Machinery Lease Versus Purchase Decisions Under Risk

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Farmer interest in machinery, equipment, and structure leasing has developed for three reasons. First, tax law changes altered the financial incentives to lease. The Economic Recovery Act of 1981 (ERTA) and the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) changed the definition of a financial lease, use of depreciation allowances, use of investment tax credit, and transferability of tax benefits through leasing. Second, use of leasing increased in response to higher, more variable interest rates. Farmers who needed to acquire additional machinery sought financing alternatives other than costly additional debt. Third, rising machinery and equipment costs placed additional pressure on available cash flow to meet the down payment requirement on new assets. A financial lease is one means of acquiring additional machinery capacity within the firm's cash constraint.

Previous studies have considered the potential advantages and disadvantages of financial leasing (LaDue, 1982; Plaxico, Walsh). Potential advantages include altered cash flow timing, improved working capital position, and improved tax treatment through transfer of tax benefits. Potential disadvantages are relatively higher cost associated with some leasing arrangements, problems of anticipating what asset residual values will be at lease termination, and the fixed nature of a financial lease obligation. Prior studies have recognized that most leasing arrangements are tax motivated. Thus, situations in which leasing is viable are expected to involve individuals and businesses which do not have identical tax brackets or costs of capital. Differing tax rates can result in advantages to leasing even when both parties are able to utilize available tax deductions and credits.[1]

Lease versus purchase analyses typically have utilized a cash flow approach (Schoney and Massie; LaDue, 1977; LaDue, 1979; Willett and Penland; Schoney). Conventional cash flow analysis can follow either of two methodologies. One can estimate the after-tax present value cost difference between the lease and purchase and accept the alternative which generates a cost savings. Alternatively, the model may be formulated to solve for the after-tax, interest cost equivalents of the loan and lease (Wyman).[2] The rate equivalent for the lease then could be compared with

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that of the loan or the firm's cost of long term debt. Leases which result in financing rates higher than the equivalent rate on debt could be rejected, other factors held constant.

Conventional analyses share the underlying assumption that cash flows are known with certainty. Yet, several aspects of the lease versus buy decision are not amenable to a fully deterministic analysis. The objective of this paper is to evaluate how tax bracket and interest rate fluctuations over the investment period influence the financing choice.

Risk Components

Financial leases are long-term arrangements between a lessor (leasing company, financial institution, or equipment dealer) and a lessee (farmer). Thus, the benefits of leasing are subject to change as a farmer's financial and tax positions change over the life of the lease or loan transaction. Two risk components are of concern here, taxable income and the interest rate on debt. These factors are identified for study because they 1) have different affects on the cost of each financing alternative, and 2) have fluctuated significantly in recent years.

Fluctuating taxable income directly influences the cost of lease and loan financing alternatives by increasing or diminishing their tax benefits and net financing costs. Tax benefits for lessees include lease payment deductions, while tax benefits of ownership include interest payment deductions, depreciation allowances, and the investment tax credit. As taxable income varies above its expected level, tax benefits increase and net financing costs decrease. Thus, net financing costs of ownership decrease relative to the cost of leasing. Conversely, net costs of leasing decrease relative to ownership financing costs when taxable income falls below the expected level because the loan has potentially greater associated tax benefits. Thus, fluctuating taxable incomes affect the direction and magnitude of net financing costs under both alternatives.

Financial institutions are using adjustable interest rates on farm loans to reduce interest rate risk exposure. Resulting interest rate variability takes on additional significance in the lease versus purchase decision, since lease rates are usually fixed over the financing period and loan rates are periodically adjusted to reflect current market interest rates. The preferred financing alternative is potentially altered by the direction and magnitude of future interest rate movements and their differential impacts on debt and leasing costs.

The residual value of the asset represents a potentially important source of risk in addition to taxable income and interest rate variability. For example, if the cost of a machine increases over the life of the lease the residual value also is expected to increase. When this increase is not anticipated the farmer will pay a

higher-than-expected amount to purchase the asset for its remaining useful life under a fair market value lease. A farmer can limit or eliminate residual value risk through the use of a fixed purchase price option.[3]

The role of taxable income risk in lease versus purchase analysis can be illustrated for various taxable income-equipment cost combinations as shown in Figure 1. Line segment EE represents break-even combinations of taxable income and equipment cost at which the after-tax net present costs are equivalent. Under conditions of certainty the lease option would result in lower net present costs for combinations above the break-even line (e.g., point a), and the loan would be preferred below the line (e.g., point c).[4] When taxable income is a random variable, the break-even line becomes a region, shown as the area bounded by line segments UU and LL. Greater variability of taxable income is represented by moving the two bounds away from EE (which now represents the expected taxable income level). Taxable income levels which lie outside the uncertain region (e.g., points a and c) continue to indicate which financing alternative is preferred. When the equipment cost is held constant and taxable income fluctuates within the bounded region (as illustrated by point b), the preference for leasing or purchasing the asset is a function of the distribution of tax benefits of each alternative and risk preferences of the decision maker.

