

Land Leasing and Debt on Farms: Substitutes or Complements?

Ralph Bierlen*

U.S. Department of Agriculture, Packers & Stockyard Administration

Larry N. Langemeier

Kansas State University

Bruce L. Ahrendsen

University of Arkansas

Bruce L. Dixon

University of Arkansas

The study follows the methodology of Ang and Peterson (1984) to test the hypothesis that U.S. farms substitute land leasing for debt. Tobit leasing models are fitted with U.S. farm panel data where the leasing ratio is defined as the value of leased land to total assets and the debt ratio as total debt to total assets. Model results indicate that land leasing and debt are substitutes. This result is robust to estimation by OLS and when the leasing ratio is defined as the value of leased land to total land assets and the debt ratio as long-term debt to total land assets. The rate of substitution between land leasing and debt is found to be sensitive to shifting farm business conditions, but not to heterogeneous farm characteristics. When the values of leased land and total debt are normalized by equity, land leasing and debt are found to be complementary

Introduction

Theory indicates that leasing and debt are substitutes (Myers, Dill, and Bautista, 1976; Ross, Westerfield, and Jaffe, 1990). This assumes that a lease payment, which is a

* Ralph Bierlen is an economist in the Grain Inspection, Packers & Stockyards Administration, U.S. Department of Agriculture. Bruce L. Ahrendsen and Bruce L. Dixon are associate professor and professor, respectively, in the Department of Agricultural Economics and Agribusiness at the University of Arkansas. Larry N. Langemeier is an emeritus professor in the Department of Agricultural Economics at Kansas State University. In addition, Professors Ahrendsen and Dixon are principals of the Center for Farm and Rural Business Finance which is jointly sponsored by the University of Arkansas and University of Illinois. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Agreement No. 99-34275-7556. We also recognize the helpful comments made by two anonymous reviewers of the *QJBE*.

fixed obligation like a loan, displaces debt and reduces debt capacity, i.e., if firms have optimal debt to equity ratios, then, to the extent that leasing represents off-balance sheet financing, it reduces debt capacity. The leasing-debt substitution hypothesis has been empirically tested in the corporate finance literature with leasing models fitted with firm-level corporate data. Ang and Peterson (1984)—the seminal work in the literature—fit Tobit models with 1976 through 1981 data from 600 U.S. firms. A leasing-to-book value of equity ratio is the dependent variable, and a debt-to-book value of equity ratio and other variables that control for debt capacity are the explanatory variables. Contrary to theory, model results indicate that leasing and debt are complements. Ang and Peterson suggest that inefficient capital markets, differences in tax brackets between leasing and nonleasing firms, and qualitative differences in the debt issued by leasing and nonleasing firms may be responsible for the complementary leasing-debt relation.

Subsequent studies indicate that Ang and Peterson's conclusions may result from shortcomings in the study. The Compustat data set utilized by Ang and Peterson contains firms from diverse industries and, therefore, with diverse debt capacity. Critics believe that the addition of the non-debt explanatory variables do not adequately control for diverse debt capacities that may explain the complementary relation between debt and leasing. A second criticism is that Ang and Peterson fail to include operating leases, focusing exclusively on capital leases. Graham, Lemmon, and Schallheim (1998) indicate that this may be a serious omission. Their 1981-1992 Compustat data set indicates that operating leases were present in 99.9 percent of firm-year observations, while capital leases were present in only 52.6 percent of firm-year observations. Similarly, for the same sample, operating leases accounted for 8.0 percent of firm assets, on average, while capital leases accounted for just 1.6 percent. Finally, Ang and Peterson use debt and leasing to equity ratios while other studies normalize debt and leasing with total assets. Results may be sensitive to normalization, especially when a substantial portion of total assets comprises leasing and debt.

Several studies seek to remedy the problems associated with Ang and Peterson's study. Finucane (1988) normalizes leasing and debt with total assets. Marston and Harris (1988), who examine changes in leasing and debt rather than levels, include both capital and operating leases and normalize leasing and debt with total assets. Erickson (1993) includes capital and operating leases and accounts for differences in debt capacity with industry dummy variables. Adams and Hardwick (1998) use a 1994 U.K. cross-sectional data set and, like Marston and Harris, they define leasing to include both operating and financial leases while leasing and debt are normalized by total fixed assets. Finucane and Adams and Hardwick find leasing and debt to be complements, as did Ang and Peterson, while Marston and Harris, and Erickson conclude that leasing and debt are substitutes.

The current study further examines the leasing puzzle by examining the substitution of agricultural land leasing for debt on noncorporate U.S. commercial farms. Farms are interesting examples to study the leasing-debt substitution question because they represent the vast number of small privately-held firms, a group which has been ignored

in the literature—possibly due to a lack of data. In numbers, farms lead all other types of firms and they lease at high levels. In 1997 there were 1.9 million U.S. farms, and 43 percent of agricultural acreage was leased (USDA, NASS, 1997). The high incidence of land leasing on U.S. farms is consistent with farms being capital-intensive, credit-constrained (Sharpe and Nguyen, 1995), and under pressure to expand due to ever-increasing economies of scale. Unlike large corporations, the dependency of U.S. farms on leasing increases with total assets. Over two-thirds of leased land is found on farms with 1000 or more operating acres (USDA, NASS, 1997).

The current study remedies several of the shortcomings found in Ang and Peterson. By focusing on a single industry—U.S. production agriculture—in a single state, the problem of divergent debt capacities should be greatly reduced. To further account for divergent debt capacity, the models are estimated with farm type dummy variables, following Erickson. The study accounts for the bulk of farm leasing activity: land leasing. A second form of leasing—equipment and machinery capital leases—is relatively unimportant. To determine if the results are sensitive to normalization, leasing and debt are normalized by both total assets and equity. In a departure from previous complementarity versus substitution studies, we look for evidence that leasing-debt substitution is sensitive to heterogeneous business conditions and firm characteristics.

U.S. Agricultural Land Leasing

Noncorporate farm assets consist of inside equity, debt-financed assets, and leased land. In the aggregate, inside equity accounts for 49.9 percent of total assets, debt-financed assets 15.1 percent, and leased land 35.0 percent (estimated by authors with USDA data). Although agricultural land leasing is pervasive throughout the United States, it reaches its highest levels in locations where commercial farms predominate and land is highly valued. In such production areas as the Mississippi Delta, Iowa, Illinois, and California, leasing accounts for more than 50 percent of total farmland.

