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Residual Value and the Value/Risk Trade-off in Lease-Versus-Buy Decisions

Entities with limited appetite for residual value risk may choose to lease assets because of the risk transfer benefit, even when value economics favor the buy option, provided the value impact of leasing is not too negative. This article provides a framework for measuring risk transfer and making the value/risk trade-off in this situation.

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By Andrew Apps

Entities frequently face decisions as to whether to own or lease the assets that they require. Sometimes these decisions can be relatively straightforward. For example, leasing is often a convenient and compelling solution where assets are likely required only for the short term, while finance/capital leases, where the lessor does not take a meaningful residual value risk, can sometimes be attractive for long-term needs.[1]

There remains a large group of situations where assets are required beyond the short term and a lessor is willing to take material residual value risk, for which the lease/buy decisions are often much less straightforward. At the heart of these considerations — and at the heart of their difficulty — is the uncertainty, if an entity chooses to own an asset, as to the secondhand value it can achieve in the market when it no longer requires the asset. We will refer to this as the *salvage value,* which may be lower than the asset's actual residual market value if (for example) the entity has limited access to the relevant secondary markets.

This article considers the interplay between value and risk, viewed as one of four dimensions for potential lessees evaluating lease/buy decisions for medium to long-term needs (Table 1).

Leasing will often be the natural choice when a proposed lease is value positive compared with ownership. However, risk-averse entities may choose to lease assets even when value economics favor the buy option, in order to transfer salvage value risk to the lessor, provided the value impact of leasing is not too negative. Experience shows that stronger credits may also at times enter into value-negative leases.

This article develops a framework for measuring risk transfer and for

Table 1.

Four Dimensions of Lease/Buy Analysis

Dimension	Description or comment
Borrowing capacity/cash	Some businesses (e.g., financially constrained entities) may find it easier to negotiate a lease for an asset that they need, rather than to borrow additional funds to buy it.[a]
Accounting metrics	Decision-makers may be influenced by the impact on externally published or internally targeted accounting or financial metrics such as capital employed (on versus off balance sheet), capital expenditure targets, or return on capital employed. Under the new lease accounting standards, the impacts of lease or purchase on capital employed and long-term debt will be far more similar for medium or long-term needs than in the past,[b] which could reduce the importance of these metrics in lease/buy decisions.
Value and risk	Value is a key driver for many lease/buy decisions. However, it is also important to understand and compare the risks of both lease and ownership options, by looking not just at "single point" estimates of value but at the range of possible value outcomes under each option. We therefore view value and risk as two elements of the same dimension rather than as separate dimensions.
Environmental factors	Various internal or external factors can constrain or prohibit ownership options or (more rarely) leasing options, such as outsourcing strategies,[c] asset replacement practicalities,[d] regulation,[e] joint venture partners,[f] third-party "cost plus" contracts,[g] or shortage of specialist operating skills.[h] This dimension, although listed last, should in practice be considered first because of the magnitude of the impacts when present.

a. See Andrea Eisfeldt and Adriano Rampini, "Leasing, Ability to Repossess, and Debt Capacity," *Review of Financial Studies* 22:1621-1657 (2008).

b. Under historical accounting standards, leases where there is a material residual value typically impact neither the balance sheet nor the long-term debt of the lessee. In such situations, entities reporting under International Financial Reporting Standards or U.S. GAAP accounting standards will in future typically capitalize upward of 75% of the asset's value (and book a similar level of long-term debt) if they lease the asset, compared to 100% of the asset's value if they purchase it.

c. Where an entity has outsourced certain activities, it may have a reduced appetite for owning any associated assets.

d. Practicalities include the ease and desirability or otherwise at the end of the lease term of replacing the asset and/or meeting any return conditions in the lease. Thomas Zeller, Brian Stanko, and Andrew Tressler, "How Risky Are Your Lease vs. Buy Decisions?" *Management Accounting Quarterly* 17(1):9-18 (2015), give the example of warehouse shelving that would require substantial effort to replace when the lease terminates, in which case the entity is likely either to keep extending any lease or to purchase the asset at the end of any initial lease term.

e. E.g., the U.S. Jones Act restricts what type of entities can own or operate ships transporting goods between U.S. ports.

f. E.g., a financially weaker joint venture partner may veto ownership options for an asset that the joint venture requires.

g. Where an entity uses an asset to service a third-party contract on a cost-plus basis, the cost reimbursement provisions can sometimes make leasing more favorable than ownership — e.g., if there is limited provision under ownership for reimbursement of the interest cost/return on capital/residual risk taken. (See Peter Nevitt and Frank Fabozzi, *Equipment Leasing,* 4th ed. New York: Wiley, 2000, p. 24.)

h. The desired asset and its associated maintenance/operating skills may be available only via a lease — e.g., for certain types of drilling rigs in the oil industry and for some test equipment. (See Tevis Martin, "Common Sense and the Lease vs. Buy Model," *Evaluation Engineering*, April 1999, available online at https://www.evaluationengineering.com/home/article/13001337/common-sense-and-the-lease-vs-buy-model.)

Source on all tables: Author.

The range of net present cost (NPC) outcomes under ownership will usually be larger than those under leasing, compounded by the difficulty many entities face in estimating salvage values.

jointly considering value and risk in such situations. We also identify four factors that have a material impact on this value/risk trade-off. The findings are relevant both to potential lessees, by providing a practical methodology for weighing a negative lease value against the risk-transfer benefit, and to researchers interested in factors that lead entities to lease rather than buy the assets they need.

The approach is applicable to many asset types that traditionally have attracted operating/true leases: for example, vehicles, IT and office equipment, nonspecialist equipment, buildings, and big-ticket mobile assets such as railcars, aircraft, and ships.

We focus on depreciating assets expected to be required for the medium or long term relative to the asset's useful life (e.g., for at least a quarter of the asset's useful life[2]), which have a meaningful residual value at the end of the proposed lease term, and with residual value risk in any leases at that point borne by the lessor.[3]

For simplicity, we also assume that the primary risk transferred to the lessor (other than credit risk) is residual value risk.[4] We use the term *entity* throughout to refer to a business or public entity facing a lease/buy decision, occasionally using *lessee* when the context is clearly a lease rather than ownership.

MEASURING VALUE AND RISK TRANSFER IN LEASE/BUY DECISIONS

We use the standard method[5] to calculate value via the net advantage to leasing (NAL), equal to the expected net present cost (NPC) of ownership minus the expected NPC of leasing. We measure risk as the uncertainty in the NPCs under ownership and leasing, expressed as "present values at risk" so as to be comparable with the NAL. The entity would determine the *buy risk* and the *lease risk,* which capture the potential value downsides under each option.

