THE EVALUATION OF ALTERNATIVE PROFITABILITY MEASURES OF LEVERAGED LEASING: A SIMULATION APPROACH

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ABSTRACT

This paper summarizes alternative leveraged lease evaluation models and applies them, from the lessors point of view, to a number of simulated leveraged leases. The study compares the alternative evaluation models based upon whether they satisfy two characteristics: 1) the model leads to correct accept/reject capital budgeting decisions and 2) the measure is intuitively appealing. We conclude that the return on invested capital model is the superior lease evaluation technique.

INTRODUCTION

Over the past several decades the use of long term leases to finance the acquisition of assets has grown rapidly to the point where such financing is commonplace. More recently, a type of lease which has found particular favor, due principally to favorable tax treatment by the Internal Revenue Service, is the leveraged lease.

Due to unique after tax cash flows associated with leveraged leases, a number of analytical problems occur in the determination of the level of profitability of the leveraged lease. These problems have led to the development of alternative leveraged lease evaluation models.

This study will compare alternative profitability decision models based upon whether they satisfy, from the lessor's point of view, two desirable profitability measure characteristics. The research will be based on a study of a number of simulated leveraged leases and the analysis of these leases by the alternative evaluation models.

The remainder of this paper will be organized as follows. First, the characteristics of leveraged leases, including tax requirements and after tax cash flow patterns, will be discussed. Second, five alternative lease evaluation models are presented. Third, the simulation methodology is discussed. Fourth, observed decision model characteristics based upon the simulated leases are presented. Finally, user decision guides are suggested.

CHARACTERISTICS OF LEVERAGED LEASES

A leveraged lease is a financial leasing agreement in which the lessor borrows a substantial portion (usually 50% - 80%) of the purchase price of the leased property from a third party. Thus, there are three parties to a leveraged lease: 1) the lessee, 2) the lessor, usually a financial institution, and 3) the lender, usually another financial institution. The debt instrument used would normally give the lender a direct claim against the rental payments made by the lessee and against the leased property, but would generally be nonrecourse as to the general credit of the lessor.

The key element of a leveraged lease involves the income tax consequences of such a transaction. Of central importance to the leveraged leasing issue is the classification of the lease agreement as a "true" lease by the Internal Revenue Service for tax purposes. The lessor must structure the leveraged lease in order to meet both a minimum level of profitability and the leveraged leasing requirements of the Internal Revenue Service.

Tax Characteristics of Leveraged Leases

The lessor receives tax savings through the depreciation expense deductions, loan interest deductions, and the investment tax credit (currently 10% of the asset's cost). In addition, the lessor has the right to amortize the initial front-end lease costs, such as broker, attorney, and accountant fees, over the term of the lease. One of the greatest benefits of all is the lessor's ability to depreciate the asset for tax purposes using the class life method of depreciation in which the asset depreciation range (ADR) rules will permit a tax payer (in order to obtain the greatest accelerated depreciation allowable) to: (1) depreciate personal property over a depreciable life which is up to 20% shorter than the applicable class (prior guideline) life; (2) reduce the salvage value of personal property, with at least a three-year life, by 10% of its cost and ignore salvage value when computing depreciation (however, the asset may not be depreciated below its salvage value less the 10% reduction); (3) change from the double declining balance (DDB) method to the sum-of-the-years' digits (SYD) depreciation method without the consent of the Internal Revenue Service (IRS); and (4) not recognize any gain or loss on the ordinary disposal of an asset from a group asset account (See Internal Revenue Service Reg. Sec. 1.167(a)-11).

The most important tax issue involved in a leverage lease is whether the Internal Revenue Service (IRS) rules that the lease is a true lease or a conditional sales contract. If the transaction is ruled a conditional sale, the lessor will lose the benefits of the investment tax credit and the accelerated depreciation deductions while the lessee will lose the deductibility of the rental payments. If the lessor loses any of the tax benefits, the lease agreement may require the lessee to pay the lessor an amount of money which maintains the lessor's rate of return (however defined).

In 1975, the IRS issued new guidelines which it uses for advance ruling purposes in determining whether certain transactions are true leases for Federal income tax purposes [6]. The guidelines relevant to this paper are:

(1) The lessor must have made an initial minimum unconditional investment equal to at least 20% of the cost of the asset.

