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Including Real Options in Evaluating Terminal Cash Flows in Consumer Auto Leases

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Abstract

Leasing has become a popular method of financing automobile acquisitions. According to White (2001), consumers now acquire a majority of luxury automobiles using lease financing. Traditional lease analysis ignores the value of options embedded in the lease that affect the terminal cash flows. This paper shows that the terminal cash flows from an automobile lease should be viewed as a call option and several put options, each containing different exercise prices. The paper contains data to assist in empirically estimating the values of these options at the end of an automobile lease. Results show that ignoring the interplay of option values at the end of the lease may lead to costly financing decisions by the consumer.

JEL Classification: D12

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1. Introduction

Over the past several decades leasing has gained popularity with retailers as a financing tool for selling merchandise. Consumers now find it easy to lease home furnishings, entertainment centers and automobiles. Although consumers are cognizant that signing a lease commits them to making future payments, often they are unaware that they have also purchased and sold several financial options that may be costly to them in the future. These options are embedded in a lease's lengthy legal terminology, which makes it difficult for the

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average consumer to comprehend the full extent of the financial liabilities contained in the contract. Furthermore, it may be impossible for the lessee to estimate the value of these options at the end of the lease. Also, unlike a loan, a lease does not list an annual percentage rate (APR) that the consumer can use in choosing between different leases. As demonstrated in this paper, the APR of the lease is a critical parameter in determining the optimal method of financing the acquisition of an automobile using either a lease or a loan. Yet, the Federal Consumer Leasing Act does not require the lessor or dealer to disclose the APR to the consumer.

Nowhere are consumer misunderstandings more prevalent than in automobile leasing, which has become a popular financing method for consumers to acquire automobiles. According to White (2001) 30% of new vehicles are leased instead of purchased. For luxury automobiles the lease rate is much higher indicating that some consumers upgrade to expensive cars because the advertised monthly lease payments appear to be less than traditional automobile purchase loans. Yet, by focusing on the monthly lease payments consumers may fail to realize other financial commitments embedded in a lease. A typical automobile lease contains many options that expose a lessee to future financial uncertainties. Contract clauses inserted by the lessor create options with the intent of transferring some of the ownership risks to the lessee. An average consumer that lacks contracting or leasing experience may be unaware that s/he has sold options to the lessor. Typically, automobile leasing advertisements focus the consumer's attention on only one of the options in the lease, the option to purchase the car at the end of the lease. Very often (Burgess, 1999) the end of lease purchase price of the vehicle is set artificially high by the dealer as a marketing ploy. Although the lessee owns this option, at expiration of the lease, the option is worthless. Unfortunately, some consumers exercise the option with the false notion that it allows them to avoid financial consequences of other options in the lease owned by the lessor.

Nonetheless, leasing has grown in popularity with consumers and dealerships. On the surface it appears that leasing allows consumers to acquire the use of an expensive automobile for less of a financial commitment than purchasing a vehicle. Dealers like leases because more consumers can qualify for the lower monthly lease payments on a high-end vehicle than those that can qualify for a loan to purchase the vehicles. However, comparing monthly payments between a lease and a purchase loan does not satisfactorily account for option values in the lease. This paper examines the cash flows associated with options that the dealer and consumer have at the end of a lease. This paper focuses on typical closed end leases with a guarantee purchase price for the lessee. Furthermore, this paper contains data that can be helpful in determining the end of lease cash flows associated with a lease.

2. Motivation for leasing

The literature (Gitman, 2000, p. 750) documents several common motivations for corporations to lease fixed assets. These include taxes, maintenance, obsolescence, and expected time needs of an asset. Corporations can reduce taxable income through lease payments as opposed to depreciating owned assets. Leases enable a corporation to defer the upkeep and maintenance to the lessor. In addition, leases can be structured to permit the lessee to

periodically upgrade equipment when it becomes obsolete. Computers are a prime example of equipment that becomes obsolete before a user has an opportunity to recover the equipment cost through depreciation. Also, disposition of the asset at the end of a lease is easier for corporations since they do not have to account for capital gains or losses from the equipment or expend resources in removing and disposing of the equipment once its usefulness to the corporation has been exhausted.

Assuming that the vehicle will be for personal use, consumers do not receive the same tax advantages from leasing that corporations do. The consumer cannot deduct the lease payment from taxable income. Furthermore, none of the maintenance costs associated with the vehicle qualify as a personal tax deduction. Consequently, consumer motivation to lease may depend on behavioral rather than financial reasons. Some consumers may lease simply because they prefer a new vehicle every one to three years. In such cases leasing can make acquisition (little or no down payment) and disposition easier (no issues associated with reselling the car) and the consumer is accustomed to always having a monthly transportation expense. Also, social status may play an important behavioral motivation behind consumer automobile leasing. Sales volumes at luxury car dealerships have benefited from leasing. A majority of luxury automobiles are now acquired by leasing. Many consumers who could not afford the monthly loan payments on a luxury automobile find that they can qualify for lower monthly payments of a lease. This allows the consumer to upgrade to a higher-end car that carries more societal prestige. Although a lease may have lower monthly payments than a loan, the consumer appears to neglect other increases in periodic expenses (e.g., insurance, routine maintenance, and operating costs) associated with a higher end vehicle. Thus, from a practical viewpoint, although the monthly lease payments on a luxury vehicle may be equivalent to loan payments on a standard vehicle, the associated maintenance, and the insurance and tax liabilities of the luxury vehicle make it significantly more expensive.

