landowner prior to production. At harvest time, the crop (not revenue or profit) is divided between the farmer and landowner, with the farmer receiving sQ and the landowner receiving

[21] Because $\varepsilon \sim (1, \sigma^2)$ and because risk-neutral parties maximized expected profits, the error term, ε, vanishes from all first-order conditions.

[22] Occasionally cash rent is paid in two or three installments during the growing season.

$(1 - s)Q$, where $0 < s < 1$. The farmer bears all costs of the variable inputs except the differential cost of the land's unpriced attributes.[23] Now the second-best solutions, f^s and l^s, satisfy $sh_f(f^s) \equiv w$ and $sh_l(l^s) \equiv r^l$. These solutions indicate that the farmer supplies too few of his inputs because he must share the output with the landowner; that is, $f^s < f^*$. As with cash rent, the farmer overuses the land attributes, or $l^s > l^*$; however, the use of the land is less excessive than it is with cash rent, implying $l^r > l^s > l^*$.

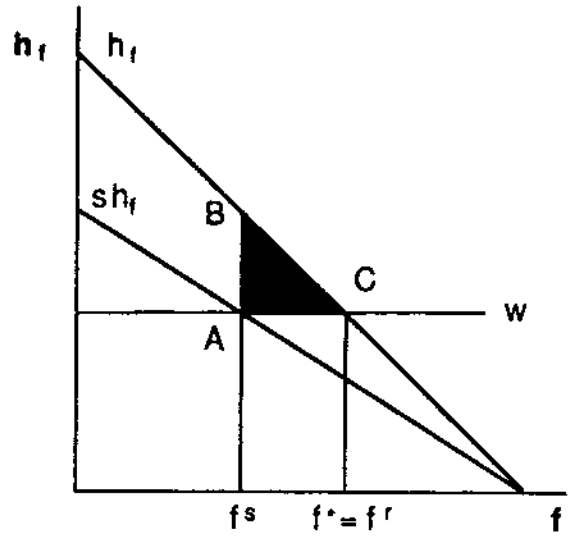
Figure 1 demonstrates the model. For simplicity of presentation, the graphs use identical and linear marginal-product curves for each input, although this is not required. When contracts are enforced without cost, the first-best input levels, f^* and l^*, are chosen. In a cash-rent contract, the farmer faces reduced costs of using land attributes and chooses l^r, resulting in a deadweight cost of DFG. In a share contract, the perceived marginal products to the farmer are lower, and, therefore, he reduces the amount of both inputs used to f^s and l^s, resulting in two deadweight costs: ABC and DEH. In order to understand the differential effects of the contract, consider a switch from cash rent to cropshare. In cropshare, the farmer chooses less of both inputs, and this has two offsetting effects: the reduction of l increases the value of the contract, while the increase in f lowers it. The optimal share will be the one that just equates the marginal loss due to reducing f (AB) to the marginal gain due to reducing l (EH). One obvious implication of the model is that l^s is always greater than l^*. Hence, if there were no output-division costs, the cropshare contract would always be superior to cash rent because of the reduction in total input distortion. Cropshare contracts, however, do not always dominate cash-rent contracts since they do create an incentive to underreport the quality and quantity of crop.

C. Comparative Statics of Contract Choice

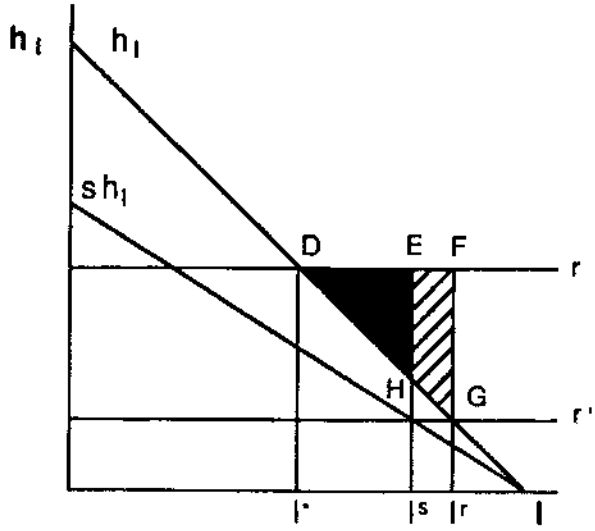
Farmers and landowners choose the contract that maximizes the joint expected return to the tract of land.[24] Analytically, this requires comparing the expected net return to the land in both contracts, where the net

[23] Eswaran & Kotwal, *supra* note 4, assumed that net revenue is shared, which implies that input costs are shared in the same proportion as the output and that the costs of output division are zero. Both of their implications are inconsistent with our data set. Dollars are never shared, and inputs are not always shared in the same proportion. See Allen & Lueck, *supra* note 20, for a complete discussion on variations in output shares and the relationship between input and output shares.

[24] This solution ignores questions of income distribution; we assume that the bargaining costs are low enough so that the most valuable contract is chosen.



a) Farmer's Capital (f)



b) Land attributes (l)

FIGURE 1.—How share contracts minimize total input distortion

return is given by the appropriate indirect objective function. For the cash-rent contract,

$$V^r(w, r, r') = h(f^r, l^r) - wf^r - rl^r.$$

With the cropshare contract, there are additional costs of measuring and dividing the harvested crop. These costs are given by d so that the net value function is

$$V^s(w, r, r', d) = h(f^s, l^s) - wf^s - rl^s - d.$$

The joint-maximization problem is to choose the larger of V^r and V^s.