The Simulation Model

An interactive simulation program was developed to generate a quasi-random sequence of taxable incomes. Taxable income was assumed to be beta-distributed under three taxable income-machinery cost scenarios.[5] The selected scenarios are shown in Table 1. Equipment costs are representative of various sizes of farm tractors for which new costs vary from $51,000 for a 135 horsepower, two-wheel drive tractor to $130,000 for a 300 horsepower, four-wheel drive tractor. The corresponding expected taxable incomes were identified using the break-even locus of points shown in Figure 1.

TABLE 1. TAXABLE INCOME-MACHINERY COST SCENARIOS

Scenario	Machinery Cost	Expected Taxable Income
I	$ 51,000	$21,125
II	76,500	31,175
III	130,000	51,450

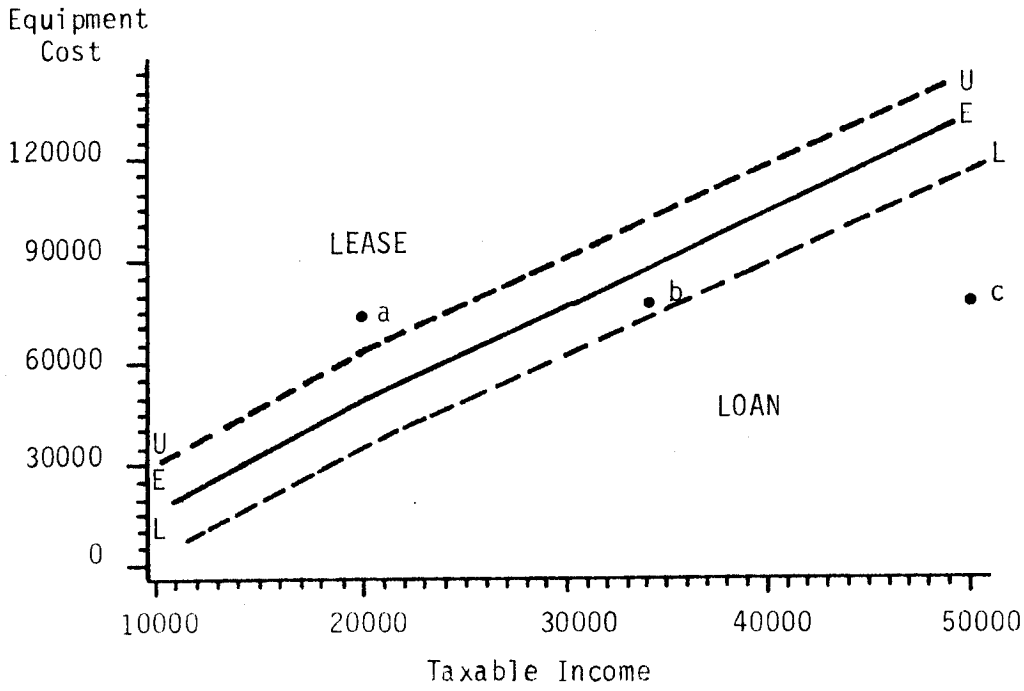

Figure 1. Lease and Purchase Combinations of Taxable Income and Equipment Cost when Taxable Income is Random

The simulation model was used recursively to randomly draw five-year sequences of taxable income for the lease and purchase net present cost computations. The model produced 50 iterations to generate a distribution of net present cost for each alternative under each set of model assumptions. The resulting frequency distributions of net present costs were summed to generate separate cumulative distributions for the lease and purchase financing alternatives. Cumulative distributions were ranked for decision makers with different risk preferences using stochastic dominance with respect to a function.[6]

Four interest rate scenarios were evaluated using the model. Table 2 contains those four sequences of interest rates. Interest rates were treated as uncertain, but not as random variables in the simulation model. Scenarios A and B represent average annual loan rates charged on machinery loans by a representative Production Credit Association during 1973-77 and 1977-81, respectively.[7] Scenarios C and D are hypothetical patterns of future interest rate movements assuming loan rates start from an initial 12.8 percent rate. All simulations assumed that lease rates were fixed at 1 percent below the initial interest rate on the loan to reflect the tax benefits captured by the lessor. Additionally, the loan was assumed to require a 20 percent down payment. The loan and the lease were five-year contracts.