The range of NPC outcomes under ownership will usually be larger than those under leasing, compounded by the difficulty many entities face in estimating salvage values. This difference gives rise to *risk transfer,* which we define as the *excess of buy risk over lease risk.*[6]

Measuring the Buy Risk

The estimated salvage value is typically the only uncertain component in the NPC under ownership calculation, as we are assuming that salvage value risk is the primary risk transferred under the lease. In the worst case, the salvage value under ownership would be zero (e.g., for a totally obsolete asset). So the simplest measure of the buy risk is to take the present value of the entire after-tax salvage value estimate included within the NAL calculation.

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Entities with access to secondhand historical market data can obtain a more accurate estimate of the buy risk by establishing a severe salvage value downside estimate.

Entities with access to secondhand historical market data can obtain a more accurate estimate of the buy risk by establishing a severe salvage value downside estimate. For example, this could be at the 5th percentile (1 in 20 case) based on forecast secondhand market values for the asset and the distribution or volatility of historical secondhand market values, ideally determined over at least two economic cycles. In this case, the salvage value at risk is simply the difference between the expected and severe downside salvage values.[7] The two methods are illustrated in Table 2.

Measuring the Lease Risk

For simple leases (leases with fixed rentals, a single primary period, no extension, early termination or purchase options, and where the asset is certain to be handed back at the end of the lease), the lease risk will be zero. For other leases, risk may arise from:

- contingent rentals that depend on usage, turnover, or an external index such as inflation
- the cost of meeting any stipulated return conditions
- uncertain extension rentals or purchase option costs, linked to an external index or market rate

Table 2.

Calculating the Buy Risk – Example

ABC Corp. requires a Superwidget for 5 years. The Superwidget has a 10-year estimated useful life and costs 100. ABC Corp. has a tax rate of 30% and an after-tax cost of capital of 9%. ABC Corp. forecast a high salvage value of 59 in 5 years' time, but adopt a more prudent midrange estimated salvage value of 45 after 5 years for the purposes of the NAL calculation.

- In the worst-case view, the buy risk is 45 * (1 – 30%) / 1.09^5 = 20.5.
- If, however, ABC Corp. can forecast a severe downside "1 in 20" salvage value of 31, based on historical secondhand market data, then the pretax salvage value at risk would be 14, and the buy risk would be 14 * (1 – 30%) / 1.09^5 = 6.4.

For both methods, the formula is[a]:

$$\text{Buy risk} = \frac{\text{After-tax salvage value at risk for the entity}}{(1+r)^{\text{(Required duration in years)}}}$$

where r = discount rate for the salvage value (e.g., entity's after-tax cost of capital).

a. This is the relevant formula where the required asset duration is known upfront. We will consider later on in this article the situation where the required asset duration is uncertain.

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The net advantage to leasing (NAL) will often be positive if the lessor can access material economic benefits not available to the entity and is willing to pass these on through a lease.

or negotiated toward the end of the primary period (see also Table 9).

The risks here often have no upper bound, so the lease risk should capture the impact on the lease NPC of a severe 1 in 20 case of higher than expected rentals[8] (Table 3).

THE VALUE/RISK TRADE-OFF WHEN THE NAL IS NEGATIVE

Nature of the Value/Risk Trade-off

The NAL will often be positive if the lessor can access material economic benefits not available to the entity and is willing to pass these on through a lease. For example, a captive lessor may be able to offer a rather higher residual value than the entity's expected salvage value.[9]

Where the lessor has no inherent advantage over the entity, however, and we are considering medium to longer term leases for stronger credits (e.g., rated entities), we would typically expect the NAL to be negative, as the lessor's cost of funds plus margin (allowing for credit and asset risk) would normally be higher than the entity's own borrowing cost in the bond markets.

Experience shows, however, that entities still choose to lease some assets where the NAL is negative — for example, because of perceived nonquantified leasing benefits such as convenience, transfer of risk, or optionality, even where a

Table 3.

Lease Risk and Risk Transfer – ABC Corp. Example

ABC Corp. has obtained some 5-year lease proposals for the Superwidget. One proposal features a low initial rental, with a market-related rent review after 2 years. ABC Corp. estimates that the lease's net present cost will lie between 50 and 60 with 90% likelihood, depending on the review, giving:

- an estimated lease NPC of 55 (i.e., a midrange NPC with balanced upside and downside)
- a lease risk of 5

The NPC and lease risk capture the *range* of possible lease outcomes (i.e., an NPC of 55, plus or minus 5), thus reducing the need for ABC Corp. to guess in advance the result of the future rent review.

This lease would reduce the value downside risk/uncertainty from 20.5 under ownership, taking the worst-case view of salvage risk (per Table 2), to 5 under the lease, giving a risk transfer of 15.5. The risk transfer would be 1.4 if ABC Corp. took the market view of salvage risk.

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Provided the expected salvage value assumption under ownership in the NAL calculation is reasonable, the potential upside and downside for the actual versus expected salvage value will tend to be balanced.

lease outcome is not dictated.[10] We shall see shortly that this is to be expected for risk-averse entities in particular.

Entities could simply view the negative NAL as insurance against the risk under ownership of a lower salvage value than expected.[11] Unlike typical insurance risks, however, if the entity owns the asset, it not only bears the possibility of loss but also retains any salvage value upside. Provided the expected salvage value assumption under ownership in the NAL calculation is reasonable, the potential upside and downside for the actual versus expected salvage value will tend to be balanced, and similarly for any lease uncertainties.

Therefore, choosing to lease rather than buy is economically equivalent to receiving value equal to the NAL in return for reducing the risk (two-way variation in value outcomes) by an amount equal to the risk transfer.[12] Hence the NAL and risk transfer capture the range of possible lease-versus-buy value outcomes (Table 4).

From a value and risk perspective, therefore, entering into a simple lease rather than ownership is economically equivalent for the

Table 4.

Range of Lease-Versus-Buy Value Outcomes – ABC Corp. Scenarios

ABC Corp. is evaluating two 5-year lease proposals for the Superwidget. The NAL and minimum/maximum values below now capture the *range* of possible lease-versus-buy value outcomes for each scenario, avoiding the need for ABC Corp. to rely on a single (likely incorrect) guess as to salvage value.

Lease-versus-buy scenario	Range of value outcomes for lease versus buy: Expected (NAL)	Min	Max	Risk transfer (per Table 2 and Table 3)
A. 5 year simple lease, worst-case view of buy risk	- 4.3[a]	-24.8	16.2	20.5
B. 5 year simple lease, market view of buy risk	-4.3	-10.7	2.1	6.4
C. 5 year lease with low initial rental and rent review after 2 years, market view of buy risk	-1.6[b]	-3.0	-0.2	1.4

a. Assumes expected NPCs are 53.4 for buy and 57.7 for the simple lease

b. NPC range for buy is 47.0 to 59.8, as buy risk is 6.4. Expected lease NPC is 55, range 50 to 60. Leasing reduces the 2-way NPC variation by 1.4. NAL is-1.6.