3. Lease components

A lease is a contract where the lessee (the consumer) promises to make future periodic payments to the lessor (leasing company) for the use of the lessor's asset (automobile). The periodic payments represent an annuity consisting of finite payments of a fixed amount. The lessor determines the payment amount by computing the difference between the current sale price and the estimated resale price of the asset at the end of the lease. This difference represents the principal financed by the lessor. The lessor uses a required rate of return to calculate the payments such that the present values of the payments and the resale price equal the current sale price. Although automobile lessors follow the same logic for computing a lease payment, the technique is altered by using a money factor instead of an annualized interest rate, making it difficult for a consumer to understand the financing terms embedded in the lease.

In addition to making periodic lease payments, the lessee gives further assurances to the lessor regarding the upkeep and maintenance of the vehicle. Automobile leases are essentially triple net leases where the lessor requires the lessee to pay for maintenance, taxes, and insurance on the vehicle. By doing this, the lessee provides assurances to the lessor that the

vehicle will be kept in an optimal operational and marketable condition. Failure by the lessee to maintain the vehicle, insure the vehicle, and pay taxes on the vehicle constitutes default under the lease contract.

Additional components in the lease can include a guarantee purchase option, additional usage charges, early termination, and disposition conditions. All of these components represent financial call and put options that can be exercised at the end of the lease. A closed-end automobile lease will state a price that the consumer can purchase the vehicle at the end of the lease. This represents a guarantee by the lessor that the lessee may purchase the asset at the end of the lease for a prespecified price (which is the exercise price of a call option). The lessor limits the lessee's usage of the vehicle by charging for mileage that exceeds an annual allotment set by the terms of lease. Exceeding the mileage limits constitutes excess use of the vehicle that the lessee must pay to the lessor. In addition, the lessor allows the lessee to terminate the lease before the contracted expiration date. At the end of the lease, the lessor usually requires an inspection of the vehicle to ensure that it has been maintained to manufacturer's specifications. The lessor often employs an agent that inspects the vehicle's maintenance records, exterior and interior finishes, tires, windshield, and so forth for excessive wear and tear. Any indication that the vehicle is in poor marketable condition requires the lessee to pay a fee when the vehicle is returned at the end of the lease.

4. Contractual options embedded in the lease

Contractual clauses within a lease create options for both lessor and lessee. The lessee's interests are in using the lessor's asset to its maximum potential for minimal costs. The lessor's interests are in ensuring that the asset retains as much market value as possible. Because of the potential conflict between the lessor and lessee's interests, lease contracts contain clauses that reallocate future risks between the two parties to the contract. For example, the lessee receives a European call option when the lease allows the lessee to purchase the asset at a guarantee price at the end of the lease. In theory, the lessor sets the option's exercise price based on past resale performance of the vehicle's model. As shown by Gutman and Yagil (1994), the lessor's superior knowledge of the resale value gives s/he an advantage over the lessee that can have an effect on future cash flows.

The lessor's risk associated with the end of lease market value of the vehicle depends on many factors, some of which the lessor cannot control. However, since the lessee's care of the vehicle has a significant effect on the vehicle's future value, the lessor can exert control over the lessee's upkeep of the vehicle by purchasing a series of put options from the lessee. The lessee creates the put options by making assurances to the lessor that the vehicle will have an implied condition and market value at the end of the lease. When the lessee's lack of upkeep of the vehicle causes the vehicle to have a below market value at the end of the lease, the lessor exercises his/her put option to force the lessee to make up the loss of value. A maximum mileage allotment during the lease represents another put option owned by the lessor. Because excessive mileage reduces the market value of the car the lessor charges the lessee for returning the vehicle with mileage that exceeds limits placed in the lease. Unlike metering (Grenadier, 1995), the lessee receives no benefits for using the vehicle less than the

allotted mileage. An additional put option owned by the lessor requires the lessee to have the vehicle periodically serviced to conform to the manufacturer's specifications. If the lessee fails to perform these tasks, s/he may be penalized at the end of the lease. Exterior finish and body integrity and interior fabric and finishes must be free of signs of abuse or excessive wear that may diminish the car's value. As a consequence of the put options, the lessee may owe a fee if the lessor finds the car in unsatisfactory condition at the end of the lease. Unfortunately for the lessee, s/he may be unaware of the function of these options and their potential cost if the lessor exercises the options at the end of the lease. Furthermore, some of the factors affecting the value of these options may be beyond the complete control of the lessee. For example, damage to the exterior finish may result from poor road and weather conditions experienced by the driver during the course of the lease.

Options in the lease facilitate redistributing risks associated with the asset during and at the end of the lease. The values of these options may be interdependent. For example, excess mileage may coincide with excessive wear and tear of the vehicle, which reduces the value of the lessee's purchase option while the value of the lessor's put options increase. Such interdependencies make it difficult or impossible to develop a precise financial model for valuing the options at the inception of the lease contract (Lander & Pinches, 1998). However, past data on automobile resale values, maintenance costs, and the lessee's personal knowledge of driving habits should allow for estimating future values of some of these options.