The trade-off between the two contracts is straightforward. The benefit of cash rent is the avoidance of the costs of dividing output d. The benefit of cropshare is the reduction in the total distortion of input levels. The effect of parameter changes on the net value of each contract can illuminate this trade-off and lead to hypotheses about contract choice. We consider changes in output-division costs, d, and the opportunity cost of land attributes, r.

Consider first how changes in d affect V^r and V^s. The net value of the cash-rent contract, V^r, does not depend on output-division costs. The net value of the cropshare contract, V^s, however, declines as these costs increase.[25] For low costs, the cropshare contract maximizes net value; for high costs, the cash-rent contract maximizes net value. The implication is clear: as the costs of output division increase, it is less likely that the cropshare contract will be chosen. The comparative statics for r are similar.[26] An increase in the cost of land attributes will lower the value of either contract (holding r' constant), but it will lower the value of the cash-rent contract more because land inputs are used more intensively than in a cropshare contract ($l^r > l^s$). As these costs increase, the cropshare contract is more likely to be chosen. This implies that, as land becomes more valuable, the contract will more likely be a cropshare contract, which inherently reduces the farmer's incentive to exploit the unpriced attributes.

IV. Implications of the Model

Our model makes clear predictions regarding the choice of contract for different levels of crop-division costs, d, and a farmer's incentive to exploit the soil, $r - r'$. Even though these parameters are not directly

[25] By the envelope theorem, $\partial V^s/\partial d < 0$.

[26] By the envelope theorem, $\partial V^s/\partial r = l^s$, and $\partial V^r/\partial r = -l^r$, where $l^r > l^s$. Because neither l^s nor l^r depends on r, the second derivatives of V^s and V^r with respect to r are zero. Therefore, V^s and V^r are linear functions of r.

observable, there are clear instances when division costs are high and when the ability to exploit the soil is great, allowing us to test the model's implications. This section discusses some features of Midwestern farming that allow us to test our model of contract choice and compare its implications to those of other models.

Our model also has implications about the level of input use under both types of contracts. Unfortunately, the data available in our survey of Midwestern contracts only allow a test of the contract-choice implications. There are no data on the use of any farm inputs in this survey. Radwan Shaban's study, however, offers support for our implications for input choices.[27] Using data from (South Asian) Indian villages, Shaban found that input use was significantly lower (19–55 percent) on shared land when compared to owned land. He concluded that the data refuted the idea that landowners are able to stipulate and perfectly monitor input uses in a share contract.

A. Costs of Dividing Farm Output

Our model implies that a cropshare contract is most likely to occur when the costs of dividing the crop are relatively low. Crops can be divided into two categories to identify changes in output-division costs: crops sold through public markets and crops sold through private sales. Most cash crops grown in the Midwest are sold at local elevators, where the crop is independently weighed, graded, and, if there is a cropshare contract, divided. Most towns in the Midwest have very few elevators, so it is usually well known where farmers take their crops. Crops that must go to an elevator are easier to measure than crops sold privately. The crops in our sample that never go to an elevator are the hay crops: alfalfa, brome, and native hay. Because hay crops are more difficult to measure at the time of harvest, we expect cash-rent contracts are more likely to be chosen.[28] Another implication is that cash rent is more likely to be chosen when the costs of on-farm storage is high, rendering crop storage in a public elevator more likely.

Not all farmland owners are private individuals. In some cases, farmers lease land from city or state governments, Native American tribes, banks, or other institutional landowners. For these landowners, relatively large crop-division costs are likely. The institutions' agents would have little a priori knowledge or interest in yield or possibilities for underreporting.

[27] Radwan Ali Shaban, Testing between Competing Models of Sharecropping, 95 J. Pol. Econ. 893 (1987).

[28] Hay is often used as a livestock feed by the leasing farmer, making third-party measurement even more difficult.

We expect institutional landowners to be more likely to cash rent their land than private landowners.

B. Land Value and Farming Practices

If farmland is soon to be used for purposes other than agriculture, then soil quality becomes less important. In the extreme case, where the land is to be converted at the end of the current contract, the incentives of the landlord and the farmer toward soil extraction would be identical ($r' = r$). In this case, a cash-rent contract would approximate the first-best solution and would be chosen over cropshare. We expect cash-rent farming to be more common for farmland near urban populations because the value of the land for nonfarm uses is relatively high.

With a cash-rent contract, the farmer has an incentive to overuse the unpriced attributes of the land. In Nebraska and South Dakota, like much of the Midwest, moisture content is one of the most important characteristics of the soil. In an effort to increase moisture, land is often left fallow for a complete growing season to conserve moisture for future crops.[29] When fallowing the land is important, the farmer's ability to deplete soil moisture or to damage the long-term viability of the land increases. When land lies fallow, such factors as the level of crop residue and the method of fertilizer application can have a large effect on future crops. Practices that increase next year's crop may come at the expense of later crops. For example, the landowner may want to leave the crop residue to prevent wind and water erosion, while the farmer may want to work the residue into the soil to fertilize the next crop. Farmers also like to till land that lies fallow to control for weeds and raise the quality of the next crop; however, the frequency and depth of tilling can increase soil erosion. Hence, although fallowing might be easily observed, the quality of fallow is not. In terms of the model, as fallowing becomes more important, the deviation between the farmer's perceived cost (r') of land and the true cost (r) becomes greater and the likelihood that cash rent will be chosen is reduced. Because the purpose of fallowing is to conserve soil moisture, irrigated land does not suffer from this incentive problem. Cash-rent contracts are expected to be more likely for irrigated land than for land that is not irrigated.