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The larger the ratio, the lower the additional downside value protection under leasing compared with ownership, and the higher the potential opportunity loss of value upside.

entity to receiving the NAL and eliminating salvage value variation.[13] Expected utility theory then tells us that a risk-averse entity may prefer leasing over ownership even if the NAL is negative, as long as the negative NAL is not too large.[14]

Table 5 shows how value and risk can play into the overall lease/buy decision for such an entity.

A Framework for Approaching the Value/Risk Trade-off

When the NAL is negative, we define the *value to risk ratio* as the value cost of the lease (negative NAL) divided by the risk transfer, expressed as a percentage. This provides a basis for making the value/risk trade-off by determining whether the value cost of the lease is justified by the scale of the risk transfer. In other words, the larger the ratio, the lower the additional downside value protection under leasing compared with ownership, and the higher the potential opportunity loss of value upside.

Table 6 shows how this could apply in the ABC Corp. example.

We can now articulate two key principles for the value/risk trade-off:

- The negative NAL should not exceed the risk transfer (value to risk ratio less than 100%). Otherwise the NPC of the severe downside ownership case would be lower than that of the severe leasing case, and the lease would have no risk-transfer benefit. Indeed, if the negative NAL starts even to approach the risk transfer, the entity would almost certainly be better off buying the asset.
- Different entities will draw their boundaries for the value/risk trade-off in different places, depending in particular on their capacity to bear salvage risk downside.

Table 5.

The Value/Risk Trade-off Within the Overall Lease/Buy Decision

Value and risk outcome	Impact on lease/buy decision
NAL positive	"Obviously lease," subject to proper evaluation of the economics if the entity were to require the asset beyond the primary period.
NAL negative but acceptable relative to the risk transfer	Either lease or buy may make sense. The final decision may be driven by other factors.
NAL negative, unacceptable relative to the risk transfer	"Obviously buy." The entity would adopt a lease solution only as a last resort after exhausting all other avenues.

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We would expect entities with higher capacity to absorb salvage risk downside to accept only low value to risk ratios because of the potential salvage value upside under ownership.

Table 6.

The Value/Risk Trade-off – ABC Corp. 5-Year Lease-Versus-Buy Scenarios

Lease-versus-buy scenario	Value to risk ratio	Lease/buy value range, per Table 4	Comment
A. Simple lease, worst-case view of buy risk	21%	NAL: -4.3 Range: -24.8 to +16.2	If the asset supported a fixed-term contract generating expected value of 10 if owned, a risk-averse entity might prefer to lock in a positive value of 5.7 through a fixed lease, rather than own it and risk a value loss of up to 10.5. Less risk-averse entities might still prefer to own.
B. Simple lease, market view of buy risk	67%	NAL: -4.3 Range: -10.7 to +2.1	The potential present value upside foregone (10.7) would be five times the additional downside protection (2.1) offered by the lease, making it unattractive for all but the most risk-averse entities.
C. Lease with rent review after 2 years, market view of buy risk	114%	NAL: -1.6 Range: -3.0 to -0.2	An unacceptable value/risk trade-off. The lease would be value negative versus ownership even for a severe salvage value and lease downside, as the negative NAL exceeds the risk transfer, and so the worst-case lease NPC (60.0) is higher than the worst-case buy NPC (59.8).

We would expect entities with higher capacity to absorb salvage risk downside to accept only low value to risk ratios because of the potential salvage value upside under ownership. Entities with lower capacity to absorb salvage risk downside, however, may be prepared to accept higher value to risk ratios. An entity's capacity to bear salvage risk downside will clearly depend on the entity's overall financial strength, but there are other factors to consider.

Correlation of Earnings With Residual/Salvage Value

Suppose an entity with limited capacity to bear salvage value risk downside is acquiring a core asset whose residual value is strongly positively correlated with

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Unless demand is constant over time, the asset portfolio will likely contain a spread of time commitments, to service long-term core demand while remaining responsive (via leases) to short- and medium-term demand fluctuations.

the health of the entity's business sector. A lease may provide valuable downside protection in this instance: if instead the entity owned the asset, then a lower than expected salvage value would likely coincide with a downturn in the entity's overall cash flow.[15]

However, where the asset's residual value is *negatively* correlated with the entity's other risks and the NAL is negative, it would make little economic sense to give up value to transfer salvage risk that would already be naturally offset within the entity if it owned the asset.[16]

Where the risks under ownership and under leasing have different correlations with the entity's future earnings, we can add multipliers to the buy-risk and lease-risk calculations to capture the extent to which the respective risks are offset by the entity's wider activities.[17]

Managing Portfolios of Similar Assets

Entities managing multiple similar assets also need to consider the *portfolio effects* of the overall asset class. Unless demand is constant over time, the asset portfolio will likely contain a spread of time commitments, to service long-term core demand while remaining responsive (e.g., via leases) to short- and medium-term demand fluctuations.[18]

In this situation, the sell-side salvage risks under ownership will tend to be *negatively* correlated with the buy-side risks of acquiring new capacity if both of the following apply for this asset type:

- there are good cross-correlations over time between the cost of new assets, secondhand values and short- to medium-term lease rates, and
- the entity is regularly in the market for new capacity (whether owned or leased) — that is, there is sufficient buy-side activity to neutralize the risks of the sell-side activity.[19]

In such cases it would make sense for entities to own some of the assets required for the longer term, as the salvage risk would be naturally hedged by the entity's regular acquisitions of new capacity. The case study in Table 7 illustrates this.

FACTORS AFFECTING THE VALUE TO RISK RATIO

We consider below four factors that affect both the NAL and the risk transfer, and which therefore have a material impact on the value to risk ratio and on the value/risk trade-off.[20] We will illustrate the impact of each factor on our ABC Corp. 5-year simple lease, and using a lease/buy model and some ABC Corp. assumptions to model the first three factors, assuming a value to risk ratio threshold of 25% with zero lease risk (so that risk transfer equals buy risk).[21]

A fifth factor — the range of uncertainty in the residual market value — will also directly affect both the buy risk/risk transfer and the NAL, but the impact on the latter is harder to model.[22]

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There are various ways for entities with limited experience of owning an asset class to forecast an asset's residual value, even though lessors rarely disclose their own such assumptions.

Table 7.