(2) The lessor at all times throughout the lease term must maintain an equity investment equal to at least 20% of the asset cost. All of this is on a before-tax basis. This means that the cumulative total (at the end of each year is the term of the lease) of the difference between the lease payments received by or for the lessor (R) and the loan payments made by or for the lessor (L) less any front-end (direct) costs to finance the equity investment (F) cannot exceed the excess of the lessor's initial equity investment (E) over 20% of the cost of the asset (A) plus the cumulative pro rata portion (presumably straight line) of profit (P) from the transaction. Profit (P) for this purpose is defined as the excess of the sum of the total amounts required to be paid by the lessee over the term of the lease to or for the lessor plus the residual (salvage) value of the asset (S) over the total amount required to be paid by or for the lessor over the term of the lease in connection with the ownership of the asset, including the lessor's initial equity investment and any direct costs to finance the equity investment. If we let n equal the term of the lease, we would first calculate the profit (P):

$$P = \sum_{k=1}^{n} (R_k - L_k) + S - F - E.$$

Then, for each year i = 1 to n, the following inequality must hold:

$$\sum_{k=1}^{i} (R_k - L_k) - F \le E - (.2)(A) + (P/n)(i).$$

(3) The profit (P) as defined in requirement 2 above must be positive (P > 0) <u>and</u> the total lease receipts must exceed the total loan payments by a reasonable amount, i.e., $\sum_{k=1}^{n} (R_k - L_k) =$ reasonable amount. The taxpayer has the burden of proving reasonableness.

(4) The leased asset must be expected to have, at the end of the lease term, a remaining useful life of the longer of one year or 20% of the originally estimated useful life of the asset, <u>and</u> it must have a reasonably estimated fair market value equal to at least 20% of the original cost of the asset.

After Tax Net Cash Flows

The after tax cash flow pattern associated with a leveraged lease is one in which there may be multiple changes in the signs of the cash flows as follows:

(1) Initial outflow: the initial investment by the lessor

(2) Period of inflow: the aggregate of:
  a. Excess of rents received over debt payments to the lender
  b. Reduction in income taxes by utilization of the investment tax credit
  c. Reduction in income taxes because accelerated depreciation charges and interest expense on debt to the lender exceed rental receipts

(3) Period of outflow: the initial income tax advantages reverse as depreciation charges and interest deductions are reduced; income tax payment outflows exceed the inflows from rental receipts less debt payments

(4) Final inflow: relization of residual value of the property (net after tax).[1]

For purposes of this paper, the following assumptions are made: (a) cash flows occur at the end of the period (b) the investment tax credit is taken at the end of period 1 and (c) the leased asset is sold by the lessor at the end of the lease. Alternative assumptions would just change the periods in which the cash flows occur. In addition, front-end costs, which increase the outflow in period zero, are assumed to be zero. The after tax cash flow stream can be shown as follows:

$$\begin{aligned} ATNCF_0 &= -E \qquad (1)\\ ATNCF_1 &= (D_1 + I_1 - R)(T) + R - L + C\\ ATNCF_j &= (D_j + I_j - R)(T) + R - L \text{ for } j = 2 \text{ to } n-1\\ ATNCF_n &= (D_n + I_n - R)(T) + R - L + S \end{aligned}$$

where:

$ATNCF_j$ = after tax net cash flow in period j
n = the number of periods in the life of the lease
A = asset cost
E = lessor's initial equity investment
C = .1A = investment tax credit (assumed taken in period 1)

R = lease rental receipts to the lessor (R is assumed to be constant)
S = salvage value for cash flow purposes (assumed received in period n)
T = tax rate for lessor
D_j = tax depreciation expense in period j (calculated using the ADR depreciation method)
i = loan interest rate (in decimal form)

V = present value of an annuity = $\dfrac{1 - \dfrac{1}{(1+i)^n}}{i}$

$B_0 = A - E$ = amount of the asset cost financed through nonrecourse loan
$L = B_0/V$ = loan payments from the lessor to the debt participant (L is assumed to be constant)
$I_1 = (B_0)(i)$
$B_j = L - I_j$ = amount of L in period j which represents repayment of the loan prinicpal (for $j = 1$ to n)
$I_j = (B_0 - \sum_{k=1}^{j-1} B_k)(i)$ = amount of L in period j which is loan interest (for $j = 2$ to n)

Three types of cash flow patterns were generated for the simulated leveraged leases (see Table 1). The cash flow patterns can differ from the pattern suggested previously due to two factors:

(1) The level of the rent receipts, and
(2) The presence of a zero salvage value.