Tilling, cultivating, and other physical manipulations of the soil present the same incentive conflict as fallowing to the landowner and the farmer.

[29] Depending on the crop, expected rainfall, soil type, and other factors, fallow time can range from every other year to every third or fourth year. Fallowing the land becomes especially important for land in relatively dry regions. In the far eastern and relatively moist reaches of Nebraska and South Dakota, fallowing is rare.

The farmer does not have the incentive to take the long view regarding tilling, especially under a cash-rent contract. In certain cases, excessive tilling can lead to wind erosion, nutrient depletion, and loss of moisture that may not be problematic in the immediate period but will lead to reduced crops in the future. For example, in very dry years, the evaporation of surface moisture draws subsurface moisture upward and reduces the total amount available for the current and following crop to draw on. Here, farmers can perform a shallow tillage that saves the subsurface moisture at the expense of completely drying out the soil exposed to the sun. This dry topsoil then becomes vulnerable to wind erosion, and, though two or three seasons of this kind of tillage may produce a crop, it can quickly destroy the land. Cropshare is more likely to be chosen when tillage becomes more important because the potential for land exploitation is greater. When considering the incentives for different tillage practices, it is useful to distinguish between row crops (such as corn, potatoes, soybeans, and sugar beets), where the land is tilled more intensively, and other crops (such as barley, hay, and wheat), where the land is tilled less intensively. Indeed, for hay crops, the farmer's ability to deplete the soil by excessive tilling is minimal because the soil is seldom manipulated; the crop is simply harvested periodically. This implies that hay crops are more likely to be governed by cash-rent contracts. Cropshare contracts are more likely to be chosen for row crops where tillage is important.

V. Evidence from Nebraska and South Dakota

To test these implications, we use data on individual farmer-landowner contracts from the *1986 Nebraska and South Dakota Leasing Survey*. The survey collected data from both farmers and landowners and contains detailed information on farmland contract terms for the 1986 crop year.[30] Each observation is a single farmland contract between a farmer and a landowner in a sample of 3,432 contracts, of which 2,424 are cropshare and 1,008 are cash rent.

Because we are considering the dichotomous choice of contract—cash rent versus cropshare—we use logit-regression analysis to test the implications presented in the previous section. In this section, we present two different tests of our model. In the first test, we estimate several logit equations where the dependent variable is one if the contract is cropshare and zero if cash rent. The different logit equations use different samples and different variables in order to test the various implications of our

[30] For further information, see Appendix A and Johnson *et al.*, *supra* note 8.

model as well as some of the implications from other models of crop sharing. In the second test, we estimate a logit equation to determine the factors influencing the inclusion of an adjustment clause found in some cash-rent contracts. In this logit equation, the dependent variable is one if an adjustment clause is used. The variables used in all of these estimation procedures are defined in Appendix B, and their means are reported in Table 1.

A. Logit Analysis of Cash Rent versus Cropshare

The logit equations in Table 2 estimate the influence of selected variables on the choice of contract. The table's first regression equation includes all contracts. The coefficient estimates for HAY, IRRIGATION, ROW, and DENSITY have the expected signs, are statistically significant, and have relatively large effects on the probability of which contract will be chosen. The variable HAY is expected to be inversely related to the likelihood of a cropshare contract because the land is not subject to extensive tilling and output measurement is difficult. The variable IRRIGATION is expected to be negatively correlated because irrigated land cannot have its soil moisture exploited by the farmer. The variable ROW denotes crops that require extensive tilling, so the possibility of soil exploitation is high, implying that ROW will increase the likelihood of cropshare contracts that reduce this exploitation. Finally, DENSITY approximates the urbanization of an area and indicates that farmland may have alternative uses. This implies that soil exploitation is of less concern, so that a cropshare contract should be less likely. In the table's second and third regression equations, all the coefficient estimates for these variables still fulfill the predictions, although, in a few cases, the *t*-statistics fall. These estimates offer support for our theory of contract choice and are consistent with the observation of Grey *et al.*: "Especially in the Corn Belt it is frequently customary to cash rent the hay land while sharing the grain crop."[31]

The variable FAMILY is included to examine how family relationships influence the choice of contract. Keijira Otsaka and Yujiro Hayami argued that contracts between family members will generally be easier to enforce, so that most contracts will be between related individuals rather than "strangers."[32] The aggregate evidence for our data set, however, refutes their hypothesis: the choice of contract does not depend on fam-

[31] Gray *et al.*, *supra* note 7, at 589.

[32] Otsaka & Hayami, *supra* note 1.