Case Study – Modeling the Risk of a Major Oil Company's Future Tanker Requirements

An oil company wanted to determine whether to use ownership or leases to meet its long-term shipping needs. There are strong cross-correlations for oil tankers between new-build costs, secondhand asset values, and shorter term lease rates. Modeling[a] showed that there was no material difference between the total cash flows at risk in the ownership and lease strategies: that is, there were no discernible risk-transfer benefits from using leases to meet the long-term needs.

a. Future shipping requirements were determined and assumed to be met by an appropriate combination of voyage charters, one-year "time charters," and either ownership or 10-year leases. Monte Carlo simulation was then used to simulate the forward voyage charter, time charter, and new-build and secondhand value rates, with the four time-series of random variables generated in such a way as to preserve historically observed cross-correlations. For each simulation, the total cost of accessing the new requirements in each year was determined, from which the 1 in 20 (5th percentile) cash flow at risk was determined. The conclusion remained robust under a series of stress tests such as increases or decreases over time in the entity's overall shipping demand.

The Estimated Residual Market Value of the Asset

This critical input affects both the negative NAL (as it impacts rentals) and the risk transfer, but in opposite directions. Figure 1 shows how the NAL, risk transfer (left-hand scale), and value to risk ratio (right-hand scale) for the 5-year ABC Corp. lease vary with the estimated residual value. The lower the acceptable value to risk ratio for this ABC Corp. project, the higher the required estimated residual value for the lease to be acceptable. In this case, a value to risk ratio of 25% or less would require an estimated residual value of at least 43% of asset cost.

There are various ways for entities with limited experience of owning an asset class to forecast an asset's residual value, even though lessors rarely disclose their own such assumptions.[23]

The Entity's Ability to Achieve Full Market Value When Selling the Asset

Another factor is the extent to which the entity and lessor can achieve similar disposal proceeds (or realize value through ongoing use of the asset, in the case of the lessor) once the entity no longer requires the asset — that is, how the salvage value compares with the market residual value.

This affects the negative NAL and buy risk in the same direction. As we have seen, the NAL may be positive if the entity is disadvantaged in this respect. Table 8 shows some typical situations.

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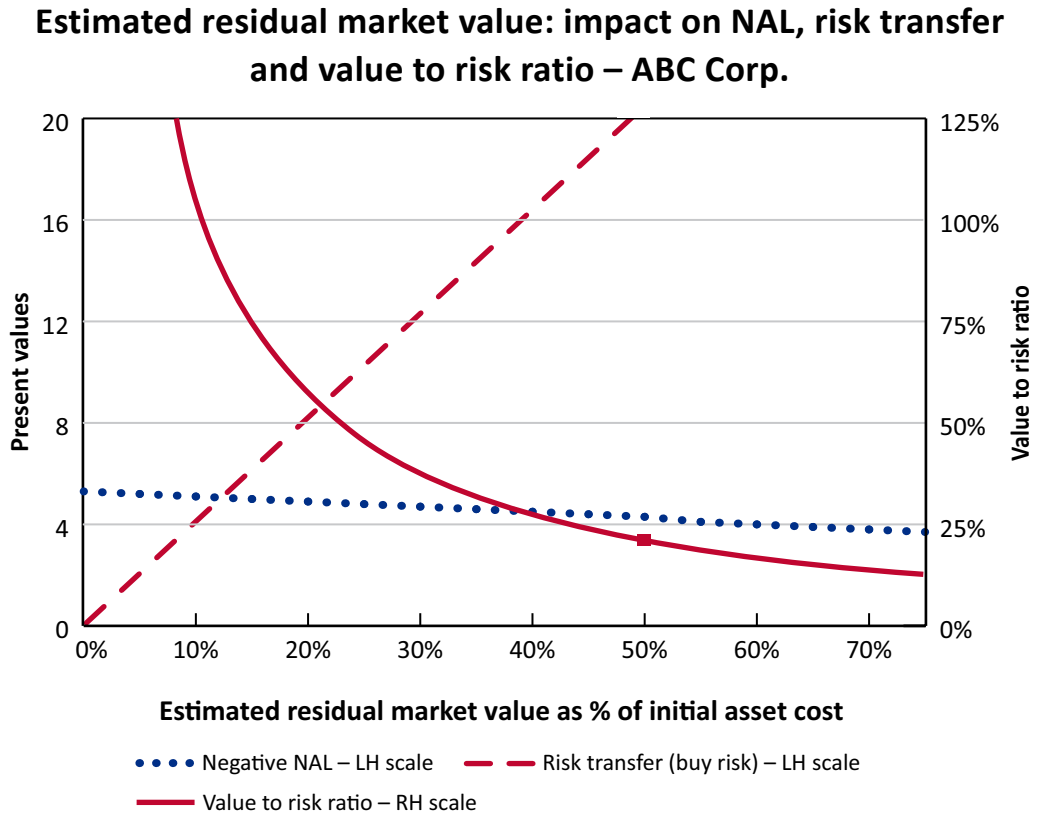
Figure 1. Impact of Estimated Residual Market Value on the Value to Risk Ratio



Source: Author's model (5-year lease, ABC Corp. assumptions but varying the estimated residual value of 50%)

Table 8.

Entity's Position in the Secondhand Market – Some Typical Situations

Nature of secondhand market	Entity as owner disadvantaged relative to lessor?	Examples
Transparent	Entity on a par with lessor	Financial lessors in broker-dominated markets such as shipping
Transparent	Entity disadvantaged due to limited experience selling in this market	Entities requiring commercial vehicles, for whom this is not their core business
Opaque	Entity significantly disadvantaged	Some IT and office equipment

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As the lease length increases, the NAL will usually become less positive or more negative, whereas both the absolute salvage value and the applicable discount factor will decrease, and so the risk transfer will fall sharply.

Figure 2 shows how the NAL, risk transfer, and value to risk ratio for the 5-year ABC Corp. lease vary with the entity's salvage value (as a proportion of market value). This lease is value positive, provided the salvage value is less than 71% of the market value, while the value to risk ratio is less than 25%, provided the entity can achieve no more than 95% of the market value.