5. Including real options in lease valuation

Undergraduate and MBA finance curricula teach students to use a discounted cash flow (DCF) analysis to compute the net advantage to leasing (Brigham, Gapenski & Ehrhardt, 1999, chap. 19). Consequently, when students become professional analysts they rely on DCF analysis to evaluate capital budgeting projects. Surveys of corporations (Nunnally & Michael, 2000; Farragher, Kleiman, & Sahu, 1999) have shown that DCF analysis is the most common method of capital investment analysis. Traditional DCF analysis requires the analyst to develop initial, periodic, and terminal cash flows caused by both alternatives: leasing and purchasing. Because assets for personal use do not have tax consequences, before-tax and after-tax cash flows are equivalent. Under the traditional DCF analysis, terminal cash flows for the purchase alternative consist of the net after tax proceeds from disposing of the asset. With the lease alternative, terminal cash flows consist of return of deposits. The analysis ignores possible cash flows that may result from purchasing the asset at the end of the lease or penalties for excessive use that may be due the lessor. The analyst then uses an appropriate discount rate to compute the present value of the future costs for the two alternatives. The alternative with the lowest present value of costs represents the superior alternative. Nunnally and Plath (1989) provided an example of using traditional DCF analysis for automobile leases.

Although some researchers (Brigham et al., 1999, p. 742) have claimed that DCF analysis generally result in correct decisions, many researchers (Hodder & Riggs, 1985) have criticized DCF analysis for ignoring potential cash flows caused from exercising options in a lease. This has led to the inclusion of real option analysis when evaluating leases. Real

options extends investment option theory to lease analysis as a method of including option values associated with early termination, end of lease purchases and mileage charges. Several authors (Grenadier, 1995; Schwab, 1995; Miller, 1995) have developed complex valuation models that use real options for valuing leases. Typically, these models assume that the option's value results from an underlying asset that has a known (or assumed) probability distribution and stable variance. Furthermore, the underlying asset must be measurable, usually through some type of market pricing data. With these assumptions in place, the authors use stochastic calculus to model the pricing behavior of the assets. When more than one option exists in the lease, the models easily become intractable and require simplifying assumptions so that an approximate solution to the model can be estimated. Consequently, many models focus on valuing a single option and ignore other options that coexist in the problem (Hendel & Lizzeri, 2002).

Miller (1995) developed an option based model for valuing car leases. By assuming that the depreciation rate of an automobile is a randomly distributed variable with known variance and mean, he valued the guarantee purchase option for the lessee using a modified version of the Black–Scholes option pricing model (Black & Scholes, 1973) for a European call option. The results of his model indicated that traditional lease valuations are biased towards purchasing because they ignore the value of the purchase option. Miller's model assumed that the lessee exercises the purchase option when the market value of the car exceeds the lease's guarantee purchase price. A problem with this assumption is that the consumer may not have access to sufficient market data to accurately estimate the price of the car at the end of the lease. In addition, a car dealer's market price of the car (the dealer's asking price) will most likely be greater than the market price that an individual can get for a car (which can be equated to a dealer's bid price). Although the consumer may access several internet sites that provide estimates of the current dealer value of the car, it may not reflect the actual price that the consumer can receive from reselling the car.

Also, Miller (1995) assumed that exercising the purchase option is costless to the consumer. However, this is not the case. According to Miller when the dealer's asking price exceeds the guarantee purchase price in the lease, the consumer should buy the car and then resell it, making a profit equal to the difference between the asking price and the guarantee purchase price. This profit might be realized if cars were traded in security markets, but selling a car takes significant time and transaction expenses, which reduces the actual profit for the lessee. The lessor, who has superior information relative to the consumer, is aware of these costs and would only offer to buy the car from the lessee at the dealer's bid price. Consumers also face additional financing costs when exercising the purchase option. Typically, consumers enter into leases to avoid large down payments. Because most consumers lack the capacity to pay cash for the vehicle's purchase at the end of the lease, they must take out a used car loan. Interest rates on used cars are always greater than interest rates on new cars because of the additional risks associated with a used vehicle. This represents an additional cost to the consumer for postponing the purchase decision until the end of the lease. Consequently, the value of the purchase option for the consumer at the end of the lease is more complicated than simply the difference between the dealer's asking price (or market price) of the vehicle and lease's guarantee purchase price. While Miller included the

purchase option (the lessee's call option), he simplified his model by ignoring put options in the lease.

A lessee assumes that there is no risk in making future lease payments when evaluating a lease. However, terminal cash flows for the lessee and lessor are unknown because of the presence of options owned by the lessee and lessor. Lee, Martin & Senchack (1982) argued that the terminal or salvage cash flows from a leased asset consist of three components, an asset's expected resale price at the end of a lease, a call option to buy the asset at the end of a lease, and a put option that guarantees the asset's resale price at the end of a lease. The salvage value of the asset to the lessor can be expressed as a combination of these options:

$$S_T = X + \text{Max}(0,S_T\text{-}X) - \text{Max}(0,X\text{-}S_T) \quad (1)$$

Where S_T is the asset's total salvage value and X is the lessor's expected resale value of the asset at the end of the lease. Since the objective of the lessor is to obtain at least a value of X for the asset at the end of the lease, the lessor writes the call option for the lessee and buys the put option, which results in the following equation.