Cash flow pattern (1) exists when the level of rent receipts, R, and possibly a positive salvage value, SV, are at levels where they are greater than the reduced depreciation and interest deductions in the latter years of the lease. Hence all cash flows, except the initial investment, are positive.

Cash flow pattern (2) is similar to the one described previously, with the exception that the final salvage value is zero, resulting in a negative last period after tax net cash flow.

Cash flow pattern (3) is as described previously. This pattern is often considered to be characteristic of many leveraged leases, but is clearly not the only possible pattern for a qualifying leveraged lease.

Table 1 has been moved to end of paper.

THE EVALUATION MODELS

Major analytic difficulties in evaluating the profitability of leveraged leases are caused by two factors. The first factor is the distinct after tax cash flow patterns of certain classes of leveraged leases. These patterns are portrayed in Table 1. Cash flow patterns (2) and (3) (which have more than one change in the signs of the cash flows) may cause analytical difficulties. The second factor is the desired characteristics of a profitability measure. The desired characteristics are:

(1) The measure should lead to correct accept/reject capital budgeting decisions.

(2) The measure should be intuitively appealing in its interpretation (i.e., recognizing the various patterns of ATNCF, the measure should yield a "true" rate of return which is (a) internal to the project and (b) a unique rate of return for all cost of capital, k).[2]

A number of profitability measures have been proposed for use in analyzing leveraged leases. Each of the proposed measures is an alternative to the net present value (NPV) model.

The Net Present Value Model

An unambiguous managerial decision rule for accept/reject decisions is available to management uninterested in a profitability measure for leveraged leases [2, 10, 13]. The NPV model discounts the leveraged leases' after tax net cash flow and arrives at an increase or decrease to the value of the firm:

$$NPV = \sum_{j=0}^{n} ATNCF_j \, (1 + k)^{-j}. \tag{2}$$

The decision rule is to accept those projects for which the NPV is greater than or equal to zero. However, many managers find it difficult to compare increments in the net present value and prefer a profitability or rate of return measure for decision making purposes. For this paper, if a particular model yields accept/reject decision which are consistent with the NPV model, requirement (1) of the desired characteristics of a profitability measure will be considered to have been met.

The Internal Rate of Return Model

A standard profitability measure for a project is its internal rate of return (IRR) [13]. The IRR model solves for the rate, r^*, at which the sum of the discounted yearly after tax cash flows is equal to zero:

$$\sum_{j=0}^{n} ATNCF_j \, (1 + r^*)^{-j} = 0. \tag{3}$$

The decision rule is to accept leases for which r^* is greater than or equal to the cost of capital, k. In many situations, this decision rule will meet the desired characteristics of a profitability measure. However, for cash flow patterns (2) and (3) in Table 1, some of the desired characteristics of a profitability measure may not be met.

To determine when the IRR decision rule may lead to decision making difficulties requires that leases be classified, based upon their cash flow pattern, as pure or mixed. A pure investment project is defined as a lease in which all project balances, calculated at the internal rate of return (r^*), are less than or equal to zero, where:

$$PB_t(r^*) = \sum_{j=0}^{t} ATNCF_j \, (1 + r^*)^{t-j} \tag{4}$$

Leveraged Leasing (continued)

A mixed investment and financing project is one for which the project balance is positive for at least one period, t. For a mixed project, when the $PB_t(r^*)$ is less than or equal to zero, the project has a level of profitability (or rate of return) which is less than the expected rate, r*, and, therefore, the firm is investing in the project. For any period, t, in which $PB_t(r^*)$ is greater than zero, the project has an accumulated return over and above the capital initially invested and the return earned on it, and it represents a source of funds and thus "loans" money ($PB_t(r^*)$ dollars) to the firm at the cost of capital rate, k [5, 8]. Referring to Table 1, cash flow pattern (1) is always a pure investment project, cash flow pattern (2) is always a mixed project, and cash flow pattern (3) can be either a pure or mixed project. Pure projects will not cause the IRR model to violate any of the desired profitability measure characteristics, while mixed projects may cause the IRR model to violate one or more of the desired profitability measure characteristics. Because of the problems inherent in cash flow patterns (2) and (3), a number of alternative return measures have been suggested.[3]

The Return on Invested Capital Model

The return on invested capital (ROIC) is the interest rate which yields a zero future value when the project balances $S_t(ROIC,k)$ are compounded at the ROIC when the project balance is negative (i.e., an investment) and are compounded at k (the cost of capital) when the project balance is positive (i.e., a source of funds) [8, 12]. Since pure projects always have project balances which are less than or equal to zero, they will be compounded at the ROIC (which equals r*) and the ROIC will be independent of k.[4] The decision rule is to accept leases for which ROIC is greater than or equal to k.

