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Valuing the Purchase Option on Car Leasing Contracts

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ABSTRACT

ENGLISH

This thesis studies the role of the residual value in financial leasing contracts, using the real options methodology to provide a valuation of the purchase option embedded in these contracts. Using a sample of used cars, I arrive at a cost to lessor between 1% and 12.2% of the loan amount for contracts with maturities between one and ten years, conducting separate analyses for Diesel and Petrol engines. The sensitivity analyses reveals positive impact of interest rate and reference price on the cost to lessor. The alternative of setting residual value equal to expected market value is less costly to the lessor but does not comply with the purpose of finance leases.

PORTUGUESE

Esta tese explora o papel do valor residual no contexto dos contratos de locação financeira, recorrendo a opções reais para valorizar a opção de compra implícita nestes contratos. Usando uma amostra de carros usados, concluí que esta opção pode custar ao locatário entre 1% e 12,2% do montante financiado, para maturidades entre um e dez anos e análises separadas para motores a Gasóleo e a Gasolina. A análise de sensibilidade conclui que a taxa de juro e o preço de referência dos usados têm um impacto positivo no custo para o locatário. Definir o valor residual igual ao valor esperado de mercado é menos oneroso para o locatário mas afasta-se dos objectivos da locação financeira.

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I: INTRODUCTION

Leasing is a dedicated financing instrument that allows a user (lessee) to benefit from an asset by paying regular rents to its owner (lessor). It is widely used by several companies for different assets, including real estate, vehicles, industrial equipment, among others.

This financing mechanism works as a regular loan, except for the fact that the ownership transfer only happens at the end of the contract, and if the lessee desires to do so. The purchase option available to the lessees is the subject of this thesis.

Lessors are usually financial institutions that want to avoid having the asset returned at the end of the lease. They tend to set residual values significantly below the asset's expected market value to encourage the lessee to exercise the option and to keep the debt's face value below asset value. This means that the lessee has a valuable option in hand and the lessor might be bearing a significant cost associated with it.

Focusing on car leases and sample contracts, I estimate the value of this purchase option. I conclude that the policy of setting low residual values is costly for lessors, but that it is an amount they are willing to leave behind to reduce the chances of having the asset returned and keeping the debt under control.

Finally, I investigate the cost of having a car returned to the lessor and compare the above policy to a contract where the residual value equals the expected market value of the asset, concluding that it is usually cheaper but not in the interest of neither the lessor nor the lessee.

This thesis proceeds as follows. Section II reviews relevant literature. The concepts required to understand the topic are detailed in Sections III and IV. Section V explains the methodological approach chosen. The results obtained are described and discussed in Section VI. Finally, conclusions are drawn and limitations and further research suggestions are presented in Section VII.

II: Literature Review

Vancil (1963) raised the question of estimating the residual value under finance leases and how it should be included in the lease-or-buy decision. Without the binomial option pricing model (1979) nor Black-Scholes (1973), the lessee should compute the cost of a lease with terminal purchase option using the residual value as the expected market value of the asset (if such amount is a reasonable assumption) and assume that the asset is bought and maturity and then depreciated. This cost can then be compared with the purchase alternative.

Later on, Myers & Majd (1983), addressed residual value estimation by establishing the parallelism between leasing contracts and American put options, stressing out the value of the abandonment option, i.e., the ability to stop using the asset earlier than the predefined end of the contract. The fact that alternative technologies depreciate differently can affect a manager's investment decision, precisely due to the value of the abandonment option. This option approach to leasing is quite common in the literature, with Grenadier (1995) being another example, where he refers to residual value insurance (a mechanism by which the lessor would agree on the realisation of a fixed residual value at the termination of the contract, in case the actual market value falls below this threshold) as an equivalent to a put option.

Furthermore, papers such as Giaccotto, Goldberg & Hedge (2007) and Miller (1995) have adopted the real options approach to value auto lease contracts, with the first focusing on penalties that significantly reduce the value of the lease cancellation option and the latter showing that the value of the abandonment option has to be taken into account in the lease vs. buy decision, otherwise there will be an unwanted bias towards the "buy" side.

Some of the most cited literature focuses on leasing on the perspective of the lessee, analysing leasing as a source of financing and comparing it to alternatives such as traditional bank loans. This is the case of Eisfeldt & Rampini (2009), who develop a model in which companies differ in the amount of available internal financing. They conclude that due to the separation of ownership and control, financially constrained firms will tend to have a higher percentage of leased assets, while other firms will opt for secured lending.