Agricultural land leases are operating or true leases, which are more distinct from debt than capital leases. An interesting facet of agricultural land leases is that they are used to acquire the use of long-term or capital assets. Leases are frequently oral and, when written, are simple one or two page documents (Allen and Lueck, 1992). Leases are typically one-year agreements subject to automatic renewal unless one party notifies the other in the fall of the year that they do not wish to renew the lease for the following year. Some leases are multi-year, but seldom exceed five years. In practice, however, a series of annual leases are the basis for a long-term commitment. Relations between landlord and tenant of 30 years or beyond are not uncommon. In a recent Arkansas survey tenants were found to have initiated their leases an average of 13.3 years ago (Bierlen *et al.*, 1999). Similar ongoing lease lengths were found in Nebraska and South Dakota (Johnson *et al.*, undated), and Michigan (Gwilliam, 1993).

Detailed long-term leases are unnecessary due to extensive common law on agricultural land leases, the importance of tenant reputation, landlord-tenant social capital, and the general absence of appropriable quasi-rents (Allen and Lueck, 1992). Reputation enforcement is most effective where information about cheating is good and

long-term relationships are desired. These conditions are frequently met in agricultural leasing situations, and a landlord is able to discipline a wayward tenant through the annual renewal or repeated dealings process. Lubricating the leasing process is tenant-landlord social capital. The Arkansas survey found that tenants and landlords were either relatives, close friends, or acquaintances at the time leases were first entered into in 92 percent of leases. The Michigan survey found that tenants and landlords were either relatives or friends in 84 percent of leases.

In return for use of the land, the tenant gives the landlord a fixed cash payment or a share of the crop. In some crop-share leases, the landlord also pays a share of the operating costs, typically in the same proportion as his or her share of the crop. In cash rent leases, payments are adjusted to reflect the expected future flow of net revenues and thus the value of land. Because the landlord's payment is a function of the market price in share leases, it automatically adjusts to reflect market conditions (Scott and Reiss, 1969).

Ang and Peterson's Model

Following the literature, the relation between the leasing and debt ratios is defined as:

$$(1) DR_o = DR_i + \alpha LR_i$$

where:

DR_o = Debt to total asset ratio of a farm that owns all of its land;

DR_i = Debt to total asset ratio;

LR_i = Leasing to total asset ratio of a similar farm that leases some or all of its land;
and

α = Extent to which leasing substitutes for (or complements) debt or the leasing to debt displacement ratio.

If leasing substitutes for debt dollar-for-dollar, the testable hypothesis is that the displacement ratio is equal to one. Klein, Crawford, and Alchian (1978) indicate that leased assets are riskier than owned assets—increasing bankruptcy and liquidity costs—thus pushing the displacement ratio beyond one. Similarly, the displacement ratio should be positive, but less than one, when leased assets are less risky than owned assets. A negative debt to lease displacement ratio indicates that leasing and debt are complementary.

There are several reasons why leasing is thought to be less risky than purchasing and financing land, i.e., a displacement ratio less than one is expected. A land operating lease is less contractual in nature than a mortgage. Most leases are verbal and can be canceled in the fall of the year. Another risk advantage of leasing is that the cost of leasing adjusts to market conditions while the cost of purchased land is fixed at the time of purchase. Finally, farmers with substantial long-term debt run the risk of suffering from debt depreciation and bankruptcy because the U.S. agricultural economy is susceptible to periodic bouts of depressed commodity and land prices. During these

periods, farmers find themselves in positions where shrinking equity makes their debt more burdensome and new borrowing may be difficult to obtain.

The primary reason why leases may be more risky than borrowing and owning is that an important goal of U.S. commercial farmers is to run their machinery over as much land as possible in order to keep average production costs low. The loss of a lease and the inability to replace it with a comparable lease will increase average production costs and thus the ability to service existing loans. This is not a concern with purchased land.

Tobit Leasing Model and Kansas Data

Equation (1) can be rewritten as.

$$(2) DR_0 = DR_1 + \alpha LR_1 = f(x_1, x_2, \dots, x_k),$$

where:

$f(\cdot)$ = A function of lessee explanatory variables that control for debt capacity.

Ignoring the DR_0 term (which is unknown), subtracting DR_1 from both sides, and dividing by α results in the general form of the estimable model of interest:

$$(3) LR_1 = -(1/\alpha)DR_1 + (1/\alpha)f(x_1, x_2, \dots, x_k).$$

Equation (3) is a nonstructural model developed by Ang and Peterson and used in subsequent leasing-debt substitution studies.

Relying on past studies with appropriate changes for agriculture and following equation (3), the actual econometric model to be estimated for farm i at time t is:

$$(4) LR_{it} = \gamma_1 DR_{it} + \gamma_2 SIZE_{it} + \gamma_3 AGE_{it} + \gamma_4 OFFINC_{it} + \gamma_5 PROFIT_{it} + \gamma_6 LIQUIDITY_{it} + \delta_i + \epsilon_{it}$$

where:

LR = Beginning period leasing to total asset ratio;

DR = Beginning period debt to total asset ratio;

$SIZE$ = Beginning period value of total assets;

AGE = Beginning period age of the principal operator;

$OFFINC$ = Previous period off-farm income to total asset ratio;

$PROFIT$ = Rate of return on capital assets in the previous year;

$LIQUIDITY$ = Beginning period current ratio; and

δ_i = A dummy variable to capture fixed effects for farm type i .¹

$SIZE$, AGE , $OFFINC$, $PROFIT$, $LIQUIDITY$, and δ_i are included in the model to control for debt capacity.

The data consist of 417 Kansas farms that were continuously enrolled in the Kansas Farm Management Association (KFMA) program from 1977 through 1992.² A 1986

¹There are 14 farm types. These include dryland cash crop, irrigated cash crop, cow-calf herd, laying hen, dairy, cattle backgrounding, cattle finishing, cash crop/cattle backgrounding, hog production, cash crop/cows-sheep, general farm, cash crop/hog production, cash crop/cattle finishing, and cattle finishing/hog production.