This decision rule satisfies all of the desired profitability measure characteristics for pure projects.[5] For mixed projects, the second desired profitability characteristic will always be violated (i.e., ROIC does not yield a "true" rate of return internal to the project because the ROIC will increase as k increases).

The Return on Equity Investment Model

The return on equity investment model splits the leveraged lease into two components: 1) The assets after tax cash flow stream ignoring any financing; this results in a unique income rate internal to the project $\bar{r}$. 2) The after tax debt rate, $\bar{k}$, on the nonrecourse loan. The model is then solved for a unique after tax rate of equity financing, $\bar{c}$, which is the lessor's rate of return on his investment in the leveraged lease [14].

$\bar{r}$ is calculated as follows:

$$A = \sum_{j=1}^{n} ATNCI_j \, (1 + \bar{r})^{-j} \tag{5}$$

where: $ATNCI_1 = (D_1 - R)(T) + R + C$

$ATNCI_j = (D_j - R)(T) + R$ for $j = 2$ to $n - 1$

$ATNCI_n = ATNCF_n$

$\bar{k}$ is calculated as follows:

$$B_0 = \sum_{j=1}^{n} [L - (T)(I_j)](1 + \bar{k})^{-j} \tag{6}$$

Since the loan interest rate, i, is generally known, it is easier to solve for $\bar{k}$ by multiplying (i) times (1 - T).

Using $\bar{r}$ and $\bar{k}$, the after-tax rate of equity financing, c, is calculated as follows:

Let $G = (A)(1 + \bar{r})^n - (B_0)(1 + \bar{k})^n$

then $\bar{c} = EXP((1/n)(Log(G/E))) - 1$ (7)

Since $\bar{r}$ represents the yield on the leveraged lease to the lessor, his effective weighted average cost of funds for the debt and equity portions combined must not exceed $\bar{r}$. Leases with debt costs, $\bar{k}$, greater than $\bar{r}$ cannot tolerate a cost of equity funds over r, while leases with $\bar{k} < \bar{r}$ can tolerate $c > r$. In general, $\bar{c}$ is a unique rate which declines when the debt financing rate increases [14]. Since the lease receipts, tax advantages, and debt payments may be considered fixed for a particular investment, c is the lessor's rate of return on his investment in the leveraged lease. The decision rule is that the investment should take place if the calculated rate $\bar{c}$ is greater than the lessor's after tax cost of equity funds.[6]

This decision rule will result in a unique rate of return for all k, but it will not yield a "true" rate of return internal to the project, and it may result in incorrect accept/reject decisions.

The Sinking Fund Model

Some lessors find the previously mentioned methods of analysis confusing and choose to circumvent the problem when multiple changes in the signs of the cash flows occur by means of a technique called the (phantom) sinking fund method. With this method, the periods of negative cash flows (outflows) are viewed as liabilities which must be met. Sufficient funds are (theoretically) set aside (no sinking fund is actually established) from preceding positive cash flows so that the sinking fund plus its earnings will cover the negative cash flows when they occur. The remainder of the positive cash flows are discounted back to the point of initial investment producing a "unique" rate of return for each different sinking fund earning rate [4]. The method can be represented as follows:

Let s = any after tax sinking fund earning rate
x = a decimal fraction such that $0 \leq x \leq 1$
m = a lease period such that m<n (typically m = n or m = n-1)
H = sinking fund earnings

then select a lease period d ($1 < d < m$) such that:

$$\sum_{j=d+1}^{m} ATNCF_j + (ATNCF_d)(x) + H = 0 \qquad (8)$$

where

$$H = ((1 + s)^{m-d} - 1)(ATNCF_d)(x) + \sum_{j=d+1}^{m-1} [((1 + s)^{m-j} - 1)(ATNCF_j)]$$

Then subtract the cash flows in equation (8), for each period from d to m, from the original cash flows, $ATNCF_j$ for $j = 0$ to n. Call the adjusted cash flow series ACF_j. Then the sinking fund rate of return, s*, is the unique rate which solves the following equation:[7]

$$\sum_{j=0}^{n} ACF_j(1 + s^*)^{-j} = 0 \qquad (9)$$

The decision rule is to accept the project if $s^* > k$. This model will result in a unique rate of return for all k (at a given sinking fund earning rate), but it may not yield a "true" rate of return internal to the project, and it may result in incorrect accept/reject decisions.