TABLE 1

VARIABLE MEANS

VARIABLE	SAMPLE						
	Full	Farmer	Landowner	Cash Rent	Dryland Crop	Dryland Corn	Dryland Wheat
CONTRACT	.706	.653	.737	N.A.	.786	.889	.956
ADJUSTMENT	N.A.	N.A.	N.A.	.098	N.A.	N.A.	N.A.
IRRIGATION	.359	.368	.354	.452	N.A.	N.A.	N.A.
INSTITUTION	N.A.	.094	N.A.	N.A.	N.A.	N.A.	N.A.
HAY	.326	.355	.309	.318	N.A.	N.A.	N.A.
ROW	.661	.662	.661	.252	N.A.	N.A.	N.A.
ROW*HAY	.208	.233	.197	.067	N.A.	N.A.	N.A.
DENSITY	30.2	26.6	32.4	29.3	36.4	45.5	27.1
ACRES	445.9	510.2	408.5	476.5	400.0	369.2	413.1
FARM INCOME	N.A.	2.653	1.463	N.A.	N.A.	N.A.	N.A.
FAMILY	.443	.618	.341	.418	.433	.424	.452
AGE	N.A.	3.189	4.888	N.A.	N.A.	N.A.	N.A.
CAPITAL	N.A.	28.417	N.A.	N.A.	N.A.	N.A.	N.A.
ABSENT	N.A.	N.A.	.557	N.A.	N.A.	N.A.	N.A.
CORN	N.A.	N.A.	N.A.	N.A.	.500	1.0	N.A.
SOYBEANS	N.A.	N.A.	N.A.	N.A.	.447	N.A.	N.A.
SORGHUM	N.A.	N.A.	N.A.	N.A.	.300	N.A.	N.A.
WHEAT	N.A.	N.A.	N.A.	N.A.	.462	N.A.	1.0
OATS	N.A.	N.A.	N.A.	N.A.	.133	N.A.	N.A.
BARLEY	N.A.	N.A.	N.A.	N.A.	.067	N.A.	N.A.
COUNTY VARIATION	N.A.	N.A.	N.A.	N.A.	N.A.	.264	.182
N	3,432	1,261	2,171	1,008	1,081	523	498

NOTE.—N.A. = not applicable. Due to crop rotation and the fact that a given contract may involve more than one crop, ROW, HAY, CORN, and the other crops are not mutually exclusive.

TABLE 2

ESTIMATED LOGIT COEFFICIENTS FOR THE REGRESSION: CROPSHARE VERSUS CASH RENT

	SAMPLE			
INDEPENDENT VARIABLE	Full	Farmer	Landowner	PREDICTED SIGN
CONSTANT	−1.95	−6.70	5.46	
	(−.61)	(−1.07)	(1.48)	
IRRIGATION	−20.19	−16.51	−21.73	−
	(−8.37)*	(−4.24)*	(−6.86)*	
INSTITUTION	. . .	−16.62	. . .	−
		(−3.26)*		
HAY	−7.99	−4.17	−10.75	−
	(−2.71)*	(−.79)	(−2.99)*	
ROW	57.33	47.50	66.67	+
	(23.97)*	(11.78)*	(20.36)*	
DENSITY	−.021	−.03	−.02	−
	(−2.00)*	(−1.31)	(−1.93)	
ROW*HAY	.81	3.70	−.58	?
	(.19)	(.56)	(−.10)	
ACRES	.000	.009	−.001	?
	(.28)	(2.92)	(−1.11)	
FAMILY	−1.49	−1.05	5.85	?
	(−.77)	(−.32)	(2.16)*	
FARM INCOME	. . .	−2.07	−3.44	?
		(−1.77)	(−2.76)	
AGE	. . .	1.56	. . .	?
		(1.29)		
CAPITAL	. . .	−.06	. . .	?
		(−.93)		
ABSENT	. . .	. . .	−4.44	?
			(−1.71)	
N	3,432	1,261	2,171	

NOTE.—Dependent variable = 1 if cropshare contract, 0 if cash rent. Coefficients are $\partial\% / \partial X = \beta[\bar{P}(1 - \bar{P})] \times 100$ from the logit $P = 1/(1 + e^{-X\beta})$, where $\bar{P}$ is the mean of the dependent variable. Asymptotic *t*-statistics are in parentheses.

* Significant at the 5 percent level, for a one-tailed *t*-test.

ily ties.[33] Furthermore, Otsaka and Hayami claimed that sharecropping should be more common among family members. This does not appear to be the case for our sample as a whole; however, this prediction holds for data supplied by landowners.

Two control variables—ACRES and ROW*HAY—are included in all equations. Because row crops and hay crops are occasionally grown to-

[33] See Allen & Lueck, *supra* note 12, however, for evidence on how knowledge of the contracting parties influences some of the other features of these contracts.

gether, the ROW and HAY variables have a slight overlap.[34] To control for this, we included the interaction term ROW*HAY. In all cases the coefficient for this variable was insignificantly different from zero. The variable ACRES was included to control for the possibility that the size of the land parcel would influence contract choice. As with ROW*HAY, the ACRES coefficient is not significantly different from zero in all equations.

Additional Hypotheses: Institutions and the Agricultural Ladder. To test our model against some other theories and to test our prediction about institutional landowners, we divide the data into two subsamples: one for which farmers provided data (1,261 contracts) and one for which landowners provided data (2,171 contracts). In the farmer sample, we add the variables AGE, CAPITAL, FARM INCOME, and INSTITUTION. In the landowner sample, we add the variables ABSENT and FARM INCOME.