²See Langemeier (1990) for a description of the raw KFMA farm variables.

comparison between KFMA farms and all Kansas farms indicated that the mean KFMA farm had 86 percent more assets than the mean Kansas farm (Featherstone, Griebel, and Langemeier, 1992). Because of the relatively large size of KFMA farms, the results of this study are considered to be representative of commercial or full-time operator farms. Steps taken to insure that KFMA data are complete and accurate include: operators record events as they occur and not retrospectively, the use of standardized forms and accounting procedures, and supervision and review of the process by KFMA staff.

Classified according to dominant activities, the 417 farms are composed of 203 cash crop, 134 mixed crop/livestock, 25 dairy, 25 livestock, and 30 general farms.³ About 75 percent of farms have both crop and livestock enterprises, 18 percent have exclusively crop enterprises, and 7 percent have exclusively livestock enterprises. Eight farms are dropped from the sample because of low inside equity levels, leaving 409 farms in the sample.

Leasing and debt ratio means are presented in Table 1 for 1992. Leasing and debt are normalized by total assets, total land assets, and equity.⁴ On the bottom of Table 1, the annual means of leasing and debt normalized by total assets are reported.

Unlike Compustat firms, the preponderance of the Kansas farms leased agricultural land. In 1992 land was leased by 356 of 409 farms (87 percent). Leased land was an important component of the typical asset portfolio, accounting for 35 percent of total assets and 49 percent of land assets. As expected, because of their land intensity, the mean leasing to total asset ratio is the highest for crop farms at 0.386. Livestock farms have the lowest mean leasing to total asset ratio at 0.258. The mean debt to total asset ratio is 0.156, and the mean long-term debt to total land assets is 0.110.

The means of the leasing and debt to total asset ratios and the means of the leasing and long-term debt to total land asset ratios by leasing quartiles indicate that leasing and debt are substitutes.⁵ While the mean leasing to total asset ratio increases monotonically from 0.049 in the first quartile to 0.660 in the fourth quartile, the mean debt to total asset ratio monotonically falls from 0.202 in the second quartile to 0.119 in the fourth quartile.⁶ The mean leasing and debt to equity ratios both increase in moving from the first to fourth quartiles, however, indicating a complementary relationship when leasing and debt are normalized by equity.

³In specialty farms at least 70 percent of labor is utilized in that specialty area. In crop/livestock farms at least 35 percent of labor is used in livestock production and 35 percent in crop production. General farms do not fit either of these two criteria.

⁴Total assets refers to the sum of inside equity, debt, and the market value of leased land.

⁵The quartiles in the total assets section are based on the leasing to total asset ratio and in the land assets section on the leasing to total land assets ratio.

⁶The first quartile mean debt to total asset ratio, 0.150, is actually smaller than those of the second and third quartile.

Table 1—1992 Lease and Debt Ratio Means

	All Farms		Non-Leasing Farms		1st Leasing Quartile		2nd Leasing Quartile		3rd Leasing Quartile		4th Leasing Quartile		Crop Farms		Dairy Farms		Livestock Farms	
	Farms	Leasing Farms	Farms	Leasing Farms	Quartile	Quartile	Quartile	Quartile	Quartile	Quartile	Quartile	Quartile	Farms	Farms	Farms	Farms	Farms	Farms
Panel A. 1992 Ratio Means Normalized by Total and Land Assets																		
Leasing/Total Assets	0.345	0	0	0.399	0.049	0.248	0.428	0.660	0.386	0.279	0.258							
Debt/Total Assets	0.156	0.154	0	0.157	0.150	0.202	0.155	0.119	0.141	0.202	0.198							
Leasing/Land Assets	0.493	0	0	0.567	0.084	0.404	0.626	0.856	0.515	0.556	0.471							
Long-Term Debt/Land Assets	0.110	0.147	0	0.104	0.136	0.138	0.108	0.057	0.098	0.123	0.118							
N	409	53	53	356	102	102	102	103	242	21	21							
Panel B. 1992 Ratio Means Normalized by Inside Equity																		
Leasing/Equity	1.508	0	0	1.730	0.074	0.507	1.109	4.311	1.873	1.553	0.736							
Debt/Equity	0.532	0.184	0	0.583	0.269	0.510	0.482	0.861	0.545	0.928	0.388							
N	397	51	51	346	99	99	99	100	237	20	20							
Panel C. Annual																		
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992		
Leasing/Total Assets	0.41	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.39	0.39	0.37	0.38	0.38	0.37	0.35	0.35		
Debt/Total Assets	0.16	0.16	0.15	0.14	0.15	0.15	0.16	0.16	0.19	0.20	0.20	0.17	0.17	0.16	0.16	0.16		

Notes: In the 'total assets' section the quartiles refer to the leasing to total assets ratio and in the 'land assets' section the leasing to total land assets ratio. For the inside equity estimates 12 farms are dropped because they have equity levels below \$25,000.

The mean leasing and debt to total asset ratios are time variant. From 1977 to 1984 the mean leasing to total asset ratio remained stable at roughly 0.41. From 1984 to 1992 the leasing to total asset ratio fell from 0.41 to 0.35. The debt to total asset ratio was stable around 0.16, except for 1985 through 1987 when it increased to around 0.20.

Selected variable means and standard deviations for 1992 are reported in Table 2 for the 409 KFMA farms. The full sample mean farm had \$687,000 of owned assets, \$386,000 of leased land, and \$1,073,000 and of total assets. The mean debt to owned asset ratio was 0.267, while the debt to total asset ratio was 0.156. The mean operator was 60 years old—reflecting the older U.S. farm population. Mean returns to capital assets were 0.188.⁷

There are a number of statistically significant differences at the 0.05 and 0.01 levels among the means of farm characteristics as evident in Table 2. Leasing ratios, total assets and owned assets have differing means for three of the four characteristics. Low equity, crop farms, and young operators have significantly higher leasing ratios than their respective counterparts. The greatest number of differing means occurs between low equity and high equity farms and between young and old operators. The mean large farm has nearly three times the total and owned assets of the mean small farm, \$1.691 million versus \$612 thousand and \$1.088 million versus \$412 thousand, respectively. Only 76.3 percent of old operators leased any land, whereas a significantly higher percentage of young farmers, 96.3 percent, leased land.