METHODOLOGY

There were twelve parameters which were needed for this study. These parameters were classified as lease cash flow parameters or model parameters (see Table 2 for the various values used). Potential leases were constructed by varying the following cash flow parameters:

1. The number of years in the live of the lease (n) and the economic life of the asset (nl) were allowed to vary. Seven values for n were chosen with the minimum lease term of 7 years chosen so as to avoid the restriction on the investment tax credit created by shorter term leases.[8] In order to meet requirement (4) of the IRS leveraged leasing guidelines, nl was set equal to n/.8.

2. The asset cost was set at $1,000,000. It was felt that generalizations could be made by defining other monetary parameters as a percent of asset cost.

3. The lessor's initial investment was varied with the minimum amount being 20% of asset cost as required by requirement (1) of the IRS leveraged leasing guidelines.

4. The lessor's lease receipts were kept constant per year (an annuity) while three different annuity values (10%, 15%, and 20% of asset cost) were chosen. The IRS leveraged leasing guidelines will allow lease receipt patterns other than an annuity, but these patterns must meet certain rules;[9] therefore, an annuity pattern was chosen as logical. Some of the shorter term leases could not be constructed using lease receipts of 10% or 15% of asset cost because they would have violated requirement (3) of the IRS leveraged leasing guidelines.

5. The cash salvage of the leased asset at the end of its lease term was set equal to either a conservative value of zero or 20% of the asset cost which corresponds to the minimum value of requirement (4) of the IRS leveraged leasing guidelines.

6. The interest rate on the nonrecourse loan was set at either 9% or 12%. It was assumed that the loan payments were annuity payments consisting of interest and principal similar to a home mortgage loan.

7. The investment tax credit of 10% of asset cost was assumed to be taken at the end of year 1.

8. The income tax rate (combined Federal, state, and local) was assumed constant at 52% of before tax net income. In addition, all tax credits were assumed to be used immediately by offsetting other taxable income of the firm (i.e., there was no need for tax carryforwards).

9. The ADR method of depreciation (explained earlier in the paper) was chosen in order to maximize the tax benefits.

10. Front end costs were assumed to be zero.

Two model parameters were varied:

1. The cost of capital rate was varied to be representative of a wide range of firms (10%, 15%, and 20%).

2. The after tax sinking fund earning rate was varied between 0% (the most conservative assumption) and 6% (a high cost of funds rate in excess of the rate on leading 60-89 day certificates of deposits of $100,000 or larger)[4, 11].

Table 2 has been moved to end of paper.

Once the potential leases were generated, they were input to a computer program which determined those leases which clearly qualified as leveraged leases under the IRS guidelines. There were 208 qualifying leveraged leases which were used as the basis for the conclusions of the study. Table 3 classified the 208 leases as pure or mixed and by cash flow pattern.

TABLE 3

208 Simulated Leases

Cash Flow Pattern		Type of Project Pure	Mixed	Total
(1)	- + + +	84	--	84
(2)	- + - -	--	66	66
(3)	- + - +	44	14	58
Total		128	80	208

RESULTS

IRR and ROIC Models

Both the IRR model and the ROIC model did not satisfy all of the desired profitability measure characteristics for mixed projects. At each of the three cost of capital rates for all leases, the ROIC model always made correct accept/reject decisions while the IRR model made correct accept/reject decisions in 204 of the 208 qualifying leases. There were four leases which each had two positive IRRs; these leases were the only ones to give ambiguous accept/reject decisions, given the IRR model decision rule of accept if $r^* > k$.[10]

Out of 80 mixed projects, 74 resulted in a unique positive IRR (four had multiple IRRs, one had only a negative real IRR, and one had no real IRRs). However, none of the mixed projects yields an IRR which is the "true" rate of return internal to the project. The mixed projects can be subclassified according to the 3 types of IRRs generated:

1. Multiple positive real IRRs. These leases violate all of the desired profitability measure characteristics. Because only 4 of the 80 mixed projects had multiple IRRs, multiple IRRs do not appear to be a frequently occurring decision making burden.

2. All negative or no real IRRs. These IRRs have no economic interpretation, and thus these leases should correctly be rejected. Of the 80 mixed leases which qualified under the IRS requirements, only two fell into this category (one with all negative IRRs, and one with no real IRRs).