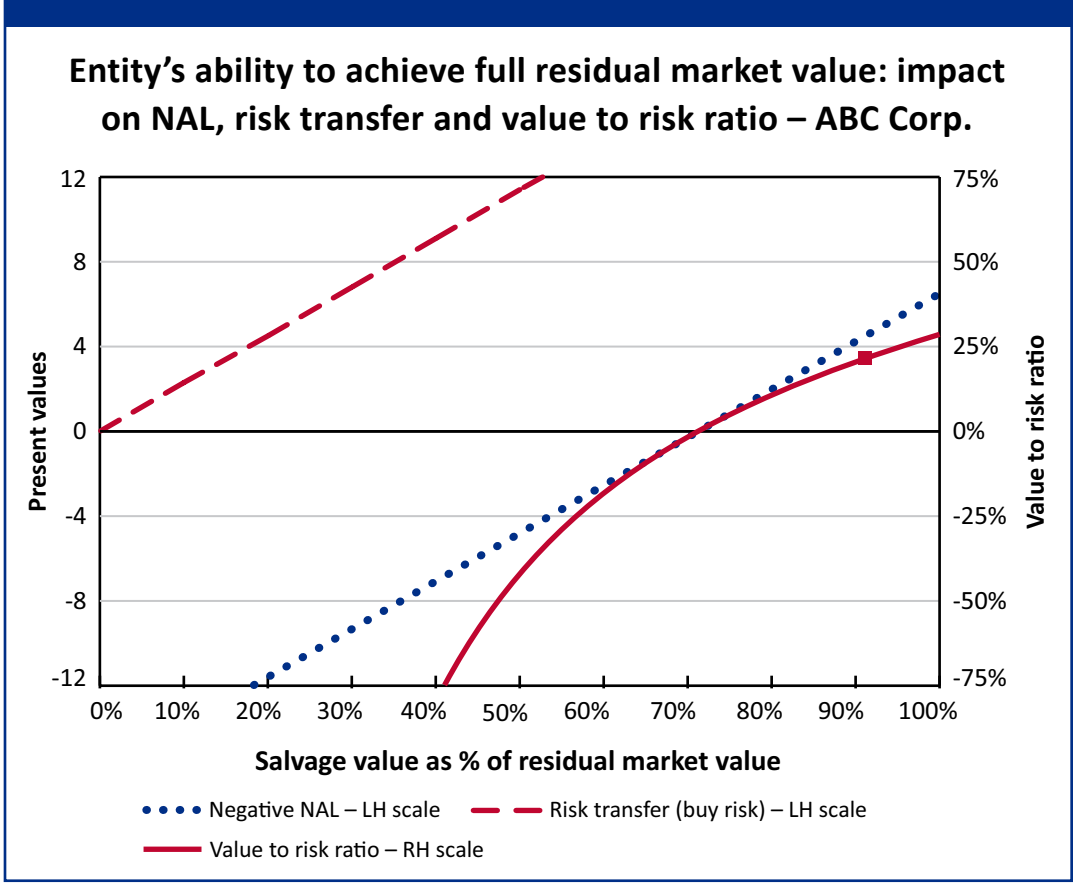
How Long the Asset Is Required for, Relative to the Asset's Useful Life

As the lease length increases, the NAL will usually become less positive or more negative,[24] whereas both the absolute salvage value and the applicable discount factor will decrease, and so the risk transfer will fall sharply. Figure 3 shows how the value to risk ratio increases rapidly with lease duration for the ABC Corp. lease, where the asset has a 10-year life.[25]

This simple analysis shows why:

- Leases are the obvious economic (as well as convenient) solution when an asset is required for only a relatively short proportion of its useful life.
- Ownership generally becomes increasingly attractive as the asset requirement lengthens.

Figure 2. Impact on Value to Risk Ratio of Entity's Ability to Achieve Full Market Value



Source: Author's model (5-year lease, ABC Corp. assumptions but varying the 90% salvage value assumption).

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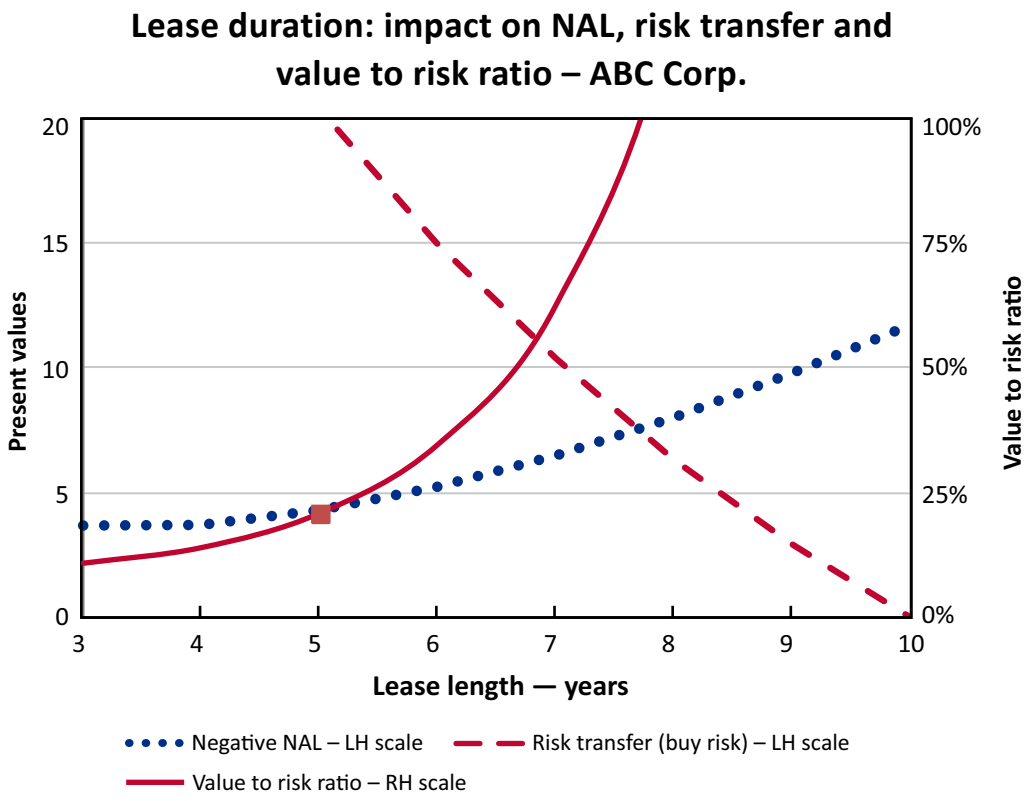
In practice, many business requirements for assets do not have a fixed duration that is known upfront. This uncertainty about how long the asset is actually required for has a major impact on lease/buy decisions.

Figure 3. Impact of Lease Duration on the Value to Risk Ratio



Source: Author's model (ABC Corp. assumptions but varying the 5-year assumed lease duration).

- The lower the acceptable value to risk ratio for a project, the lower the maximum acceptable lease duration before ownership becomes preferable. For example, in Figure 3, a value to risk ratio of 25% or less would require a lease length of less than 5.5 years.

We conclude that leases of depreciating assets for the majority of their useful life will generally be hard to justify *solely* by reference to risk transfer, as the risk transfer will be too low relative to the negative NAL.[26]

Uncertainty About How Long the Entity Requires the Asset

So far we have mainly considered simple leases, where an asset is required for a fixed period and will be handed back to the lessor (if leased) or sold at the end of the fixed period (if owned).