The two groups with the largest number of significant differences—high versus low equity and old versus young farmers—have varying patterns of divergence. Both have significant differences in lease ratios but the age split shows the difference in mean debt ratios to be larger. In contrast, the equity split shows a much greater divergence in total assets and owned assets between high equity and low equity farms.

Model Results

Because of the potential bias associated with the censoring of the leasing ratio, models are estimated with the Tobit procedure in which the lower bound is set at zero and the upper bound at one.⁸ Models estimated with panel data (both time-series and cross-sectional components) may be inefficient due to autocorrelation and heteroskedasticity. To avoid potential autocorrelation and the restriction that the displacement ratio be constant across time, models are estimated for each year of the 1977-92 period. Tobit models that did not account for heteroskedasticity and Tobit

⁷The returns to capital assets do not reflect an opportunity cost for the farmer's unpaid labor and management, thus the true returns to capital assets are lower.

⁸When leasing is normalized by total assets all leasing ratios remain below 0.9 because of inside equity and debt. However, when leasing is normalized by total land assets several farms hit the upper bound because they lease all of their land. When leasing is normalized by equity, there is no upper bound because equity can vary from 100 percent of total assets to less than five percent. The lower bound, however, is meaningful for all normalizations.

Table 2---1992 Variable Means and Standard Deviations

	Full Sample	Low Equity	High Equity	Small Farms	Large Farms	Crop Farms	Livestock Farms	Young Operators	Old Operators
Lease Ratio	0.347 (0.236)	0.446** (0.245)	0.260** (0.205)	0.318 (0.232)	0.354 (0.241)	0.387* (0.265)	0.324* (0.208)	0.409** (0.214)	0.302** (0.249)
Percent Leasing	87.0 (23.6)	89.7 (30.5)	83.8 (37.0)	83.1 (37.6)	89.7 (30.5)	86.8 (34.0)	88.2 (32.3)	96.3** (19.0)	76.3** (42.7)
Debt/Total Assets	0.156 (0.167)	0.167 (0.179)	0.153 (0.167)	0.146 (0.173)	0.160 (0.161)	0.145 (0.166)	0.182 (0.164)	0.192** (0.154)	0.108** (0.149)
Debt/Owned Assets	0.267 (0.278)	0.334** (0.308)	0.226** (0.260)	0.223 (0.232)	0.273 (0.270)	0.265 (0.284)	0.305 (0.274)	0.340** (0.251)	0.184** (0.260)
Operator Age	60.0 (9.9)	57.6** (9.4)	60.8** (10.9)	59.6 (9.8)	60.0 (10.6)	60.2 (10.8)	61.2 (9.5)	52.8** (5.2)	65.6** (12.3)
Total Assets	1073.0 (753.7)	790.5** (489.4)	1485.3** (860.9)	612.1** (322.2)	1690.5** (875.2)	1032.9 (747.9)	1155.8 (854.3)	1191.0** (811.0)	947.0** (645.3)
Owned Assets	686.6 (547.3)	411.1** (347.8)	1061.5** (617.5)	412.3** (223.8)	1087.6** (697.6)	612.9* (512.5)	766.9* (648.0)	697.6 (566.8)	638.4 (476.0)
Livestock Inventories/Total Inventories	0.344 (0.316)	0.323 (0.313)	0.361 (0.316)	0.320 (0.303)	0.356 (0.320)	0.108** (0.201)	0.549** (0.294)	0.350 (0.303)	0.319 (0.338)
Net Income/Capital Assets	0.188 (0.189)	0.234** (0.233)	0.150** (0.153)	0.177 (0.134)	0.193 (0.194)	0.224* (0.204)	0.174* (0.217)	0.168 (0.112)	0.182 (0.191)
Current Ratio	0.781 (1.59)	0.752 (1.322)	0.645 (1.537)	0.739 (1.61)	0.737 (1.59)	0.869 (1.835)	0.765 (1.258)	0.939 (1.518)	0.652 (1.804)
N	409	136	136	136	136	136	136	135	139

Notes: The lease ratio is the market value of leased land to total assets. Dollar amounts are in thousands of 1992 dollars. See the appendix for sample split criteria.

** denotes a significant difference at 0.01 on a two-sided test for a given pair of means.

* denotes significance at 0.05.

Except for the Percent Leasing category, we test the difference between means with a standard difference of means test in which the t-values are obtained by the difference of the two estimated means divided by the square root of the sum of the means' variances less twice their covariance. See Gujarati (1988, p. 227) for details. Because the farms can be thought of as 114 samples from a larger population of farms, we expect the error terms to be uncorrelated between the two samples so that the estimated covariance is restricted to be zero. The proportions (Percent Leasing) are tested as in Freund and Williams (1982, p. 370).

models that accounted for heteroskedasticity with the multiplicative heteroskedasticity approach of Harvey (1976) are estimated for each year. Likelihood ratio tests indicate that heteroskedasticity is not significant in any year. Thus, the annual models are estimated without adjusting for heteroskedasticity. To further establish the robustness of results, models are estimated with leasing and debt normalized by both total assets and equity. Finally, all models are estimated with both Tobit and OLS. OLS results are virtually identical to Tobit results and are not reported here. This result is not surprising, given the small percentage of censored observations.⁹

Table 3 reports α , the estimated leasing to debt displacement ratio, and the Tobit coefficient estimates of the control variables. The market value of leased land and total debt are normalized by total assets. Two-sided p-values associated with the coefficients are reported in parentheses. The farm type dummy coefficient estimates are not reported due to space considerations and lack of economic interpretation.

The displacement ratios are all positive and highly significant, supporting the hypothesis that leasing and debt are substitutes. That the displacement estimates are greater than one is consistent with the notion that lenders consider land leasing to be riskier than owning assets and borrowing because average production costs per acre may increase sharply and loans may become more difficult to service should producers be unable to renew land leases.