3. One positive real IRR. When the ROIC is "flat" (explained below), these IRRs are good surrogates for the "true" rate of return internal to the project. When the ROIC is not "flat" the "true" rate of return internal to the project cannot be closely approximated by the IRR.

For all of the mixed projects, the ROIC resulted in a rate of return which increased as k increased. However, for at least 60 of the 80 mixed investment projects, both the IRR and the ROIC models appear to be robust to violations of the desired profitability measure characteristic of being intuitively appealing. Table 4 shows that for cost of capital rates ranging from 10% to 40%, the ROIC is "flat" and equals the IRR ± 1% for 60 of the mixed projects. For an additional 10 mixed projects, ROIC is "flat" and equals IRR ± 2%.[11] Of the remaining 10 mixed leases, 4 had multiple IRRs, one had no real IRRs, one had only a negative real IRR, and the remaining 4 ROICs ranged from IRR ± 2.4% to IRR ± 12%. These last 4 leases were all 7 or 10 year lease terms (i.e., all of them were the shorter term leases).

In summary, both IRR and ROIC are good surrogates for the "true" rate of return internal to the mixed lease project for longer term leases (greater than or equal to a 15 year lease term) when only one positive real IRR exists. Since the surrogate appears good within ± 2% of the IRR, the IRR can be effectively used to both make the correct accept/reject decisions and to give a reasonable approximation of the "true" rate of return internal to the project for this subclass of mixed lease project. (Of course, for pure projects, both the IRR and the ROIC decision models meet all of the desired profitability measure characteristics.)

Return on Equity Investment Model

The return on equity investment (REI) model made numerous decision errors under a wide range of conditions. In fact, of a total of 208 decisions, the REI model gave the correct answer in 36 cases (including 13 reject decisions). The incorrect decisions, classified by cash flow pattern and investment type are displayed in Table 5 below.

Table 4 has been moved to end of paper.

TABLE 5

REI Decision Errors

Pattern	Pure	Mixed	Total # in Pattern
1	73	-	84 (87% wrong)
2	-	53	66 (80% wrong)
3	30	16	58 (79% wrong)

The apparent inappropriateness of the REI model may be seen by comparing it to the internal rate of return model when analyzing a project with cash flow pattern (1), which is a pure investment. In this case, the IRR model satisfies all of the profitability measure requirements, and is clearly consistent with the net present value model. Since the sign of the cash flow stream changes only once, multiple rates of return will not exist, and analytical difficulties are not presented for this pure investment alternative. Thus, this is not one of the difficult cases for which the REI model was proposed as an alternative to the other models discussed in this paper, and it is clearly a situation where the REI model should be consistent with the decisions made by the net present value (and, in this case the IRR) model.

The IRR model, as formulated in equation (3), is:

$$ATNCF_0 = \sum_{j=1}^{n} ATNCF_j (1 + r^*)^{-j}.$$

By substituting the detailed components of $ATNCF_j$ from equation (1), and omitting salvage value and the investment tax credit for simplicity, we arrive at the following more detailed statement of the IRR model:

$$E = \sum_{j=1}^{n} [(D_j + I_j - R)(T) + R - L](1 + r^*)^{-j} \quad (10)$$

The unambiguous solution to this equation, r*, is the only meaningful ("true") return measure internal to this project.

In the REI model, when solving for the return on equity investment $(\bar{c})$, as shown in equation (7), values for $\bar{k}$ and $\bar{r}$ are needed. From equation (5) we see that

$$A = B_0 + E = \sum_{j=1}^{n} ATNCI_j (1 + \bar{r})^{-j}.$$

By substituting the detailed components of the $ATNCI_j$, and omitting the investment tax credit and the salvage value for simplicity, we arrive at the following detailed formulation:

$$B_0 + E = \sum_{j=1}^{n} [(D_j - R)T + R](1 + \bar{r})^{-j}. \qquad (11)$$

From equation (6), B_0 may be written as

$$B_0 = \sum_{j=1}^{n} [L - (T)(I_j)](1 + \bar{k})^{-j}. \qquad (12)$$

Subtracting equation (12) from equation (11) yields an expression for E, given the $\bar{r}$ and $\bar{k}$, which can be solved for $\bar{c}$ (REI) as shown in equation (7):

$$E = \sum_{j=1}^{n} [(D_j - R)T + R](1 + \bar{r})^{-j} - \qquad (13)$$
$$\{\sum_{j=1}^{n} [L - (T)(I_j)](1 + \bar{k})^{-j}\}$$