TABLE 2. ADJUSTABLE INTEREST RATE SCENARIOS

Scenario	Year 1	2	3	4	5
	percent				
A (1973-77)	9.6	10.0	9.3	9.0	8.8
B (1977-81)	8.8	10.2	12.6	13.8	17.3
C[a]	12.8	13.9	15.1	16.3	17.3
D[a]	12.8	11.8	10.8	9.9	8.8

[a]Hypothetical interest rate series.

Simulation Results

Summary statistics for the lease and purchase NPC distributions are shown in Table 3. Mean net present costs of the lease and purchase distributions were nearly equal in all scenarios. The small mean value difference reflects the similarity of the lease and loan terms specified in the model and the fixed interest rate loan assumption initially employed in the analysis. Standard deviation was nearly twice as great for the purchase alternative due to the relatively greater importance of ownership tax benefits in reducing financing costs when incomes were allowed to fluctuate. The standard deviation is a useful statistic for identifying the preferred financing alternative when the underlying distribution is approximately symmetrical.

Skewness statistics indicate that the simulated NPC distributions were not symmetric about the mean under scenarios I and III. Those two distributions exhibited positive (right-tail) skewness with the lease exhibiting the greatest positive skewness in all three scenarios. The primary reason for the different shapes of the distributions was the disparity between the utilization of tax benefits as taxable income fluctuated. When taxable income randomly fluctuated above the mean income level, tax benefits increased proportionately for both the lease and loan distributions. However, when taxable income fluctuated below the expected level some or all of the available tax benefits were not used because tax liability was less than available tax benefits. Unused tax benefits from leasing were not recovered in subsequent years since they could not be carried forward. As a result, lease NPC outcomes tended to locate in the higher-cost end of the distribution. Unlike leases, loans did not lose all unused tax benefits when tax liability was low. Investment tax credit was a substantial part of total tax benefits of ownership and could be carried forward to offset future tax liability.

TABLE 3. SUMMARY STATISTICS OF NPC DISTRIBUTIONS FOR TAXABLE INCOME SCENARIOS[a]

Scenario	Financing Alternative	Mean	Standard Deviation	Skewness
I	Lease	$38,243	$ 570	28.5
	Loan	38,733	940	10.0
II	Lease	$54,495	$1,085	2.2
	Loan	55,071	1,816	-1.0
III	Lease	$83,147	$2,681	32.3
	Loan	83,785	4,336	16.2

[a]A fixed interest rate assumption was employed in generating the reported NPCdistribution results for the loan alternative.

The NPC distributions were ranked for decision makers with different risk preferences as shown in Table 4.[8] Resultant rankings indicated that the lease financing alternative would be generally selected by risk-neutral and risk-preferring farmers given the model assumptions. The mean net present cost of the lease was lower than the cost of purchasing in each scenario, thus the risk-neutral farmer would rank the lease higher due to its mean dominance. Risk-averse farmers would prefer leasing at lower break-even levels of machinery cost and taxable income (Scenario I), and prefer purchasing at higher break-even levels (Scenario III). Risk-averters would manage their financial risk most efficiently by selecting the alternative which accumulated probability most rapidly at lower levels of net present cost. Risk-preferring farmers would rank the lease ahead of the purchase alternative in all three scenarios, even though the loan accumulated probability faster at lower cost levels. Risk-preferrers were compensated by selecting the lease which illustrated faster accumulation of probability over the full range of net present costs. The lease and purchase alternatives could not be ranked in two situations shown in Table 4, using the range of risk aversion coefficients which was selected.

Simulation results for the four interest rate scenarios are presented in Table 5. Underlying the rankings is the effect of interest rate movements on the break-even line. A falling interest rate (Scenarios A and D) shifts the break-even line upward, increasing the range of outcomes which favor the loan. This result is shown by a comparison of rankings under scenarios A and D with rankings generated using scenarios B and C. Interest rates fall less significantly under scenario A than under scenario D, thus the preference for the purchase alternative is not as

pervasive. Rising interest rates (Scenarios B and C) shift the break-even line downward (in Figure 1), increasing the range of taxable income-machinery cost situations which favor the lease.