In practice, many business requirements for assets do not have a fixed duration that is known upfront. This uncertainty about how long the asset is actually required for has a major impact on lease/buy decisions. Firstly, it affects the design of any proposed leases, such as the initial lease term and options at

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The risk transfer if a lease is to be renewed will depend on the nature of the renewal option. In this case the lease and buy options may both have significant uncertainty, so that both the buy risk and lease risk will need to be considered.

expiration. For example, the entity may be able not only to hand the asset back, but also to:

- purchase the asset during or at the end of the lease.
- extend the lease for a secondary period, either via extension options agreed upon upfront or by negotiation at the end of the lease. (This can sometimes result in the lessee paying for an asset several times over when all the extensions are taken into account.)
- negotiate a lease for a new replacement asset when the first lease finishes.

Secondly, this uncertainty affects both the negative NAL and the risk transfer, in opposite directions. The NAL will usually be less positive or more negative if a lease is renewed, compared with when the asset is handed back at the end of the primary period, while the buy risk will reduce due to the lower salvage value.

The risk transfer if a lease is to be renewed will depend on the nature of the renewal option; in this case the lease and buy options may both have significant uncertainty, so that both the buy risk and lease risk will need to be considered. Table 9 shows typical risk outcomes for three lease renewal options exercisable at the end of an initial term.

When the duration for which the asset is required cannot be

Table 9.

Typical Risk Outcomes for 3 Lease Renewal Options, Assuming They Are Exercised

Renewal option	Buy risk	Lease risk	Risk transfer
Fixed-price purchase option	Depends on duration, not on type of option. Usually lower than buy risk at end of primary period.	Same as buy risk	Zero. Asset will be owned during the extension period irrespective of whether it is initially owned or leased.
Fixed-rate extension		Zero	Equals buy risk
Market-rate extension		Lease risk may be material, and for longer extensions could be comparable to or higher than buy risk, giving rise to low or negative risk transfer. Buy risk depends on asset value at end of secondary period, whereas lease risk depends on market conditions at end of primary period, when the market value and discount factor will be higher than at the end of the secondary period.	

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If the asset is likely required for 7 years, with just a small chance of being returned after 5 years (if, for example, there is an unexpected technology change), then the lease/buy decision should clearly give greater weight to the 7-year rather than the 5-year economics.

determined upfront but depends on future events, the economic impacts can be evaluated by:

- identifying the most relevant scenarios and estimating their probabilities of occurrence[27]
- determining the NAL, buy risk, lease risk, and risk transfer for each scenario
- calculating the blended NAL and risk transfer, probability weighted across the relevant scenarios[28]

To illustrate this, suppose ABC Corp. needs a Superwidget for either 5 or 7 years, and that ABC Corp. will either buy the asset (and sell it when no longer needed) or will sign a 5-year lease, and exercise a pre-agreed 2-year fixed-rate extension option if the asset is needed for 7 years.

If the asset is likely required for 7 years, with just a small chance of being returned after 5 years (if, for example, there is an unexpected technology change), then the lease/buy decision should clearly give greater weight to the 7-year rather than the 5-year economics. A focus only on the initial lease term would tend to overstate the benefits of leasing.

Figure 4 shows how the NAL, risk transfer, and value to risk ratio vary with the likelihood that ABC Corp. will need the asset beyond year 5. Here, the value to risk ratio is less than 25%, provided the chance of ABC Corp. needing the asset beyond 5 years is less than 16%.

We have focused here on options under leasing. Ownership brings a different set of options — for example, to sell the asset at any time, to retain it for as long as required at low extra cost, freely to enhance or modify it, and freely to lease it out to others. The option under ownership to sell the asset at any point will tend to limit the switching benefits available under leasing (e.g., if new technology becomes available).

The ability to retain the asset for as long as required can also be very valuable. For example, the benefit of ownership would increase in the above example if there was a chance that the asset might be required for 10 years.

CONCLUSIONS

Lease/buy decisions for assets required for the medium to long term (e.g., for more than a quarter of the asset's useful life), and where the salvage risk under ownership is an issue, need to consider both the expected value outcome (NAL) and risk (the uncertainty or range of potential value outcomes), alongside other factors.

We have proposed a simple approach that potential lessees can use to quantify the risks of both ownership and lease options. The approach can also be applied to leases with renewal options. The range of value outcomes under ownership is usually greater than

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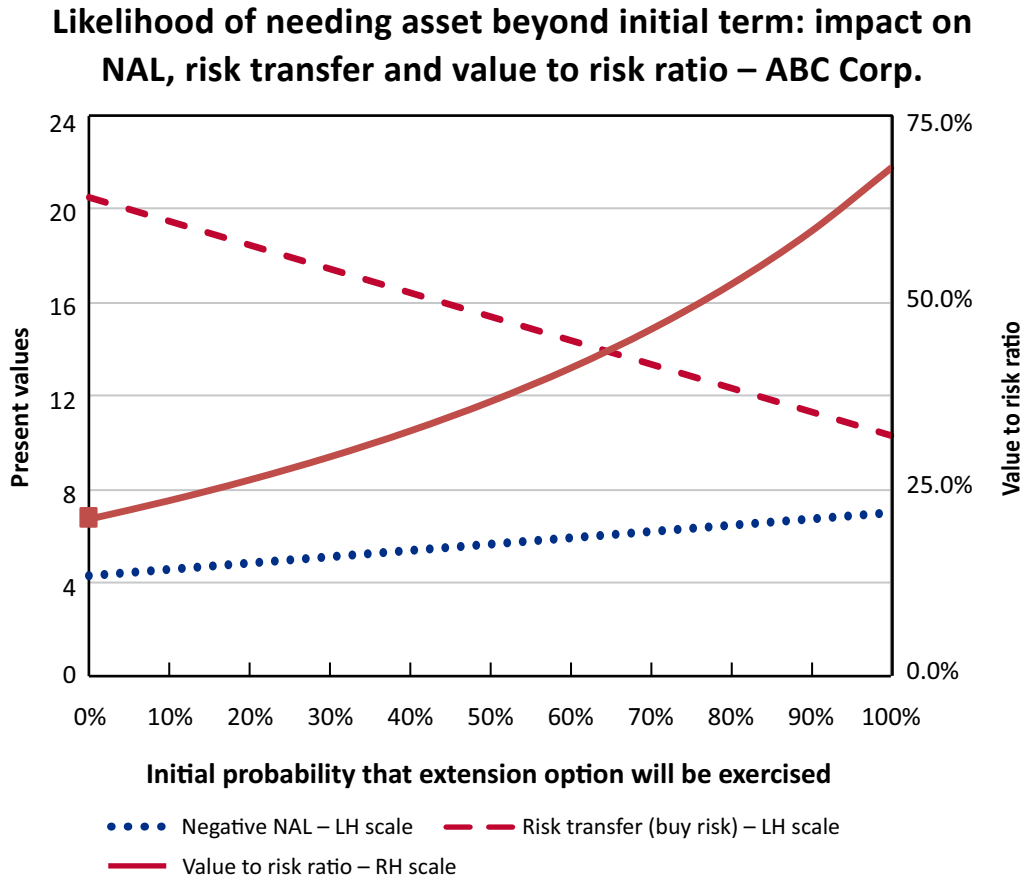
Provided the assumptions underpinning the NAL calculation are reasonable, choosing to lease rather than buy is economically equivalent to receiving value equal to the NAL in return for reducing the risk (two-way variation in value outcomes) by an amount equal to the risk transfer.