The coefficient for INSTITUTION is expected to be negative because the higher output-division costs for institutional landowners will provide an incentive, ceteris paribus, to use cash-rent contracts. The evidence in the table's second regression equation supports this implication. In the traditional theory of the agricultural ladder,[35] AGE would be expected to be negatively related to the probability of cropshare contracting. In the ladder theory, farmers graduate with age from cropshare to cash rent and ultimately to sole ownership of the land. The evidence here, however, rejects this hypothesis because the coefficient is small, positive, and insignificant. In a cash-rent contract, a farmer must pay the landowner prior to harvest; in a cropshare contract, the payment comes after harvest. Thus, some have argued that farmers facing capital constraints will be more likely to choose a cropshare contract.[36] The variable CAPITAL is one possible measure of this constraint. The farmer who owns more of his land base should have better collateral and be able to secure loans more inexpensively; therefore, he should be more likely to cash rent. The capital constraint theory, then, implies a negative coefficient for CAPITAL, which we have found, although it is small and insignificant.

In the landowner sample, ABSENT is included to test a common prediction of landowner behavior. In many sharecropping models, landowners are assumed to provide valuable farming information and policing along with the land; therefore, the absentee landowner faces higher costs

[34] One type of hay crop—alfalfa—is a legume that fixes nitrogen into the soil and so is occasionally rotated with row crops.

[35] W. J. Spillman, The Agricultural Ladder, 9 Am. Econ. Rev. 170 (1919).

[36] For instance, Gray *et al.*, *supra* note 7.

of participating in farming activities.[37] These theories imply that absentee landowners will be more likely to cash rent their land; that is, the coefficient for ABSENT should be negative. In our model, however, the landowner provides only land, and his presence is unnecessary. Even though the coefficient is negative, it is small, and the low level of significance fails to reject our prediction that absentee landowners are just as likely to engage in cash-rent contracts as in cropshare contracts.

Testing Risk-sharing Hypotheses. Although we have assumed risk neutrality, risk sharing has often been suggested as an important determinant of contracts, particularly in agriculture.[38] A cropshare contract is said to reduce risk more than a cash-rent contract by reducing the variance in income. Thus, under the assumption of risk aversion, cropshare contracts are preferred to cash rent as an "insurance policy." In this section, we test some plausible implications of a risk-based theory of contract choice.

Before proceeding with the evidence, it is important to note that, even if risk aversion is important, the cropshare contract is not the best method of reducing risk. As noted above, the farmer and the landowner share the crop—hence the term "Cropshare"—yet risk could be further reduced if they shared the gross revenues or profit from the sale of the crop. By sharing revenues, each party shares the risk inherent in selling the crop, and, by sharing profits, each party shares the risk of choosing costly inputs. Simply sharing the crop is not the best way to reduce the variance of income.

Regarding assumed preferences toward risk, in the American Midwest, both landowners and farmers are demographically similar and must be treated so. Given that farmers and landowners are similar, risk aversion must apply to both or neither. Therefore, we assume both have the same degree of risk aversion. Because of this, however, each has an opposite incentive toward contract choice. A risk-averse farmer prefers a cropshare agreement in order to reduce the variance in his income. A risk-averse landowner, however, prefers a cash-rent contract because the variance in his income is zero.

In Table 2, the variable FARM INCOME is included in both the farmer and landowner samples to examine a plausible implication of risk aversion: it measures the fraction of the farmer's or landowner's income that is derived from farming.[39] If farmers are risk averse, they would be more

[37] For example, see Eswaran & Kotwal, *supra* note 4.

[38] For example, see Cheung, *supra* note 4; or Newberry & Stiglitz, *supra* note 4.

[39] We would prefer to include the wealth levels of the farmer and landowner. Unfortunately, the data are insufficient for this.

likely to enter into a cropshare agreement as their income becomes more and more dependent on farming. Thus, risk aversion implies a positive coefficient on FARM INCOME in the farmer sample. Contrary to this hypothesis, however, the estimated coefficient is negative. Landowners can reduce the variance of their income by avoiding the cropshare contract and entering a cash-rent contract. Thus, risk aversion implies a negative coefficient on FARM INCOME in the landowner sample. Our results are consistent with this prediction, though the coefficient is still relatively small.

Cheung developed another risk-based hypothesis that is often used to rationalize cropshare contracts.[40] Cheung's argument was that crops with highly variable yields are more likely to be shared than crops with stable yields. Despite the fact that Rao found that high-variance crops (tobacco) were cash rented while low-variance crops (rice) were shared, this prediction still remains popular.[41] We test this risk hypothesis by examining the influence of variability in per-acre yields across crops and variability in per-acre yields by crop and across counties on the choice of contract.

Using county-level data from Nebraska and South Dakota, we have calculated the coefficient of variation for per-acre yields for the region's six major dryland crops (barley, corn, oats, sorghum, soybeans, and wheat) for the 1985 and 1986 seasons.[42] These numbers are reported in Table 3 by crop and in Table 4 by county. Table 3 shows that, in terms of the coefficient of variation, corn and sorghum are the most risky crops and therefore should be the ones most likely governed by cropshare contracts. Wheat and soybeans are the least variable crops and are expected to be governed by cash-rent contracts. The first logit equation in Table 5 tests this implication by adding dummy variables for each crop and estimating their effect on the probability that a cropshare contract is chosen. Because irrigation drastically reduces crop variability, only a sample of contracts governing dryland crops (excluding hay) is used. The results from the first logit equation in Table 5 reject the crop-variability thesis. For instance, both corn and wheat are positively correlated with an increased probability of cropshare contracting even though the yield variability inherent in these crops differs greatly.

[40] Cheung, *supra* note 4.

[41] C. H. Hanumatha Rao, Uncertainty, Entrepreneurship, and Sharecropping in India, 79 J. Pol. Econ. 578 (1971).