The signs and magnitudes of the coefficient estimates associated with the control variables are generally robust over the 16-year period. The coefficient estimates on AGF are negative and highly significant, which supports the life cycle theory that farmers lease relatively less land as they age. The SIZE coefficient estimates are positive and highly significant, which indicates that leasing plays a key role in increasing the size of productive assets. This finding is contrary to Branson (1995) and Erickson who find that leasing is inversely related to the size of the firm. The signs on the total assets coefficients in Ang and Peterson's models are not consistent, but are negative when the coefficient estimates are statistically significant. The OFFINC coefficient estimates are negative and generally significant. This supports the hypothesis that farms with higher off-farm income levels use off-farm income to finance land purchases and/or that lenders are more willing to lend to farms with higher off-farm income levels. The PROFIT and LIQUIDITY estimates are positive and significant. The positive coefficient estimates are consistent with the hypothesis that operators choose to lease because, ignoring capital gains, cash flow and returns to capital are thought to be higher with leasing than borrowing and purchasing (Barry, Bierlen, and

⁹There is some concern that the models may suffer from multicollinearity. DR, AGE, and SIZE are most likely to be multicollinear. To detect multicollinearity, simple pairwise correlation coefficients were estimated among the three variables for each year. Although several correlation coefficients were significant at the five percent level, only a few exceeded 0.20 in absolute value, with the largest coefficient being 0.26. Based on this evidence, we concluded that multicollinearity was not a serious problem.

Table 3 -----1977-92 Annual Tobit Coefficient Estimates with Leasing and Debt Normalized by Total Assets

Year	α	AGE	SIZE	OFFINC	PROFIT	LIQUID	N	Censored
1977	1.1433 (0.0001)	-0.0075 (0.0001)	7.44e-8 (0.0234)	-9.0603 (0.0001)	0.0723 (0.0165)	0.0362 (0.0001)	409	28
1978	2.0725 (0.0001)	-0.0056 (0.0001)	5.51e-8 (0.0408)	-9.4153 (0.0001)	0.6311 (0.0001)	0.0235 (0.0410)	409	21
1979	1.4550 (0.0001)	-0.0056 (0.0001)	5.51e-8 (0.0222)	-9.6204 (0.0001)	0.4612 (0.0001)	0.0408 (0.0004)	409	21
1980	1.6147 (0.0001)	-0.0040 (0.0004)	9.62e-8 (0.0001)	-1.0386 (0.1831)	0.6144 (0.0001)	0.0349 (0.0014)	409	27
1981	1.4620 (0.0001)	-0.0051 (0.0001)	7.15e-8 (0.0053)	-1.3295 (0.0219)	0.4747 (0.0001)	0.0209 (0.0123)	409	22
1982	1.6570 (0.0001)	-0.0057 (0.0001)	1.01e-7 (0.0003)	0.4717 (0.5185)	0.2753 (0.0001)	0.0204 (0.0057)	409	23
1983	2.6724 (0.0001)	-0.0052 (0.0001)	8.53e-8 (0.0067)	-0.4535 (0.4016)	0.3451 (0.0001)	0.0077 (0.2635)	409	28
1984	2.4290 (0.0001)	-0.0053 (0.0001)	7.85e-8 (0.0113)	-1.9548 (0.0024)	0.6316 (0.0001)	0.0047 (0.4506)	409	27
1985	3.4554 (0.0001)	-0.0051 (0.0001)	1.15e-7 (0.0023)	-1.6685 (0.0001)	0.4199 (0.0001)	0.0083 (0.1213)	409	30
1986	3.2680 (0.0001)	-0.0059 (0.0001)	1.24e-7 (0.0047)	-1.3156 (0.0023)	0.2878 (0.0001)	0.0176 (0.0054)	409	31
1987	3.5486 (0.0001)	-0.0063 (0.0001)	1.60e-7 (0.0016)	-1.1080 (0.0038)	0.1397 (0.0001)	0.0154 (0.0209)	409	35
1988	2.6961 (0.0001)	-0.0063 (0.0001)	1.33e-7 (0.0025)	-0.3642 (0.3405)	0.2385 (0.0001)	0.0228 (0.1005)	409	33
1989	3.3222 (0.0001)	-0.0052 (0.0001)	1.74e-7 (0.0001)	-0.2653 (0.2503)	0.3473 (0.0001)	0.0275 (0.0016)	409	34
1990	2.6681 (0.0001)	-0.0064 (0.0001)	1.36e-7 (0.0017)	-0.9958 (0.0040)	0.4215 (0.0001)	0.0299 (0.0002)	409	39
1991	3.1566 (0.0001)	-0.0078 (0.0001)	1.09e-7 (0.0123)	-1.0289 (0.0060)	0.3579 (0.0001)	0.0178 (0.0100)	409	48
1992	3.5817 (0.0005)	-0.0069 (0.0001)	1.29e-7 (0.0027)	-0.3994 (0.1559)	0.4277 (0.0001)	0.0210 (0.0103)	409	53

Notes The dependent variable is the ratio of the market value of leased land to the market value of total assets DR is the ratio of total debt to the market value of total assets The leasing to debt displacement ratio, α , is estimated from the model coefficient on DR, $-1/\alpha$ The estimated asymptotic standard error of α is α^2 multiplied by the standard error of the estimated $-1/\alpha$, i.e., this is derived via Theorem 4.17 in Greene (2000) All models are estimated with firm type dummy variables Two-sided p values are in parentheses See the appendix for other variable definitions

Sotomayor, 2000). The positive coefficient estimates on PROFIT are inconsistent with Ang and Peterson, and Branson, who find higher levels of leasing to be associated with lower profitability levels. The positive coefficient estimates on LIQUID are consistent with the findings of Ang and Peterson, but contrary to Branson.

Following Ang and Peterson, leasing and total debt are normalized by equity to determine if the displacement ratio coefficient estimate is robust to this change. *A priori* we expect the results to be more sensitive to this change than those of corporate studies. Commercial farms tend to be more highly leveraged and lease at higher levels than U.S. corporations, thus the gap between total assets and equity is substantially larger. Table 1 indicates that, on average, debt and leasing comprise just over 50 percent of total assets and equity just under 50 percent. In a panel of about 550 U.S. corporations from 1983 through 1988, Branson indicates that equity accounts for about 70 percent to 75 percent of total assets. Because leasing and debt are so important to the sample of farms [the debt ratio declines as the leasing ratio increases when normalized by total assets, but both increase when normalized by equity (Table 1)], a complementary relation is expected when debt and leasing are normalized by equity.