$$X = S_T - \text{Max}(0,S_T - X) + \text{Max}(0,X - S_T) \quad (2)$$

Lee, Martin & Senchack's (1982) model of salvage value can be adapted for an automobile lease containing calls and put options. However, the existence of more than one put option affecting a lease's terminal cash flows requires introducing additional parameters in the model. Furthermore, the exercise or strike prices for these options are not the same. Consequently, the following model separates the two most common put options so that they can be evaluated. The lessee's guarantee purchase option is as follows:

$$\text{BUY} = \text{Max}(0,S_T - X_P) \quad (3)$$

S_T represents the lessee's resale price (or lessor's bid price) at the end of the lease. This is also the lessee's salvage value at the end of the lease. X_P is the amount of the lessee's guarantee purchase price, which is equivalent to the lessor's expected asking price for the vehicle at the end of the lease. The mileage put option owned by the lessor can be expressed as follows:

$$\text{MILEAGE} = \text{Max}(0,(M_T - X_M) * \text{PPM}) \quad (4)$$

M_T represents the vehicle's mileage at the end of the lease, X_M is the maximum vehicle miles allowed by the lease and PPM is a price per mile assessed by the lessor as a penalty for excessive use of the asset.

Expressing the excessive wear and tear put option presents a more difficult problem because of its dependency on several factors, including excessive mileage. Since the purpose of this option is to guarantee the lessor's expected asking price, the model can be expressed in a generalized form as:

$$\text{WEAR} = \text{Max}(0, X_P - (S_T + \text{Max}(0,(M_T - X_M) * \text{PPM}))) \quad (5)$$

X_P and S_T are the same as in (3) and M_T, X_M, and PPM are the same as in (4). The WEAR option includes the MILEAGE put option (5) to account for the loss in resale value S_T that

occurs from excessive mileage. Hence, the WEAR option has value when factors that include excessive mileage have caused the lessee's resale value to drop excessively below X_P. The implication of accounting for the separate MILEAGE option is to recognize the separate exercise conditions of the lessor's put options.

Another important consideration is the interaction between the value of the BUY call option and the MILEAGE and WEAR put options. At the end of the lease, the lessee may avoid the financial obligations of the put options by exercising the call option and buying the car. As a result (3) must be modified to reflect this as follows:

$$\text{BUY} = \text{Max}(0, S_T + \text{MILEAGE} + \text{WEAR} - X_P) \tag{6}$$

This shows that the lessee should exercise the call option whenever his/her resale price plus the cost of the MILEAGE and WEAR put options exceeds the lessor's expected asking price of the vehicle at the end of the lease.

Because the lessor wants to ensure receiving his/her expected asking price, X_P, at the end of the lease, the lessor will sell the BUY call option to the lessee and purchase the MILEAGE and WEAR put options from the lessee. The following shows the lessor's position created by the lease.

$$X_P = S_T - \text{BUY} + \text{MILEAGE} + \text{WEAR} \tag{7}$$

With these options in place, the lessor has hedged against the reduction in value of the automobile from excessive use by transferring the risk to the lessee.

When $S_T + \text{MILEAGE} + \text{WEAR} > X_P$ the BUY option is in the money for the lessee. By exercising the option the lessee either avoids the cost of the put options or may realize a resale profit of $S_T - X_P$. The lessee's exercise of the call option cancels the lessor's exercise of the put options and results in the lessor receiving his or her desired cash flow of X_P for the vehicle at the end of the lease. However, it is unlikely that the lessee can obtain a resale profit of $S_T - X_P$ because of additional costs to exercise the call option. In addition to implied costs of time and effort to locate a buyer, the lessee pays a financing penalty associated with higher interest rates on a used car loan. This assumes that the lessee lacks cash to pay for the purchase at the end of the lease and must finance the purchase. Consequently, exercising the lease may require considering the present value of the difference between payments based on interest rates for used car loans and interest rates for new car loans.

For the case that $S_T + \text{MILEAGE} + \text{WEAR} \leq X_P$, the BUY call option is worthless. Since the values of the MILEAGE and WEAR options are non-negative, the lessee's resale price is less than or equal to the lessor's expected resale price, that is, $S_T \leq X_P$. If the lessee has not violated the lease contract through excessive use of the automobile both the WEAR and MILEAGE options would be worthless and the lessee would not have any additional cash flows at the end of the lease. Also, note that a value of zero for the WEAR option implies, $S_T = X_P$. The lessee would return the automobile to the lessor and walk away and the lessor would receive a terminal cash flow of X_P. However, if the lessor's WEAR option is in the money the lessee must pay the lessor an amount equal to the loss in market value of the car due to his/her excessive use of the vehicle. Often the car has excessive mileage,

as defined by the terms of the lease, when returned to the lessor. Hence, the MILEAGE option will be in the money for the lessor and will have a value equal to the per mile charge times the excessive miles driven by the lessee. Provided the lessee has maintained the car such that the WEAR option is not in the money, the lessee will owe the value of the MILEAGE option to the lessee.