Figure 4. Impact on Value to Risk Ratio of Likelihood of Needing Asset Beyond Initial Term



Source: Author's calculations. Assumptions: For initial 5-year term, NAL =-4.3, risk transfer = 20.5; for 5-year term plus 2-year extension, NAL =-7.0, risk transfer = 10.3.

for a lease option, and this difference gives rise to risk transfer.

Provided the assumptions underpinning the NAL calculation are reasonable, choosing to lease rather than buy is economically equivalent to receiving value equal to the NAL in return for reducing the risk (two-way variation in value outcomes) by an amount equal to the risk transfer. We would therefore expect a risk-averse entity to be willing to bear a negative NAL in return for the risk transfer, provided the NAL is not too negative. Experience shows that stronger credits may also at times enter into value-negative leases. Entities can use the value to risk ratio (the negative NAL divided by the risk transfer) to make this value/risk trade-off and determine when the NAL becomes too negative relative to the risk transfer.

This decision will depend critically on the entity's capacity to bear salvage risk, which in turn is affected by any correlation between the asset risks and the entity's earnings. Where an entity

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Table 10.

Typical Impacts of Key Factors on the Value to Risk Ratio

Value to risk ratio lower (lease more acceptable)	Factor	Value to risk ratio higher (lease less acceptable)
Higher expected rv%	Expected residual market value (rv) as % of initial cost	Lower expected rv%
Lower salvage value%	Achievable salvage value for entity under ownership, as % of residual market value	Higher salvage value%
Shorter lease duration	Lease duration as % of asset life	Longer Lease duration
Lower chance of renewal	Uncertainty how long the entity requires the asset for (e.g. chance of lease renewal)	Higher chance of renewal

Where an entity manages a portfolio of similar assets, there may be a stronger case for owning some of the longer term assets, as the salvage risk under ownership may be naturally hedged by the wider portfolio.

manages a portfolio of similar assets, there may be a stronger case for owning some of the longer term assets, as the salvage risk under ownership may be naturally hedged by the wider portfolio.

We have identified four factors that affect both the NAL and risk transfer and hence materially affect the value to risk ratio. Typical impacts are summarized in Table 10. In particular, leases of depreciating assets for the majority of their useful life will generally be hard to justify just by reference to risk transfer. Entities involved in multiple lease/buy decisions could use these factors, alongside their overall corporate finance policies, to develop frameworks to guide their decisions, rather than having to work on a case-by-case basis. ■

Acknowledgments

The author gratefully acknowledges the multiple interactions with BP colleagues and projects over many years and their influence on the ideas developed in this article. These ideas have evolved considerably since the author's retirement, and the article is not intended to and should not be construed as representing BP's approach to lease evaluation.

Endnotes

1. For example, such leases may prove attractive if the lessor can offer a lower overall effective borrowing rate than the entity's normal debt, due to the lessor's advantaged tax position. These types of lease/buy decisions typically compare the net present costs of two types of long-term financing that have similar accounting and risk outcomes.

2. "Quarter of useful life" is suggested as a rule of thumb as to when detailed lease/buy analysis is worthwhile.

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3. We are assuming that leases are noncancelable, offering a one-time protection against salvage value risk at the end of the lease term (and at the end of any pre-agreed extension options), in the form of the lessee's option to hand back the asset at that time: e.g., if it no longer requires the asset, or if a better leasing deal or better technology has become available. We will not consider leases where the lessee may share in any residual value upside and/or downside at the end of the lease (e.g., in the latter case, by way of a residual value guarantee).

4. However, the "1 in 20" approach described below for quantifying the risks under ownership can also be applied in situations where salvage value is not the only uncertainty, but where the lessor takes operating risks as well: for example, by dint of providing additional services such as maintenance or full operation of the asset.

5. Stewart Myers, David Dill, and Alberto Bautista, "Valuation of financial lease contracts," *Journal of Finance* 31: 799-819 (1976), as modified for situations where there is a salvage value under ownership. (See James Schallheim, *Lease or Buy: Principles for Sound Corporate Decision Making,* Boston: Harvard Business School Press, 1994, page 126.) The NPCs are calculated after tax using after-tax discount rates. Most cash flows are discounted at the entity's marginal after-tax cost of debt, except for the after-tax salvage value under ownership and any operating cost savings under leasing, which are discounted at a higher discount rate to reflect their riskiness. A simple approach is to use the entity's normal after-tax cost of capital as the discount rate for the after-tax salvage value. Schallheim (*Lease or Buy,* chapter 8) describes a more sophisticated approach of estimating asset betas and using these to determine salvage value discount rates based on asset type.

6. This is a simplified approach that aims to minimize the use of probability distributions. Where the probability distributions of key unknowns (e.g., salvage value) and the correlations between them can be estimated, even if roughly, then Zeller, Stanko, and Tressler ("How Risky ...?") suggest using Monte Carlo analysis to estimate the distributions of the present value variations under ownership and leasing, thus providing additional insight for decision-makers.

7. This method can be applied asset by asset; entities with many assets could also determine salvage value risk weightings by asset class. Asset classes with volatile or illiquid secondary markets might be given a 100% risk weighting, so that in the severe downside case 100% of the estimated salvage value would be at risk. Asset classes where (for example) historical second-hand market lows are well in excess of half the estimated residual value might be assigned (say) a 40% risk weighting, so that the buy risk would be 40% of the worst-case figure.

8. It should normally be possible to make reasonable upper-bound estimates for contingent rentals, based on history and/or forecasts of the relevant rate factors. For extension rentals, where entities do not have access to sufficient rental or market history, the scale of the risk can be roughly estimated using simple approaches such as allowing forecast rentals or purchase option costs to increase by a certain percentage.