Annual 1977-92 displacement ratio estimates and Tobit control coefficient estimates with leasing and debt normalized by equity are reported in Table 4. All displacement ratio coefficient estimates are negative and highly significant, indicating that leasing and debt are complements and that the displacement ratio is sensitive to normalization. There is no indication that corporate studies would be sensitive to this normalization, given that the gap between total assets and equity are lower for large corporations. While Ang and Peterson normalize by equity and find leasing and debt to be complements; Finucane and Adams and Hardwick also find a complementary relation although they normalize by total assets. Marston and Harris and Erickson normalize by total assets and find that leasing and debt are substitutes.

The control coefficient estimates are also not robust between the two normalizations. The signs on AGE remain negative, but most of the coefficient estimates are no longer significant. The coefficient estimate on SIZE is now negative and is significant for all but two of the years. The OFFINC coefficient estimate shifts from negative to positive and remains significant in most years. The coefficient estimates on PROFIT remain positive and significant, but increase in magnitude by a factor of about ten. The coefficient estimates on LIQUID switch from positive to negative, but generally are not significant.

Because capital leases—the focus of many previous studies—are used to control capital or long-term assets, many studies focus on long-term debt and total capital assets. We re-estimate the model with debt defined as long-term debt and leasing and debt normalized by total land assets—the primary long-term assets.¹⁰ The only other

¹⁰ We also estimate models with the debt ratio defined as short-term debt to total assets, and short- and medium-term debt to total assets. Although the displacement ratio is positive in all but one year, half of the displacement ratios are not significant at the 0.05 level. These results indicate that although land leases are operating leases, they substitute for long-term debt, because the asset in question, land, is a capital asset.

Table 4—1977-92 Annual Tobit Coefficient Estimates with Leasing and Debt Normalized by Inside Equity

Year	α	AGE	SIZE	OFFICE	PROFIT	LIQUID	N	Censored
1977	-0.6215 (0.0001)	0.0141 (0.3629)	-2.92e-6 (0.0002)	40.5992 (0.0001)	1.3996 (0.0002)	-0.1759 (0.1029)	403	28
1978	-0.6938 (0.0001)	0.0061 (0.5718)	-1.83e-6 (0.0005)	20.9166 (0.0022)	4.6331 (0.0001)	-0.0843 (0.4604)	406	21
1979	-0.6291 (0.0001)	-0.0059 (0.5534)	-1.95e-6 (0.0001)	20.5671 (0.0008)	3.3826 (0.0001)	-0.0848 (0.4952)	408	21
1980	-0.7860 (0.0001)	0.0092 (0.3408)	-1.90e-6 (0.0001)	12.4368 (0.0001)	5.8836 (0.0001)	-0.2456 (0.0072)	408	27
1981	-0.6024 (0.0001)	0.0034 (0.7994)	-2.42e-6 (0.0001)	11.2471 (0.0001)	3.4003 (0.0001)	0.0281 (0.7726)	406	22
1982	-0.4951 (0.0001)	0.0106 (0.4293)	-2.77e-6 (0.0001)	3.8909 (0.0298)	1.2832 (0.0246)	-0.1410 (0.0869)	406	23
1983	-0.5301 (0.0001)	-0.0021 (0.8746)	-1.97e-6 (0.0009)	6.47726 (0.0003)	4.6030 (0.0001)	-0.1110 (0.1389)	399	28
1984	-0.6494 (0.0001)	0.0121 (0.3742)	1.90e-6 (0.0049)	8.7161 (0.0001)	8.0464 (0.0001)	-0.0410 (0.7505)	401	27
1985	-2.3164 (0.0001)	-0.0253 (0.0484)	-2.43e-6 (0.0019)	16.4737 (0.0001)	4.0404 (0.0001)	-0.1397 (0.0263)	391	30
1986	-1.0857 (0.0001)	-0.0072 (0.5786)	-2.34e-6 (0.0122)	4.2484 (0.0014)	5.0533 (0.0001)	-0.1476 (0.0593)	387	31
1987	-1.4241 (0.0001)	-0.0108 (0.3599)	-3.13e-6 (0.0004)	3.2237 (0.0056)	0.9736 (0.0007)	-0.2211 (0.0023)	385	34
1988	-1.1740 (0.0001)	-0.0039 (0.7105)	-2.96e-7 (0.0001)	0.3904 (0.7546)	1.8820 (0.0001)	-0.1423 (0.1215)	391	31
1989	-0.7251 (0.0001)	0.0111 (0.3584)	-8.56e-6 (0.2798)	2.6814 (0.0264)	5.2306 (0.0001)	0.0332 (0.7296)	387	32
1990	-0.9235 (0.0001)	-0.0064 (0.6508)	-2.81e-6 (0.0025)	8.1451 (0.0001)	2.8591 (0.0004)	-0.3602 (0.0014)	392	38
1991	-1.4031 (0.0001)	-0.0230 (0.0539)	-0.0230 (0.0230)	5.8970 (0.0001)	2.9212 (0.0001)	-0.0629 (0.3654)	394	45
1992	-0.5669 (0.0001)	0.0028 (0.8180)	-1.36e-6 (0.0647)	0.9570 (0.3569)	4.9408 (0.0001)	-0.2328 (0.0045)	397	51

Notes: The dependent variable is the ratio of the market value of leased land to the market value of equity. DR is the ratio of total debt to the market value of equity. The displacement ratio, α , is estimated from the model coefficient on DR, $-1/\alpha$. The estimated standard error of α is α multiplied by the standard error of the estimated $-1/\alpha$. e , this is derived via Theorem 4.17 in Greene (2000). All models are estimated with farm type dummy variables. Two-sided p-values are in parentheses. A dozen farms are dropped because of low or negative equity levels. See the appendix for other variable definitions.

long-term assets are buildings, but these are relatively unimportant relative to land. The model results, not reported here due to lack of space, remain robust to this change in the definition of the leasing and debt ratios. Most importantly, the displacement ratio estimates remained positive, significant, and of similar magnitudes to those in Table 3.