A DCF analysis would show that the lessor expects to receive X_P cash flow at the end of the lease, which equates to the lessor's expected salvage or resale value of the automobile. The writing of the put options ensures the lessor's future cash flow because the lessee has provided the lessor with insurance on the vehicle's salvage value. Traditional DCF analysis would show that the lessee has a terminal cash flow of zero associated with returning the vehicle to the lessee and walking away without further payments. However, the introduction of the options shows that a zero terminal cash flow for the lessee only occurs when the resale price equals the lessor's expected salvage value, $S_T = X_P$, implying the lessor's put options are worthless. The above analysis shows that the lessee's terminal cash flow may be positive or negative depending on the lessee's use of the car, the market demand for the car at the end of the lease and the exercise parameters of the options that have been defined by the lessor.

6. Unknown and unwanted risk for the lessee

As shown in Eq. (7) the lessor constructs the terms of the lease to maximize his/her cash flow at the end of the lease. When the lessee operates the vehicle within the constraints of the lease, he/she will not have additional cash flows to consider at the end of the lease. However, the terms of the lessor's put options often make it impossible for the lessee to avoid terminal cash flows. The lessor's marketing strategy focuses the lessee's attention on the monthly payments and only mentions the lessee's additional obligations relative to mileage and excessive use of the vehicle in foot notes to advertisements or in return and cancellation clauses of the lease contract. The low payments may result from an unrealistic residual value (X_P) set by the lessor (Burgess, 1999). Consequently, the lessee initially believes that the lease offers a low monthly payment for use of the car and is not cognizant that he/she has underwritten an insurance policy for the lessor guaranteeing the condition of the vehicle and its residual value (X_P) at the end of the lease.

Furthermore, the lessor's superior knowledge of the residual value of the vehicle and driving conditions allows the lessor to design the put and call options so that the lessor can obtain the desired cash flow, X_P, at the end of the lease without regard to exogenous market conditions that may have lowered the actual resale price of the vehicle below X_P at the end of the lease. This occurs if the lessor sets conditions on the lessee's use and care of the vehicle that are improbable for the lessee to keep. Often this is done by setting low mileage limits, high per mile charges, and like new return conditions on routinely replaceable parts such as tires, brakes and exhaust systems. Although the lessee may be able to avoid excessive mileage charges by carefully monitoring the use of the vehicle, the other lease conditions may still force the lessee to pay additional costs associated with replacing tires and brakes and refurbishing the exterior and interior finishes.

Many lessees enter into leases to avoid large down payments associated with purchasing a car because they are cash poor. Hence, at the end of the lease when faced with a cash settlement on the lessor's put options, the lessee may elect to avoid the put obligations by exercising his/her call option to purchase the vehicle for a price of X_P. This represents an optimal decision by the lessee only when his/her resale price S_T and the avoided cost of the MILEAGE and WEAR options exceed the BUY option's purchase price, X_P. Unfortunately, problems interfere with the lessee's making an optimal decision which include:

1. The lessee does not know with certainty his/her resale price of the vehicle, S_T, because he/she lacks experience in the used car markets.
2. Exercising the BUY option requires a cash outlay of X_P. Typically, this exceeds the lessee's cash resources and he/she must borrow the funds. This equates to an additional penalty to the lessee because financing charges on a used vehicle are significantly higher than a new vehicle.

As a result, the lessee may unnecessarily purchase the vehicle at the end of the lease incurring additional charges.

Also, Burgess (1999) suggests that if the lessor's resale value of the car at the end of the lease is less than the lessee's BUY exercise price, the lessee should negotiate with the lessor to purchase the vehicle at the lessor's current market resale price. However, the existence of stringent put options may eliminate this as a choice for the lessee because the settlement value of the put options makes up for the loss in the vehicle's market value. For this to be a viable choice for the lessee, the lessor would have to be willing to give up the settlement value of the put options and accept a sale price of the car that is less than X_P, which is unlikely. The lessor will pursue a strategy of using the costs of settling the put options to sway the lessee to purchase the vehicle at the BUY option price of X_P and avoid the put option settlements.

The lessor's put options have placed an unwanted uncertainty on the lessee that must be reconciled at the end of the lease. When the put options require a cash outlay, the lessee can either pay cash to settle the put options, avoid the put options by purchasing the car or role the settlement cost of the put options into the financial obligations of a new lease on a new vehicle. Unfortunately, most consumers are unaware of this financial obligation until it is time to return the vehicle to the lessor.

7. Leasing data and analysis

Previous researchers (Nunnally & Plath, 1989; Miller, 1995) sampled newspaper advertisements to collect data on automobile leases. This paper's author also reviewed current newspaper ads for leasing parameters. However, newspaper ads often omit significant details contained in the leasing contracts, for example, mileage allowances, capitalized cost, and normal wear requirements. Consequently, this paper includes Internet resources that were not available to Nunnally and Plath or Miller at the time of their research. In addition, lease contracts were obtained from Honda Motor Corporation and Suntrust Banks and used as

proxies for typical leasing contracts. These resources were reviewed and aggregated to develop general parameters for a lease contract.

For the lessee to evaluate the lease, the following parameters must be known or estimated:

- Capitalized cost of the automobile, which is the negotiated purchase price of the vehicle.
- The amount of the monthly lease payment. Lease payments are made in the beginning of a month, thus a lease is an annuity due.
- Any capital reduction payment required at the beginning of the lease. This essentially amounts to a down payment by the lessee that serves to reduce the capitalized cost of the vehicle and the monthly payment.
- Acquisition fees charged by the lessor. These ubiquitous fees have no clear definition except to compensate the lessor or dealer and improve their profitability.
- Any security deposits required by the lessor at inception of the lease.
- Sales tax on the lease payment and capital reductions.
- Length of the lease.