9. Other lessor advantages that could lead to a positive NAL include being better able to monetize the capital tax reliefs on the asset (e.g., for financial lessors such as banks); being able to secure a lower acquisition cost; and

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for service leases exploiting synergies from combining ownership with maintenance or operation of the asset (e.g., for "industry lessors"). Gary Andrew and Dennis Gilstad, "A Generation of Bias Against Leasing," *Journal of Equipment Lease Financing* 23(2):1-14 (2005), discuss such potential entity/lessor basis differences.

10. For example, the Government of Western Australia's lease analysis guidelines (Lease Analysis Guidelines, Department of Treasury and Finance, Government of Western Australia, August 2005, previously available online) indicate that a cost premium of up to 5% of the capital cost of the equipment would generally be considered an acceptable cost to transfer residual/salvage risk from entity to lessor.

11. Where there are lease renewal options, the "loss" under ownership may include other factors such as failure to capture new technology benefits that might become available. We note that entities frequently choose to insure even though insurance usually has a negative net present value on a pure expected value basis.

12. So by leasing, both the downside (worst-case ownership downside versus worst-case lease downside) and the upside (best-case ownership upside versus best-case lease upside) are reduced by an amount equal to the risk transfer. It is irrelevant here to what extent the ownership and lease upsides or downsides are correlated with each other (although, as we shall see, the correlations of the upsides or downsides with the entity's earnings *are* relevant).

13. So, for the entity, a simple lease is economically like a floating to fixed-rate swap on the after-tax salvage value, with the NAL representing the value cost of entering into the swap, and the "fixed rate" being the entity's expected after-tax salvage value.

14. Per expected utility theory (e.g., see Jean-Pierre Danthine and John Donaldson, *Intermediate Financial Theory,* 2nd ed., Cambridge, Mass.: Academic Press, 2014, chapter 4), a risk-averse entity would prefer leasing over ownership as long as the negative NAL does not exceed the "risk premium." In this context, the risk premium is the excess of the present value of the expected after-tax salvage value over its "certainty equivalent," which in turn is the lowest amount of immediate money-for-certain that the entity's decision-maker would be willing to accept instead of the uncertain future after-tax salvage value, if it owned the asset. In practice, however, the risk premium is not easy to determine: it requires knowledge of the entity's value utility function. We have adopted a simpler approach based on a "value to risk ratio," which is also applicable in cases where both leasing and ownership carry economic risk.

15. For noncore assets, however, it may be less likely that a low salvage value will coincide with a downturn in the entity's business, and so the downside protection may be less valuable.

16. Wenyuh Tsay, "Residual value risk in the lease-or-buy analysis," *Journal of Academy of Business and Economics* 1(1):87-94 (2003), develops an example where the entity should purchase if earnings and residual value are negatively correlated, and otherwise should lease.

17. For example, if residual value and lease extension rates are both strongly positively correlated with the entity's future earnings, we might assign multipliers of 0.8 to the buy risk, but only 0.2 to the lease risk, as high lease extension rates would be largely offset by higher entity earnings.

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18. William Gibson, "Aircraft lessor prospects and lease valuation for airlines," *IATA Economics,* October 2008, www.iata.org/en/iata-repository/publications/economic-reports/aircraft-lessor-prospects-and-lease-valuation-for-airlines/, and Tevis Martin, "Common Sense ...," consider these issues for aircraft and test equipment respectively.

19. We are ignoring the normal termination of leases, as these do not typically create market exposure for the lessee.

20. These expand on some of the factors considered in Clifford Smith and Macdonald Wakeman, "Determinants of Corporate Leasing Policy," *Journal of Finance* 40(3):895-908 (1985).

21. ABC Corp. assumptions: ABC Corp. is a reasonable credit; book value depreciates on straight-line basis over 10-year asset life to nil; estimated residual market value equals book value; lessor assumed residual value risk in the lease equals 80% of estimated residual market value; ABC Corp. estimated salvage value is 90% of estimated residual market value; ABC Corp.'s tax rate is 30%; tax depreciation is the same as accounting depreciation; ABC Corp. can borrow at 5%; lease rentals are fixed and paid annually in arrears (so lease risk is zero); implicit interest rate in lease is 8%; ABC Corp. cost of capital is 9%; buy risk calculated using worst-case method.

22. An asset whose residual value has greater certainty should attract a lower lessor margin, if it is leased, and may also warrant a lower discount rate for the salvage value if it is owned, leading to lower net present costs of both ownership and leasing. The net impact on the NAL will depend on the individual circumstances of lessor and entity.

23. E.g., entities may be able directly to access relevant secondhand market value data, or indirectly to estimate forward values/trends using data on the underlying factors that typically drive the relevant secondhand values. See Stephen Low, "Forecasting Residual Values," *Journal of Equipment Lease Financing* 2(3):18-25 (1984).

24. By analogy with the situation for loans of increasing durations.

25. For the worst-case method, the NAL and buy risk graphs cross at the lease duration for which the lease-versus-buy decision is value neutral assuming zero salvage value under ownership. This point will depend on factors such as market conditions (e.g., lessor margins), the nature of the asset, and any inherent lessor advantages.

26. The NAL may be positive if the entity is sufficiently disadvantaged in the secondhand market relative to the lessor, even for longer term leases, but the lease justification is then the positive NAL rather than the risk transfer.

27. Models have been developed to quantify the option value within leases, for example using variants of the Black-Scholes formula (see Schallheim, *Lease or Buy,* p. 168). These techniques, however, may ignore the option value under ownership, and as Gibson ("Aircraft Lessor Prospects ...,") suggests, can also result in a "black box" number, which may be difficult to interpret. For potential lessees, we believe an approach that looks at specific scenarios is not only easier to compute but is also much more insightful for decision-makers.

28. To calculate the "true" "1 in 20" downside risk where there are multiple scenarios would be complex and require estimating probability distributions for each scenario. The blend approach is quick, easy, and intuitive, offering an indicative "fit-for-purpose" method for determining the value to risk ratio in many of these types of situations.

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Prior to his retirement from BP Treasury, London, in 2014, Andrew Apps spent 12 years managing a sizable portfolio of structured ship leases, developing financing strategies, and delivering financing solutions for BP Shipping's vessel requirements. In 2006, he was nominated onto the BP Group's advisor program, and in that role he advised the BP Group on a wide range of leasing issues covering multiple asset classes. Dr. Apps subsequently co-developed and co-authored BP's internal guidelines on lease evaluation. Before joining BP Treasury in 1999, he held a variety of analytical, planning, strategy and business change management roles over a period of 18 years in BP's refining and marketing businesses. Dr. Apps holds a first-class honors degree in mathematics, an MMath with distinction, and a PhD in mathematics, all from the University of Cambridge, United Kingdom. He is also a Fellow of the Institute of Mathematics and its Applications.

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