[42] All irrigated crops are deleted from this analysis because they tend to have a much higher average yield and much lower variance. The data used to calculate the coefficients of variation come from Nebraska Agricultural Statistical Service, 1987 Nebraska Agricultural Statistics (1988); and South Dakota Agricultural Statistical Service, South Dakota Agriculture (1987).

TABLE 3

CROP VARIABILITY FOR NEBRASKA AND SOUTH DAKOTA, 1985–86

	NEBRASKA				SOUTH DAKOTA				COMBINED	
CROP	Minimum	Maximum	Mean	C.V.	Minimum	Maximum	Mean	C.V.	Mean	C.V.
Barley	21	57	45	.16	13	65	40	.31	43	.25
Corn	28	132	82	.31	17	102	66	.33	77	.33
Oats	20	84	57	.22	22	71	45	.28	52	.27
Sorghum	33	104	66	.29	10	70	42	.38	57	.38
Soybeans	21	43	32	.16	18	49	28	.17	31	.18
Wheat	28	52	37	.15	15	48	29	.24	34	.22

SOURCE.—See Appendix A.

NOTE.—C.V. = the coefficient of variation. All data are from county yield averages for the 1985–86 crop season, and all numbers except C.V. are in bushels per acre.

TABLE 4

COUNTY YIELD VARIABILITY FOR NEBRASKA AND SOUTH DAKOTA, 1975–90

	NEBRASKA		SOUTH DAKOTA	
	Corn	Wheat	Corn	Wheat
Low coefficient of variation	.2056	.0695	.1099	.1595
High coefficient of variation	.3879	.2568	.5155	.3347
Mean coefficient of variation	.2701	.1638	.2304	.2438

SOURCE.—See Appendix A.

NOTE.—All data are from county yield averages for 1975–90 crop seasons; means are in bushels per acre. The coefficient of variation for county yields is in bushels per acre for dryland corn and wheat.

TABLE 5

ESTIMATED LOGIT COEFFICIENTS FOR THE REGRESSION: RISK AVERSION AND CONTRACT CHOICE

Independent Variable	All Dryland Crops	Dryland Corn	Dryland Wheat	Risk-based Predicted Signs
CONSTANT	−36.70	25.97	20.81	
	(−5.61)*	(3.28)*	(4.91)*	
CORN	25.60	. . .	. . .	+
	(5.65)*			
SOYBEANS	26.61	. . .	. . .	−
	(5.72)*			
SORGHUM	34.51	. . .	. . .	+
	(6.18)*			
WHEAT	53.61	. . .	. . .	−
	(11.14)*			
OATS	14.81	. . .	. . .	?
	(2.09)*			
BARLEY	6.74	. . .	. . .	?
	(.73)			
COUNTY VARIATION	. . .	−15.47	−34.99	+
		(−.55)	(−1.96)*	
ACRES	−.003	−.001	.002	?
	(−1.74)	(−1.06)	(.71)	
FAMILY	−5.82	−6.53	−4.42	?
	(−1.71)	(−2.33)*	(−2.20)*	
DENSITY	.028	.086	.034	?
	(1.49)	(1.52)	(.808)	
N	1,081	523	498	

NOTE.—Dependent variable = 1 if cropshare contract, 0 if cash rent. Coefficients are $\partial\% / \partial X = \beta[\bar{P}(1 - \bar{P})] \times 100$ from the logit $P = 1/(1 + e^{-X\beta})$, where $\bar{P}$ is the mean of the dependent variable. Asymptotic *t*-statistics are in parentheses.

* Significant at the 5 percent level for a one-tailed *t*-test.

Since variation across crops may reflect only statewide variation in crop yield and may not reflect the true crop-yield variability faced by the farmer, we also examine the variation in corn and wheat yields within different counties in the two states. Table 4 shows summary statistics for coefficients of variation calculated from time-series data on dryland county yields for corn and wheat and shows that individual dryland crop yields also vary within counties. For example, the county coefficient of variation for corn ranges from .1099 to .5105 and for wheat from .0695 to .3347. An implication of the crop-variability hypothesis is that, for any given crop, the proportion of cropshare contracts will be highest in those counties where crop-yield variability is highest. The last two equations in Table 5 test this by examining the contract choice for dryland corn and dryland wheat. In both equations, the variable COUNTY VARIATION (the coefficient of variation for a given county and crop) is negative and, in one case, significantly different from zero. When corn is produced in a county where its yield is more variable over time, there is a decrease in the use of cropshare contracts and a similar result for wheat.[43]

Taken together, these tests suggest that risk sharing is not useful in explaining contract choice. Furthermore, these results bolster the interpretation of our IRRIGATION variable in Table 2. Because irrigated crops tend to have low variation in yield compared to dryland crops, one could argue that the negative sign had less to do with soil exploitation than with risk aversion. Given the poor performance of the risk hypotheses, however, IRRIGATION seems better interpreted as a contracting-cost variable. In fact, the result that cash-rent contracts are more likely when the crop is more variable not only refutes the risk-sharing hypothesis but is further evidence for our model. The more variable a crop, the more difficult it is to police underreporting, and the more costly a share contract becomes. Hence, our model predicts the negative coefficient of COUNTY VARIATION in Table 5.

Government Farm Programs. Federal farm-commodity programs are yet another factor suggested as influencing farmland contracts.[44] Crops such as barley, corn, oats, and wheat are part of target-price programs for which farmers and cropshare landowners get direct government payments. Hay crops have no government programs.[45] Soybeans and sugar

[43] We look only at corn and wheat because they are the two most important crops and because positive amounts of each crop are grown in practically every county.