The above parameters would suffice for a traditional discounted cash flow analysis if options did not exist in the lease. The above assumes that the lessee would return the car at the end of the lease and not face any additional penalties or purchase decisions. Because a typical auto lease includes options, parameters must be considered that define the lessee's call options and the lessor's put options.

- What is the lessee's optional purchase price of the automobile at the end of the lease? This represents the call option's exercise price at the end of the lease.
- What is the cost of early prepayment of the lease? This represents the lessee's right to purchase the lease contract from the lessor before it has been fully executed. Generally, this option exists only to facilitate terminating the lease when the vehicle has been stolen or destroyed in an accident. Usually, the lessee purchases a special insurance policy (gap insurance) to guard against this risk.
- What is the maximum mileage allowed during the term of the lease? What are the penalties for exceeding the mileage allowance? This represents one of the lessor's put options that ensures his/her cash flows at the end of the lease.
- What is considered "normal" wear and tear of the vehicle during the lease? Lessors may rely on an agency to appraise the vehicle's condition at the end of the lease. The agency may require records showing that the vehicle received the manufacturer's recommended maintenance during the term of the lease. Also, excessive body and upholstery blemishes must be accounted for during the appraisal process. Deviations from the norm are the lessee's responsibility.
- What usable life must remain on the tires and brakes at the end of the lease? This also represents a put option owned by the lessor. Typically, the clause is written such that driving the vehicle the allotted miles in the lease will require replacing the tires and brakes.

Once data for these parameters are obtained the lessee can develop a more complete analysis of the lease that includes the option values at the end of the lease.

Table 1
Example leases

Source	Atlanta/Journal	Carsdirect.com	Leasecompare.com
Capitalized cost	$72,492	$72,492	$72,492
Capital reduction	$2,995	$7,249	$0
Acquisition fee	0	$600	$400
Lease length	39	36	39
Payment	$958	$1,203	$1,202
Allowed miles	39,000	36,000	36,000
Additional mileage charge	$0.20/mile	$0.15/mile	$0.18/mile
Residual	$47,677	$39,147	$38,930
Residual as a % of capitalized cost	66%	54%	54%
Money factor	0.003401	0.004580	0.003064
Money factor APR	8.16%	10.99%	7.35%
APR	8.06%	10.77%	7.21%

Because consumers elect to lease most luxury cars, the analysis in this paper focused on luxury car leases. Table 1 lists advertised leasing parameters for a Mercedes-Benz S430 from three separate sources.

Table 1 illustrates the difficulty for consumers in evaluating leases. The parameters vary significantly between each source. In addition, some of the parameters obtained from the Internet sources never change regardless of the vehicle. For example, the Carsdirect lease requires the same acquisition fee and mileage charge ($0.15) regardless of the type of vehicle. This may make one suspect that the advertised rates will not be realized in the actual lease contract. Nonetheless, the money factors for each lease were calculated using the following industry accepted formula:

$$\text{Money Factor} = \frac{\text{Payment} - \left(\dfrac{\text{Capitalized Cost} - \text{Capital Reduction} - \text{Residual}}{\text{Lease Length}}\right)}{(\text{Capitalized Cost} - \text{Capital Reduction} + \text{Residual})} \tag{8}$$

Multiplying the money factor by 24 yields the money factor APR. The actual APR is calculated using the capitalized cost less the capital reduction as the present value of the loan, the residual as the future value of the loan at the end of the lease and the lease payment as the periodic payment:

$$\text{Capitalized Cost} - \text{Capital Reduction} = \sum_{t=1}^{N}\left[\frac{\text{Lease Payment}}{\left(1 + \dfrac{\text{APR}}{12}\right)^{t}}\right] + \frac{\text{Residual}}{\left(1 + \dfrac{\text{APR}}{12}\right)^{N}} \tag{9}$$

A consumer that used only the lease payment as a comparison would select the first lease advertised in the newspaper. Using the money factor suggests that the third lease advertised on the internet would be the best use of the consumer's money. Obviously, using the lease payment and/or the money factor alone will not provide a suitable answer because it fails to consider parameters associated with the call and put options. A large part of the value of these options at the end of the lease will depend on the lessee's driving characteristics.

An initial inspection of these data shows that the residual values do not appear to be a function of the length of the lease. The lease advertised in the newspaper has the highest residual value but a lease length equal to or greater than the other two sources. The two internet leases advertise similar residual values but have different lease lengths. These residual values appear at first to be inconsistent until the allotted mileage and excess mileage charges are considered, which define one of the put options owned by the lessor. The newspaper lease that contains the highest residual also has the highest per mile charge of $0.20. Although not listed in the table, this lease also had a second condition that raised the per mile charge to $0.25 for miles driven in excess of 44,000 miles. A comparison of the two internet leases shows that although the residual values are similar the longer lease has the same restrictions on total miles as the shorter lease and it has a higher per mile charge ($0.18) than the shorter lease. Hence, this shows that when the lessor increases the residual, which equates to decreasing the monthly depreciation of the vehicle, the lessor increases the mileage penalties in the lease.