The resulting equation (13) is identical to equation (10) except for the discount rates, $\bar{r}$ and $\bar{k}$. As was suggested earlier, for a pure investment project with cash flow pattern (1), r* is the only meaningful ("true") return measure internal for this cash flow pattern (and, therefore, for this project). Since the REI model only reduces to the IRR model if $\bar{r} = \bar{k} = r^*$, and since it would normally be expected that $\bar{r} \neq \bar{k} \neq r^*$, then the REI model fails to reduce to the IRR model in this unambiguous case and yields a return measure, $\bar{c}$ (which is not equal to r*), which is meaningless. Similar interpretations of results may be attributed to cash flow patterns (2) and (3) where numerous decision errors were also observed for the REI model.

The REI model decision rule resulted only in rejecting desirable projects. No consistent patterns could be discerned, and the model's performance appears to be essentially random when the decision rule does make the proper decision. Given the inability of the REI model to make appropriate accept/reject decisions, the uniqueness of the measure seems a moot point.

Sinking Fund Model

The sinking fund rate of return model fails to satisfy the first requirement of a profitability measure. That is, it does not always lead to correct accept/reject decisions which are consistent with net present value. The number, for which there was at least one incorrect decision classified by investment type and cash flow pattern, are displayed in Table 6. Since each lease was evaluated at three costs of capital rates (10%, 15%, and 20%) and three sinking fund earnings rates (0%, 3%, and 6%), there was an opportunity for up to nine decision errors for each lease analysis.

The nineteen leases with at least one sinking fund rate of return decision error come almost exclusively from mixed investments. However, this result should not be misinterpreted since, in the case of investment projects with cash flow pattern (1), the sinking fund rate of return model reduces to the IRR model. Thus, only when dealing with pure investment projects with cash flow pattern (3) (a total of 44) did an opportunity for disagreement exist. Nevertheless, the almost perfect record when dealing with pure projects does seem significant.

Since one model parameter, the sinking fund earnings rate, is used by the sinking fund model exclusively, an analysis of decision errors classified by cost of capital and sinking fund earnings rate was undertaken. A total of 63 decision errors were made. The results are classified in Table 7.

It may be seen that as the sinking fund earnings rate is reduced, the number of decision errors increases. Also, the type of errors made by the sinking fund model is of interest. In no case did the sinking fund model accept an undesirable project. Rather, all errors were of a conservative nature whereby acceptable projects were rejected.

TABLE 6

Sinking Fund Rate of Return Decision Errors

Pattern	Pure	Mixed	# In Cash Flow Pattern
1	0	-	84
2	-	13	66
3	1	5	58

TABLE 7

Sinking Fund Errors

Cost of Capital	Earnings Rate 0%	3%	6%	Total
10%	12	7	4	23
15%	9	5	3	17
20%	9	7	7	23
Total	30	19	14	63

USER DECISION GUIDES

The user decision guides which evolve from this simulation come directly from the observed characteristics of the alternative decision models. If one is concerned only with making correct accept/

reject decisions, then either the net present value model, the internal rate of return model, the return on invested capital model, or the sinking fund model appear equally robust for pure investments. For mixed investments the return on invested capital does not make improper accept/reject decisions, while the internal rate of return model is ambiguous in the rare case of multiple real rates. The sinking fund method makes errors in the case of mixed investments, but the direction of the error is conservative and may be acceptable to some users. The return on equity investment model tends to make numerous accept/reject decision errors, and the direction of the error is a priori unknown.

If a "true" rate of return internal to the project is desired, then the IRR model and the ROIC model provide good surrogates for this return for mixed investment project leases with lease terms of 15 years or more. For mixed investments of shorter duration, the "true" return internal to the project may not be obtainable. For pure investments, of course, internal rate of return and return on invested capital are equivalent (and also yield a "true" rate of return).

Thus, for use in evaluating all leases, the return on invested capital measure seems superior. For long leases it gives a good approximation of the "true" rate internal to the project, and for short leases (where the "true" rate may not be obtainable) it gives an accept/reject decision consistent with net present value. Thus, return on invested capital is recommended as the superior lease profitability evaluation technique, consistent with the desired characteristics of a profitability measure.