[44] For information on government programs, see U.S. Department of Agriculture, ASCS Commodity Fact Sheet (1988).

[45] Since government farm programs tend to reduce the variance of farmer income and since hay crops have no government programs, the risk-sharing hypothesis would predict share contracts. We find, however, that hay crops are almost always cash rented.

beets (both row crops) have government programs, but no direct payments are made. We are not certain what a model based on government programs would suggest since the payments do not depend on contract type. In our model, it is unclear how government programs would influence the choice of contract by influencing either the cost of dividing output or the ability to alter the soil. In an unreported regression similar to the first equation of Table 5, we used the full sample, deleted ROW, and added dummy variables for individual crops. In all cases, the coefficients for the crop dummies are positive. Furthermore, the use of these variables did not appreciably alter the other estimates. These estimates indicate that government programs do not have any differential effect on contract choice.

B. Logit Analysis of Adjustment Clauses in Cash-Rent Contracts

In the typical cash-rent contract, the farmer is the complete residual claimant of the crop. In Nebraska and South Dakota, at least, this is not always the case. In our sample, 100 out of 1,008 cash-rent contracts have provisions to vary the amount of cash rent that is due to changes in actual yields. These adjustments are always upward; that is, when the crop yield is unusually high, the cash rent is increased. This converts the cash-rent contract into a partial cropshare contract. We examine these cash-rent adjustment clauses in order to further test our hypothesis that farmer-landowner contracts are organized to reduce the losses from input distortions and output-division costs.

A higher-than-expected yield may indicate that the farmer has overused the soil compared to the landowner's desires. An adjustment clause may, in part, serve as a deterrent to a farmer's excessive use of the land because his marginal share is reduced at the point when the clause takes effect. This rationale for adjustment clauses implies that the adjustments will be more common for land where the farmer's ability to exploit the soil is high. In addition, since the adjustment clause presumes a measurement of the crop, crops where the division costs are high should be less likely to have adjustment clauses. For instance, we expect that adjustment clauses will not be common for hay land or irrigated land because the ability of the farmer to overuse the land is limited in these cases and because hay crops are easier to underreport at harvest. With row crops, where the ability to exploit the soil is greater and where the relative cost of division is lower, we expect to see more adjustment clauses.

We test our proposition by using a sample that includes only cash-rent contracts. Table 6 presents the results of a logit-regression equation that estimates the effects of several variables on the decision to include an

TABLE 6

LOGIT REGRESSION FOR FACTORS INFLUENCING THE PRESENCE OF CASH-RENT ADJUSTMENT CLAUSES (N = 1,008)

Independent Variable	Estimated Coefficient	Predicted Sign
CONSTANT	−21.61	
	(−9.19)*	
IRRIGATION	−.49	−
	(−.22)	
HAY	−6.63	−
	(−1.95)*	
ROW	7.95	+
	(3.67)*	
DENSITY	.01	−
	(2.37)*	
FAMILY	4.11	?
	(2.07)*	
ROW*HAY	−9.54	?
	(−1.52)	
ACRES	−0.00	?
	(−1.04)	

NOTE.—Dependent variable = 1 if adjustment clause is present. Coefficients are $\partial\%/\partial X = \beta[\bar{P}(1 - \bar{P})] \times 100$ from the logit $P = 1/(1+e^{-X\beta})$, where $\bar{P}$ is the mean of the dependent variable. Asymptotic t-statistics are in parentheses.

* Significant at the 5 percent level for a one-tailed t-test.

adjustment clause in the cash-rent contract. Our model predicts that all variables should have the same sign as in the previous test since the presence of an adjustment clause with a cash-rent contract approximates a cropshare contract. The signs of all variables but DENSITY are consistent with this prediction. For HAY and IRRIGATION, we expect—and find—a negative relationship, although the coefficient for IRRIGATION is not significant. Since hay crops and irrigated land are more difficult and less likely to be exploited, adjustment clauses are not necessary. The variable ROW is positive and significant, as predicted, since the adjustment clause will discourage exploiting the soil to increase the current crop. The variable DENSITY is predicted negative because alternative uses for the land reduce the cost of soil exploitation; however, this prediction is refuted by the data. We have no explanation for why a positive correlation exists between DENSITY and the presence of adjustment clauses.

Like the estimates in Table 2, we include ACRES, FAMILY, and ROW*HAY as control variables. Again, ACRES and ROW*HAY have no significant effect on whether or not to use an adjustment clause; however, FAMILY has a significant, positive effect on the probability that

an adjustment clause will be chosen. This indicates that family members are more likely to exploit the soil under a pure cash-rent contract than nonfamily members.[46]

VI. Concluding Remarks

In this article, we show the transaction-cost approach to be a useful tool for understanding the choice of contracts between farmers and landowners in modern agriculture. It is an unfortunate reality that transaction-cost models often hinge on unobservable parameters. If economists could directly and cheaply measure the ability of farmers to exploit soil moisture and nutrients or the number and quality of hay bales taken, then so could landowners, and there would be no contract-design problem. Despite the problems with identifying output-division costs and the cost of exploiting soil attributes faced by the farmer, we feel that our proxies are reasonable and accurate. In this study, our ability to obtain detailed knowledge of farming practices in the Midwest greatly helped us exploit the theoretical model, and our evidence indicates that the choice of cash-rent and cropshare contracts lies primarily in their ability to create proper incentives.