The mileage restriction represents a potential source of negative cash flow for the lessee when the vehicle is returned to the lessor. Leasing companies typically place the average annual mileage restriction between 10,000 and 12,000 miles. The lessee should assess his/her driving habits to determine a realistic annual mileage. In 1995 the Federal Highway Administration conducted the Nationwide Personal Transportation Survey (NPTS) to measure driving habits of individuals and families across the United States. The report includes mean vehicle miles traveled (VMT) from 1970 to 1995. These data show a significant positive trend in the annual average miles driven per automobile during this period. Using the NPTS data in a simple regression model, forecasted means for VMT were calculated for years 2002, 2003, 2004 of 16,560, 16,900, and 17,280 miles. These forecasted VMTs suggest that on a three year lease with a 36,000 mileage restriction started in 2002, the lessee will drive an additional 14,750 miles, which equals a mileage penalty of $2,950 based on $0.20/mile. More stringent conditions on mileage allocation and charges, which are not unusual on luxury car leases, would increase this penalty. Of course, as the end of the lease nears, the lessee may elect to reduce their use of the vehicle if it becomes apparent that they will exceed the mileage limitations in the lease. However, using a substitute vehicle or transportation method simply transfers the cost to another source. Additionally, forgoing an opportunity to travel may have significant implied costs relative to leisure enjoyment or lost business opportunities.

A careful inspection of the Honda Motor Corporation and Suntrust Bank leases showed that the expected conditions of tires at the end of a lease would require a lessee to purchase new tires before returning the vehicle, assuming that the maximum allotted miles have been driven. Leases require that the replacement tires be of similar quality as the original equipment. Furthermore, tires must be a matching set, with regard to manufacturer, quality, model and size when a lessee returns the vehicle to the lessor. This precludes a lessee from replacing one or two worn tires with inferior tires. Replacing the tires benefit the lessor's resale value of the car at the expense of the lessee that does not have an opportunity to use the new tires. In addition, other costs associated with the condition of the car must be considered when returning a vehicle at the end of the lease. A lease gives the lessor's agent significant latitude when appraising the car for excess wear at the end of the lease. Hence,

Table 2
DCF model inputs

Capitalized cost	$72,492	Lessee estimated miles driven during lease	50,750
Capital reduction	$7,249	Estimated mileage charge	$2,950
Lessor residual as a percent of capitalized cost	54%	Estimated tire charge	$400
Lessor residual	$39,147	Estimated excess usage charge	$1,500
Lessee residual as a percent of capitalized cost	47%	Money factor	0.00458
Lessee residual	$34,071	Money factor APR	10.99%
Length of lease	36	APR	10.77%
Lease payment	$1,203	Purchase loan APR	8%
Mileage allotment	36000	Length of loan	60
Excess mileage charge/mile	$0.20	Loan payment	$1,323

a lessee should anticipate an additional negative cash flow as a penalty for excessive use of the vehicle.

The example presented in Table 2 assumes that the lessor has set the residual value (54% or $39,146) at a value that exceeds the end of lease residual value of the car. As a result, the car's residual value at the end of the lease for the lessee equals $34,071 or 47% of the capitalized cost of the vehicle. Also, the money factor, APR, and loan payments result from parameters supplied by the user.

Parameters in Table 2 were used to determine the net advantage to leasing (NAL). To simplify the analysis, sales taxes, licensing fees, insurance, and acquisition fees were ignored. With the exception of sales tax, these values should be similar for either alternative. In addition, the purchase price or capitalized cost of the vehicle and the capital reduction or down payment are the same under either choice. Table 3 lists the difference in cash flows during the lease between the two choices.

The initial cash flow for the lease equals the sum of the capital reduction and the first months lease payment. The purchase alternative's first month's cash flow equals the loan's down payment. Cash flows in months 1 through 35 are the payments required on the lease and auto loan. The final cash flow on the lease depends on the residual value of the vehicle (the lessee's purchase option) and the value of the put options (excessive mileage charge, excessive wear charge, and tire replacement.) In this example, since the sum of these values,

Table 3
Net advantage to leasing

Months	Lease	Buy	NAL
0	($8,452)	($7,249)	($1,203)
1–35	($1,203)	($1,323)	$120
36	($4,850)	$3,498	($8,348)
		PV (NAL)	($4,044)

Table 4
Lease cash flow in month 36

Source	Amount
Excess mileage	$2,950
Tire replacement	$400
Excess wear and tear	$1,500
Total	$4,850

$38,921, is less than the lessee's purchase option, $39,146, the lessee would pay the total of the put option values and not purchase the vehicle. Table 4 contains a breakdown of the cash flow for the lease choice in month 36. The final cash flow for the purchase option equals the difference between the lessee's resale price, $34,071, the 36th loan payment and the payoff on the loan, $29,250.

Since the decision to purchase or lease an asset is a financing decision (Brigham et al., 1999, p. 881; Gitman, 2000, p. 744), the cash flows in column 4 of Table 3 were discounted using the contract rate on the auto loan, 8%. The negative NAL in Table 3 shows that with the above lease and loan parameters the consumer should elect to purchase the automobile. In the absence of the lessors put options, that is, no penalties for excessive usage of the vehicle, the net advantage of leasing equals ($226) which is close to an indifference point between the two choices. This shows the effect of the put options on the lessee's decision.