Model Results by Farm Business Regimes and Farm Characteristics

Farm Business Regimes

We now seek to determine whether the displacement ratio is sensitive to divergent business regimes and farm characteristics. In the last century U.S. agriculture suffered from three bouts of debt depreciation: 1920-39, 1981-86, and 1998 to the current period. Conveniently, there are three distinct farm business periods in the 1977-92 Kansas data set. Led by high commodity prices, agriculture boomed from 1973 through 1980, resulting in higher levels of sales, returns, and land prices. Lower commodity export demand coupled with higher production levels and interest payments as a result of higher debt levels and interest rates caused returns and land prices to decline in the early 1980s (the bust period). Falling land prices and higher interest rates led to higher debt-to-asset ratios, debt depreciation, asset disinvestment, farm foreclosures, and bank failures. The farm crisis began a period of more restrained lending practices as well as a shift to more conservative managerial practices (Peoples *et al.*, 1992; Bultena, Lesley, and Geller, 1986). A farm recovery began in 1987 due to rising commodity prices. Stabilized asset values and improved cash flow allowed farms to reduce their debt to asset ratios as they continued to pay down debt.

The relevant question is how shifting farm business conditions changed the relative riskiness of leasing relative to borrowing and purchasing. A major impact of business conditions is their influence on farm balance sheets, in particular the appreciation or depreciation of land values and the impact of this on farm equity. During boom periods we hypothesize that the risk of leasing increases relative to borrowing and owning because the market is rewarding ownership with rapidly appreciating land prices while leasing costs increase with commodity prices and land values. On the contrary, during bust periods we hypothesize that the risk of leasing decreases relative to borrowing and purchasing because the market punishes ownership with rapidly depreciating land prices while leasing costs decline with commodity prices and land values. Thus, *a priori* it is expected that the displacement ratios will be higher in the years prior to 1981 than those following 1980.

As indicated in Table 3, the displacement ratio coefficient estimates are contrary to the expected pattern. The magnitudes of the displacement ratio coefficient estimates tend to increase throughout the period. From 1977 through 1980 (boom), three of the four displacement coefficient estimates are less than 1.62. The 1978 coefficient estimate is 2.07. From 1981 through 1986 (bust) the coefficient estimates begin to markedly increase. While the 1981 and 1982 coefficient estimates are less than 1.66, the 1985 and 1986 coefficient estimates are greater than 3.26. All of the 1987 through 1992

(recovery) coefficient estimates are greater than 2.66 with four years in excess of 3.15. When testing the displacement ratio coefficient estimate means for the three periods, we find that the 1987-92 and 1981-86 means are both significantly greater than the 1977-80 mean at the 0.05 level. The 1987-92 mean is significantly greater than the 1981-86 mean at 0.06 on a one-sided test.¹¹

These results may be explained by equation (1). During periods of debt depreciation those farms with high levels of purchased and mortgaged land are hit hardest. Therefore, we would expect DR_0 to increase faster than DR_1 and for LR_1 to remain relatively stable because both the numerator and denominator are largely composed of the value of land. In order to maintain a constant displacement ratio, the farmer should increase leasing levels. Given that there is a fixed supply of leased land within a relatively close distance to each farm and that the turnover rate on leased land is low, the displacement coefficient will necessarily have to increase.

Farm Characteristics

In search of evidence that the displacement ratio coefficient estimate is sensitive to divergent farm characteristics, the Kansas farms are split by owned equity, total assets, the importance of livestock, and the age of the principal farm operator. Farms are first ordered by their pre-sample 1976 levels of the four cross-sectional criteria. In order to increase the diversity between the two groupings, following Bierlen *et al.* (1998), the middle one-third of the farms are deleted and annual models for the upper and lower one-third of the farms using 1977 to 1992 data are estimated. Equal sample sizes are used to avoid potential bias associated with sample size.

Annual displacement ratio coefficient estimates, estimated with the use of Tobit, are reported in Table 5 by sample splits. Leasing and total debt are normalized by total assets. Due to lack of space the control coefficient estimates are not reported here, but they are similar to the full sample models. Consistent with the full sample results, all displacement coefficient estimates are positive, larger than one except for 1977 livestock, and generally significant at the 0.05 level or higher. This indicates that the leasing-debt substitution relationship holds across farms with heterogeneous characteristics. Although many displacement coefficient estimates appear larger than their counterparts, only high equity in 1979 and crop farms in 1977 are statistically larger than their counterpart. This result indicates that the displacement coefficient estimate shows little sensitivity to divergent farm characteristics.

Concluding Remarks

Theoretically, leasing and debt are thought to be substitutes. This assumes that a lease payment, which is a fixed obligation like a loan, displaces debt and reduces debt capacity, i.e., if firms have optimal debt to equity ratios, then, to the extent that it rep-

¹¹The means of the displacement ratio coefficients are computed for each interval (1977-80, 1981-86, and 1987-92) and then t-tests are used to test for significant differences among the three means.

Table 5—1977-92 α Estimates by Farms with Heterogeneous Farm Characteristics

Year	Low Equity	High Equity	Low Assets	High Assets	Crop Farms	Livestock Farms	Young Operators	Old Operators
1977	1.0569**	1.8706**	1.4510**	1.2401**	2.1552**	0.9381**	1.0815**	1.7655**
1978	1.1700**	2.7078*	1.8208**	1.8990**	2.1313**	1.8765**	1.3428**	7.5988
1979	1.0347**	4.4217**	1.1929**	1.5686**	1.2323**	1.5060**	1.2362**	2.4260*
1980	1.2231**	1.5793**	1.6829**	1.1893**	2.3196**	1.3959**	1.2324**	2.6645
1981	1.1154**	1.9414**	1.3837**	1.2209**	2.2883**	1.2610**	1.1467**	1.6485**
1982	1.2698**	1.7658**	1.7624**	1.2433**	1.9924**	1.4538**	1.1825**	2.2553*
1983	1.7126**	2.4073**	2.9922**	1.5333**	2.7855**	2.4184**	1.9001**	6.2267
1984	1.6499**	2.4272**	2.6226**	1.6145**	2.3855**	2.7005**	1.4347**	5.8072
1985	2.8027**	5.7372	2.4685**	2.2671**	2.9481**	3.4247**	2.9682**	4.7755
1986	1.8591**	4.6275*	3.8911*	3.0148**	2.9180**	4.5872*	2.3747**	3.6860*
1987	2.2614**	10.4275	3.6738**	1.9743**	2.3288**	7.0126	2.3089**	4.3668
1988	1.9988**	5.4675	3.9698*	1.8772**	2.0986**	2.7337**	1.9142**	5.2549
1989	2.5138**	5.2521	4.2481*	2.6660**	2.5410**	5.8445	2.7832**	6.1425
1990	1.2520**	5.6882	19.3798	2.0169**	2.5426**	2.2507**	2.2026**	2.7457*
1991	1.9833**	6.9156	3.7037*	3.2584*	3.4977*	5.5617	3.9635*	3.0266*
1992	2.2707**	4.2955*	2.5063**	5.2274	2.8952*	3.8388	2.6069**	9.6805