TABLE 1

After Tax Net Cash Flow Patterns

Pattern	Initial Investment (t=0)	Early Flows (t=1, q)	Late Flows (t=q+1, n-1)	Last Flow (t=n)	Number In Study
1	-	+	+	+	84
2	-	+	-	-	66
3	-	+	-	+	58

note: q is an arbitrary period, dividing the "early" from the "late" cash flows.

TABLE 2

Cash Flow and Model Parameters

Lease Terms	7	10	15	20	25	30	40
Asset Life	8.75	12.5	18.75	25	31.25	37.5	50
Asset Cost	$1,000,000						
Lessor's Equity Investment	$200,000			$300,000			$400,000
Lease Rental Receipts	$100,000			$150,000			$200,000
Cash Salvage Values	$0			$200,000			
Nonrecourse Debt Rates	9%			12%			
Investment Tax Credit	$100,000						
Lessor's Tax Rate	52%						
Front End Costs	$0						
Cost of Capital Rates	10%		15%		20%		
Sinking Fund Earning Rates	0%		3%		6%		

TABLE 4

Mixed Projects for Which ROIC is "Flat" and IRR Approximates the "True" Rate of Return of The Lease

Internal Rates of Return	ROIC = [IRR ± X%] for k = 10% to 40% X = 0% to 1%	X = 1.1% to 2%	X = 2.1% to 3%	X = 3.1% to 4%	X > 4%
Negative to 5.0%	-	1	-	-	1
5.01% to 10.0%	3	2	-	-	-
10.01% to 15.0%	12	1	-	1	-
15.01% to 20.0%	10	2	-	-	-
20.01% to 25.0%	5	1	-	-	-
25.01% to 30.0%	12	1	-	-	-
30.01% to 40.0%	5	-	-	-	-
40.01% to 50.0%	9	1	-	-	3
Over 50.0%	4	1	-	-	-
	60	10	0	1	4

There were 5 mixed leases which could not be classified (4 with multiple rates of return and 1 with no real IRRs).

FOOTNOTES

1. It is important to note that the residual value at the end of the lease term which the lessor uses to evaluate the profitability of the lease may be different from (a) the minimum residual value (at the end of the lease term) of 20% of cost required by the leveraged leasing guidelines and (b) the salvage value at the end of the asset's depreciation guideline life which is used for determining the depreciation expense for tax purposes. However, salvage value for depreciation purposes is based upon the asset's salvage value at the end of the lease because it is assumed that the leassor will dispose of the asset at that date.

2. Multiple real rates of return, where all rates are equal, will not be considered "unique".

3. For mixed investment projects, the IRR model does not result in a "true" rate of return internal to the project because r^* is the "true" rate only if $k = r^*$ when $PB_t > 0$.

4. Let S_t (ROIC, k) be the balances compounded according to the rules above.
Then, $S_0(\text{ROIC}, k) = \text{ATNCF}_0$

$S_t(\text{ROIC}, k) = S_{t-1}(1+k) + \text{ATNCF}_t$ if $S_{t-1}(\text{ROIC}, k) \geq 0$

$S_t(\text{ROIC}, k) = S_{t-1}(1+\text{ROIC}) + \text{ATNCF}_t$ if $S_{t-1}(\text{ROIC}, k) < 0$

and $S_n(\text{ROIC}, k) = 0$

5. For pure investment projects, the IRR and the ROIC decision models are equivalent.

6. Here we refer to the nonrecourse debt which the lessor obtained for the lease as debt. All of the lessor's other funds, regardless of source, are referred to as equity funds. Therefore, the lessor's cost of equity funds should be his cost of capital, k.

7. When analyzing cash flow pattern (1) in Table 1 (all positive ATNCF after year zero), then the sinking fund decision model and the IRR decision model are equivalent (i.e., equation (8) cannot be satisfied, and therefore, the ACF equal the original ATNCF and s^* in equation (9) equals r^* in equation (3)).

8. For details of these restrictions, see Capettini and Harmelink [3].

9. For details, see Internal Revenue Service [6].

10. Quirin [9] has demonstrated that when multiple positive IRRs exist, special decision rules can be designed which give correct accept/reject decisions.

11. The importance of choosing the appropriate tolerance limit (± X%) is magnified when the IRR is near the cost of capital (i.e., in the 10% to 20% range). Table 4 shows that 26 of the 80 mixed leases fall within this range. Choosing the appropriate tolerance limit becomes less important at the very low and particularly at the very high IRR rates.

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