TABLE 4. RISK-PREFERRED FINANCING CHOICES FOR ALTERNATIVE TAXABLE INCOME SCENARIOS[a]

Scenario	Risk Preferences		
	Risk-Averse	Risk-Neutral	Risk-Preferring
I	Lease	Lease	Lease
II	Indifferent	Lease	Lease
III	Loan	Indifferent	Lease

[a]Interest rate on the purchase (with a loan) alternative was held fixed for the life of the loan.

Conclusions

Conventional certainty analysis of cash flows provides sufficient information for farmers to select the least-cost financing alternative. A large number of machinery cost-taxable income combinations could be identified which are not sufficiently close to the break-even line to warrant a risk analysis. A certainty analysis would require less information and produce sufficient results on which to base a financing decision. The break-even line between leasing and purchasing is a potentially useful device for use by farmers. The break-even line partitions combinations of machinery cost and expected level of taxable income into those which favor leasing or purchasing under various lease and loan financing arrangements and assumed economic conditions.

Loan financing was identified as a preferred, or equally preferable, alternative for risk-averse decision makers in several situations. Lease financing was the most risk-efficient financing choice assuming the decision maker was risk-preferring. One conjecture about this result is that if farmers generally exhibit risk-averse behavior in their financing decisions the purchase alternative would be the generally preferred option. This result was shown to be highly conditioned by the underlying movement of interest rates on debt. The preferred financing alternative significantly depends on a farmer's expectations of future interest rate movements in addition to the expected tax position. When considering a fixed rate lease versus a variable rate loan to finance the purchase of farm machinery, equipment, or structures, the future course of interest rates is a critical factor to evaluate in the analysis.

TABLE 5. RISK-PREFERRED FINANCING CHOICES FOR ALTERNATIVE INTEREST RATE SCENARIOS

Taxable Income Scenario	Risk-Averse	Risk-Neutral	Risk-Preferring
---------- Interest Rate Scenario A: (1973-77) ----------			
I	Lease	Lease	Lease
II	Indifferent	Lease	Lease
III	Indifferent	Lease	Lease
---------- Interest Rate Scenario B: (1977-81) ----------			
I	Lease	Lease	Lease
II	Lease	Lease	Lease
III	Lease	Lease	Lease
--------- Interest Rate Scenario C: (Hypothetical Rising Rates) ---------			
I	Lease	Lease	Lease
II	Lease	Lease	Lease
III	Indifferent	Lease	Lease
-------- Interest Rate Scenario D: (Hypothetical Falling Rates)----------			
I	Loan	Loan	Indifferent
II	Loan	Loan	Indifferent
III	Loan	Loan	Indifferent

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Footnotes

[1]Dunn and Watts demonstrated that advantages to leasing exist if the lessor is in a higher tax bracket than the lessee. The benefits of the leasing transaction derive from the sequence of fixed costs, accelerated depreciation allowances and utilization of the investment tax credit.

[2]A lease transfers significant tax benefits of ownership to the lessor, the farmer's tax position under a lease will differ from that which would result with a purchase. As a consequence, annual percentage rate (APR) comparisons between lease and purchase financing costs can be misleading. The APR is a before-tax interest rate concept and should be utilized only when comparing leases or comparing loans which are subject to similar tax treatment.

[3]The option to purchase the asset at lease termination for a price which is known in advance effectively eliminates residual value risk as a major source of risk for the farmer (lessee), and is not considered as part of this study. In effect the risk of changing residual value is shifted to the lessor, who may in turn adjust the lease rate to include a residual value risk premium.

[4]The actual shape and position of the breakeven line shown would vary by specific terms of the lease and loan arrangements.

[5]Taxable income was assumed to be distributed as a beta random variable since the actual distribution of farmer taxable income is not known. The beta distribution is sufficiently flexible that alternative taxable income distributions could be simulated for analysis. Taxable income is allowed to fluctuate within a range, which is limited to 75 percent above and below the breakeven taxable income-machinery cost combination derived under certainty.

[6]Stochastic dominance methods allow the decision maker to rank risky alternatives through a pairwise comparison of cumulative probability distributions (Zentner, et al.).

[7]The Production Credit Association interest rate series was used because: 1) they reflect the movement of interest rates in the 1973-81 period, and 2) the Association has provided fixed rate leases and variable rate loans to farmers for machinery, which gave them experience in both financing services.

[8]Coefficients of absolute risk aversion used in the stochastic dominance analysis were selected based on prior studies of farmers' risk preferences. The coefficient bounds were set for three classes of decision makers as follows: 1) risk-averse (0., .0002), 2) risk neutral (0., 0.), and 3) risk-preferring (-.0002, 0.).