Notes: The dependent variables in the total asset models are the ratios of the market value of leased land to the market value of total assets. DR is the ratio of total debt to the market value of total assets. The displacement ratio, α , is estimated from the model coefficient on DR, $-1/\alpha$. The estimated standard error of α is α' multiplied by the standard error of the estimated $-1/\alpha$, i.e., this is derived via Theorem 4.17 in Greene (2000). Other explanatory variables in the models include AGE, SIZE, OFFINC, PROFIT, LIQUIDITY, and farm type dummy variables.

** denotes that the hypothesis $\alpha = 0$ is rejected at the 0.01 level (two-tailed test).

* denotes that the hypothesis is rejected at the 0.05 level.

See the appendix for sample split criteria. Only high equity in 1979 and crop farms in 1977 are statistically larger than their counterpart. An asymptotic z test was used to test for pairwise differences in the respective pairs. The test was computed as the difference of a pair of coefficients divided by the root of the sum of their asymptotic variances.

resents off-balance sheet financing, leasing reduces debt capacity. Ang and Peterson—the seminal work in the literature—fit Tobit models with 1976 to 1981 data from 600 firms in which a leasing to book value of equity ratio is the dependent variable and a debt to book value of equity ratio and other variables are the explanatory variables. Contrary to expectations, their model results indicate that leasing and debt are complementary activities. Critics indicate that Ang and Peterson's results may be due to inadequately accounting for heterogeneous debt capacity, the failure to include operating leases, and normalization of leasing and debt by equity instead of total assets.

This study follows the Ang and Peterson methodology, but utilizes a set of firms that are distinct from those of earlier studies—noncorporate U.S. commercial farms—to test the leasing-debt substitution hypothesis. An advantage of this study is that by focusing on a single industry—production agriculture—the problem of potential industry effects is substantially reduced. In a departure from earlier studies, we examine whether the displacement ratio is sensitive to particular phases of the farm business cycle and firm characteristics.

Annual leasing Tobit models are fit with 1977 through 1992 Kansas farm-level data. The leasing to total assets ratio is the dependent variable and the debt to total assets ratio and variables, which account for debt capacity including farm type dummy variables, serve as independent variables. Results strongly support the hypothesis that land leasing and debt are substitutes and that the displacement ratio coefficient is larger than one, indicating that leasing is considered to be more risky than borrowing and purchasing. This result is robust to the use of OLS and defining the lease ratio as leasing to total land assets and the debt ratio as long-term debt to total land assets. The rate of substitution between leasing and debt is found to be sensitive to shifting farm business conditions, but not to heterogeneous farm characteristics. When leasing and debt are normalized by equity, following Ang and Peterson, however, leasing and debt are complements.

As indicated previously, the corporate literature has found leasing and debt to be both substitutes and complements. It is difficult to compare these studies because their definitions of the leasing and debt ratios are not consistent. This study has shown that the sign of the displacement ratio is sensitive to the definitions of the leasing and debt ratio, in particular whether leasing and debt are normalized by total assets or equity. What is needed is agreement on the proper definition of the leasing and debt ratios and further research to indicate whether results from corporate studies are or are not sensitive to leasing and debt ratio definitions.

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Appendix: Variable Definitions and Sample Splits

- Leasing ratio**— The ratio of the market value of leased land to the market value of total assets.
- Total assets**— The market value of owned assets plus the market value of leased land.
- Owned assets**— The sum of the market value of end of year inventories, owned land, stock of motor vehicles and machinery, breeding livestock, nonresidential buildings, and cash on hand. The depreciable capital stock of equipment and machinery is built using the perpetual inventory method (Bierlen and Featherstone, 1998).
- Value of owned and leased land**— Each farm reports the number of owned and leased acres of irrigated cropland, non-irrigated cropland, and pasture. The Kansas Board of Agriculture (Schlender) reports annual per acre land values for irrigated cropland, non-irrigated cropland, and pasture land for nine statistical districts. Land values are estimated by multiplying reported acreage by the district price and summing across land types.
- Debt ratio**— Total debt to total assets.
- Long-term debt ratio**— The ratio of long-term debt to the market value of owned and leased land. Long-term debts are those loans with a maturity over seven years (Langemeier).
- Current ratio**— The ratio of the market value of ending year current assets to current loans. Current assets include inventories of crops, feeding livestock, animal feed, livestock and crop supplies, and fuel and oil, and cash on hand.
- Age**— The age of the principal farm operator in years.

Profit— The ratio of cash flow to the market value of owned capital assets. Cash flow is net income (not including interest and taxes as expenses). Owned capital assets include real estate, breeding livestock, and machinery and equipment.

Sample splits— Low equity farms are the lower one-third of 409 Kansas farms in which 1976 equity is less than \$151,700. High equity farms are the upper one-third of 409 Kansas farms in which 1976 equity is greater than \$287,300. Small asset farms are the lower one-third of 409 Kansas farms in which 1976 owned assets are less than \$343,500. Large asset farms are the upper one-third of 409 Kansas farms in which 1976 owned assets are greater than \$549,600. Crop farms are the lower one-third of 409 Kansas farms in which 1976 feeder livestock to total inventory ratios are less than 0.147. Livestock farms are the upper one-third of 409 Kansas farms in which 1976 feeder livestock to total inventory ratios are greater than 0.456. Young operator farms are the lower one-third of 409 Kansas farms in which 1976 operator ages are less than 48. Old operator farms are the upper one-third of 409 Kansas farms in which 1976 operator ages are greater than 55.