The model provides a practical analysis of the lease versus purchase decision that includes cash flows from the end of lease options owned by the lessee and lessor. Changing the loan parameters and lease parameters affect the decision outcome. For example, if only the interest rate on the loan changes, the NAL remains negative until the loan's APR equals the lease's APR. This suggests that the lease's APR is a critical parameter that the lessee should know before selecting a lease option. Yet, current laws do not require leasing advertisements or salespeople to disclose this information to consumers. Furthermore, only disclosing the money factor without the APR would not adequately serve the consumer because the money factor must be converted to an APR. Often, the consumer does not know how to make this conversion.

As shown in Table 5, varying the length of the loan from 36 to 72 months has little effect on the NAL, which remains significantly less than zero. Increasing the lessee's expected resale value of the car at the end of the lease also has little effect on the model outcome because it also improves terminal cash flow for the purchase alternative. The existence of the

Table 5
Effect on NAL from changing loan parameters

Lease payment	$1,023	$1,023	$1,023
Loan APR	10.99%	8%	8%
Loan length	60	72	60
Loan payment	$1,418	$1,144	$1,323
Lessee residual	$34,071	$34,071	$36,246
NAL	$124	($4,044)	($4,220)

end of lease put options and the difference between the APRs on the lease and the loan have the most effect on the decision between leasing and purchasing. When the two APRs equal, the consumer should carefully weight the prospects of having the lessor's put options ending deep in the money at the end of the lease.

8. Conclusions

Although leasing accounts for a significant portion of the financing of new cars, consumers may not be receiving sufficient financial benefits to select leasing over purchasing. This is because a consumer lacks the tax benefits of a lease when the car's purpose is for personal use. Also, the existence of put options that require the lessee to compensate the lessor for excess use at the end of the lease may make leasing a less desirable financing alternative. Furthermore, the lessor's superior knowledge of the automobile sales markets allows him/her to construct the put options and the lessee's call option such that the option combinations ensures the anticipated cash flow for the lessor at the termination of the lease. By ensuring the lessor's cash flows the lessee subjects himself/herself to unwanted uncertainties at the end of the lease. It also puts a burden on the lessee to monitor his/her use and care of the vehicle during the lease.

Results obtained using a discounted cash flow analysis that included estimates of the end of lease values of the embedded options shows that the costs of the put options must be considered when choosing between leasing or purchasing. The DCF model illustrates that the decision outcome also depends on the difference between the APR on the lease and the loan. Yet the Federal Consumer Leasing Act does not require the lessor or dealer to disclose the APR to the lessee. Results of the DCF model suggest that consumers would benefit from receiving this information. Finally, the paper demonstrates that embedded options in financial contracts must be considered when evaluating a capital investment. Failure to include the option values may lead to an incorrect decision.

References

Black, F., & Scholes, M. (1973). The pricing of options and corporate liabilities. *Journal of Political Economy, 81,* 637–659.

Brigham, E. F., Gapenski, L. C., & Ehrhardt, M. C. (1999). *Financial management, theory and practice* (9th ed.). New York: Harcourt.

Burgess, D. O. (1999). Buy or lease: The eternal question. *Journal of Accountancy, 187* (4), 25–33.

Farragher, E. J., Kleiman, R. T., & Sahu, A. P. (1999). Current capital investment practices. *The Engineering Economist, 44* (2), 137–150.

Gitman, L. (2000). *Principles of managerial finance* (9th ed.). Reading, MA: Addison Wesley.

Grenadier, S. R. (1995). Valuing lease contracts: A real options approach. *Journal of Financial Economics, 38,* 297–331.

Gutman, E., & Yagil, J. (1994). A comprehensive lease/purchase model. *The Engineering Economist, 39* (4), 333–354.

Hendel, I., & Lizzeri, A. (2002). The role of leasing under adverse selection. *Journal of Political Economy, 110* (1), 113–143.

Hodder, J., & Riggs, H. (1985). Pitfalls in evaluating risky projects. *Harvard Business Review, 63* (1), 128–135.

Lander, D. M., & Pinches, G. E. (1998). Challenges to the practical implementation of modeling and valuing real options. *The Quarterly Review of Economics and Finance, 38,* 537–567.

Lee, W. Y., Martin, J. D., & Senchack, A. J. (1982). The case for using options to evaluate salvage values in financial leases. *Financial Management, 11* (3), 33–41.

Miller, S. E. (1995). Economics of automobile leasing: The call option value. *The Journal of Consumer Affairs, 29* (1), 199–218.

Nunnally, B. H., & Michael, T. B. (2000). Risk analysis and capital budgeting practices: A survey of the Fortune 1000. Paper presented at the meeting of the 2000 Financial Management Association, Seattle, Washington.

Nunnally, B. H., & Plath, A. (1989). Leasing versus borrowing: Evaluating alternative forms of consumer credit. *Journal of Consumer Affairs, 23* (2), 383–392.

Schwab, S. M. (1995). A practical guide to valuing options for leased space. *Journal of Property Management, 60* (4), 52–55.

Trigeorgis, L. (1993). The nature of option interactions and the valuation of investments with multiple real options. *Journal of Finance and Quantitative Analysis, 28* (1), 1–20.

White, C. G. (2001). Lease or purchase? A spreadsheet analysis. *The CPA Journal, 71* (7), 66–70.