Our data from Nebraska and South Dakota show that cropshare contracts are more likely when crop-division costs are low and where the ability of farmers to adversely affect the soil is high; the data also show that cash-rent contracts often contain clauses that discourage soil exploitation. Our logit estimates support the theory that the variation in contracts is largely determined by the costs of enforcing the contracts in various situations. Not only are the signs of our test variables correct, but the magnitude of the coefficients dwarf the coefficients for both the control variables and the variables that tested other theories. Furthermore, our data suggest that capital constraints and the so-called agricultural ladder are not helpful in explaining contract choice. Finally, our data offer no support for the view that contracts are chosen to avoid risk.

[46] We also estimated this equation with the farmer sample to test our prediction about institutional landlords. The coefficient for INSTITUTION was negative as predicted and significant at the 10 percent level. The other coefficients were similar in size and significance levels to the full-sample coefficients.

APPENDIX A

Data Sources

Most of the data for the landowner-farmer contracts come from the *1986 Nebraska and South Dakota Leasing Survey* that was conducted by Bruce Johnson of the University of Nebraska and Larry Jannsen of South Dakota State University.[47] The Economic Research Service of the U.S. Department of Agriculture funded the survey. A summary of the study and the survey procedures can be found in *Agricultural Land Leasing and Rental Market Characteristics: A Case Study of South Dakota and Nebraska.*[48]

Johnson and Jannsen obtained a list of landowners and farmers (from the Agricultural Stabilization and Conservation Service [ASCS] List of Producers) in each county in Nebraska and South Dakota who participate in or are eligible to participate in federal commodity programs. Essentially all farmers in these two states are eligible for federal programs.[49] As a result, we do not have any sample selection bias in the data. From the farmer-landowner list, Johnson and Jannsen chose a random sample of names and sent the survey to 6,347 individuals in Nebraska and 4,111 in South Dakota. The response rate was 32 percent in Nebraska and 35 percent in South Dakota. In the data set, the number of usable responses was 1,615 for Nebraska and 1,155 for South Dakota. Each observation represents a single farmer or landowner for the 1986 crop season. To conduct our tests, we reorganized the data so that each observation is a single farmland contract between a farmer and a landowner. Because many individuals had more than one contract, this increased the sample size by 20 percent and resulted in 2,101 observations for Nebraska and 1,331 for South Dakota.

The *Leasing Survey* data contain information on the general attributes of the farmer and landowner, the number of acres owned and leased, the type of contract, the shares and cash rent, the type of crop grown, and other similar information. The data set has no information on the levels of inputs used in farming. There are several questions on pasture-range leases, but, due to differences in the type of questions, the pasture-lease data are not comparable to that for the cropshare or cash-rent contracts. There are relatively few pasture leases as well. We combined the *Leasing Survey* data with county-level data on population per square mile taken from the *County and City Data Book 1987*.[50] This information was used to calculate the DENSITY variable used in our regressions.

We took data on dryland corn and wheat crop-yield variability from various issues of *Nebraska Agricultural Statistics* and *South Dakota Agriculture*.[51] From these sources, we calculated the coefficient of variation variable, COUNTY VARIATION, from time-series-yield data for each county. For Nebraska, the data are for 1975–90; for South Dakota, the data are for 1980–90.

[47] Johnson *et al.*, *supra* note 8.

[48] *Id.*

[49] According to Steven Munk, U.S. Department of Agriculture Extension Agent for Minnehaha County in Sioux Falls, South Dakota (conversation with authors, 1990).

[50] U.S. Bureau of the Census, County and City Data Book 1987 (1989).

[51] Nebraska Agricultural Statistical Service, *supra* note 42; and South Dakota Agricultural Statistical Service, *supra* note 42.

APPENDIX B

Definition of Variables

Dependent Variables

CONTRACT	=	1 if contract was a cropshare contract.
ADJUSTMENT	=	1 if cash-rent contract contained a clause adjusting rent for high yields.

Independent Variables

IRRIGATION	=	1 if land is irrigated.
INSTITUTION	=	1 if landowner was an institution (only available for farmer sample).
FAMILY	=	1 if landowner and farmer were related.
HAY	=	1 if alfalfa, brome, or native hay.
ROW	=	1 if row crop (corn, sugar beets, soybeans, sorghum),
	=	0 if not a row crop (wheat, oats, barley).
ROW*HAY	=	ROW × HAY.
AGE	=	1 if the farmer or landowner was less than 25 years old,
	=	2 if 25–34 years old,
	=	3 if 35–44 years old,
	=	4 if 45–54 years old,
	=	5 if 55–65 years old,
	=	6 if older than 65.
DENSITY	=	Population per square mile in the county of farm operation.
ACRES	=	Number of acres covered by contract.
FARM INCOME	=	1 if less than 30 percent of total income comes from farming,
	=	2 if 30–49 percent,
	=	3 if 50–80 percent,
	=	4 if >80 percent.
CAPITAL	=	Percentage of farmed acres that are owned by the farmer.
ABSENT	=	1 if landowner lived in county different from contracted land.
COUNTY VARIATION	=	The coefficient of variation for dryland corn or wheat yield in a county.
CORN, OATS, SOY, . . .	=	1 if corn was the major income-producing crop. Similarly, OATS is 1 if it is the major income-producing crop, and so on.

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