Earlier in time, Johnson & Lewellen (1972) have pointed out the importance of the discount rate in the analysis of lease financing. They argue that operational revenue and costs of a leased asset ought to be discounted at the firm's cost of capital, but the

predictability of lease payments means that these should be discounted at the firm's cost of debt. By comparing the financing alternatives, they determine that the difference between net salvage value and additional operating cost of owning, together with the difference between purchase price less depreciation tax savings and burden of lease payments are the most relevant variables in the financing decision. Finally, the paper points out that since a lease can be cheaper than a purchase, a previously rejected investment might turn out to be profitable if the lease terms are sufficiently attractive.

A related intense discussion in the literature is the extent to which leases use up a company's debt capacity. Albeit being a financing instrument, the characteristics of a leasing contract are significantly different from traditional financing sources in terms of the risk borne. Beattie, Goodacre & Thomson (2000) present leasing and debt as partial substitutes. The choice between them is determined by firm characteristics, of which the authors emphasise CEO share ownership (increases leases, to reduce impact on key financial ratios) and asset type (retail firms tend to lease more, given the generic nature of their fixed assets). They point out that despite being off-balance sheet items, leases do consume some debt capacity of the firm. Ang & Peterson (1984) argue differently, concluding that debt and leasing are complements. The study is performed following the implementation of accounting standards on leases, pointing out that many firms had to convert several operating leases into finance leases in light of these new regulations. They hypothesise that the positive relationship between leases and debt can be due to market inefficiency, tax reasons or qualitative differences.

The accounting treatment of leases is also discussed by Dhaliwal, Lee & Neamtiu (2011), who point out the increased scrutiny of investors regarding the differences between operating and finance leases, debating the influence of lease classification on a firm's cost of equity. Myers, Dill & Bautista (1976) focus on finance leases, understanding why firms lease. They compare this with regular financing to conclude that a leasing contract can only be valuable for both lessor and lessee (positive Net Present Value) if they face different income tax, cost of capital or tax shields, otherwise it would be a zero-sum game that would only benefit one or none of the parties involved. Franks & Hodges (1978) build on this paper to point out that if the tax rate faced by a company is not stable throughout the lease period, the payment scheme should be manipulated to optimise the tax benefits of such leases. They achieve this by constructing equivalence between leases and a purchase with debt, such that the (dis)advantage of the lease is measured by the difference in the first-period cash-flow.

This idea of equivalence between leases and other financing alternatives is also part of the work of Miller & Upton (1976), starting off with an irrelevance proposition (if all agents were subject to the same tax policy). Given that the residual value is contracted *ex-ante*, the incentive of the lessee is to minimise the sum of production and maintenance costs, regardless of the asset's final condition. This means that the longer the contract duration, the more the risk transfers from the lessor to the lessee, since the latter will have more time to suffer from the under-maintenance of the asset. The paper also refers to operation uncertainty, adapting the CAPM to incorporate a risk adjustment based on the uncertainty regarding the actual depreciation of the asset.

Erickson (1993) adds further insights to the motivations behind the leasing decision. Cost, financing choice and asset characteristics are the determinants presented. Despite the possibility that debt and leases are complements, this buy/lease choice has to be done for each individual asset. As a function of the leases/long-term debt ratio, firms for which more information is available (using market value as a proxy) tend to lease less, as well as firms in financial distress (low Altman's Z-Score) and firms with more debt. Conclusions are similar for regressions as a function of the leased assets/owned assets ratio, except for higher significance of non-debt tax shields and the reversed sign on the Altman's Z. Industries are controlled for, with transportation and real estate being two of the most significant sectors.

Grenadier (1996) determines the fair price of a leasing contract, introducing the lessee's default risk into a pricing model, while discussing the different factors that impact on the value of the contract at the eyes of the lessor, depending on the lessee's performance. This is complemented by Schmit (2004), who imports the concepts of Value at Risk and Loss Given Default into leasing contracts, including separate analysis for different asset types, such as automotive, other equipment, medical, and computers.

Risk is also a central topic for Rode, Fischbeck & Dean (2002) who identify the pre-determination of the residual value as a major source of risk, particularly when companies raise their residual values to improve competitiveness. The uncertainty arises from the fact that most valuations rely on managers' experience rather than on hard data. Therefore, one should try to understand how much information is lacking and determine the magnitude and probability of deviations. The authors build a model to compute a probabilistic distribution of the residual value, based on useful life, economic obsolescence and technological obsolescence.

Smith & Wakeman (1985) discuss the types of assets that are more likely to be leased. They present leases as an advantage for managers evaluated through ROIC, since leases are not part of the denominator of this indicator. Leases will tend to happen in assets less sensitive to use and maintenance decisions. On the other hand, assets where administrative and contracting costs are high, such as firm-specific assets, tend to be bought.

At a more macro level, Haiss & Kichler (2009) explored the usage of leasing as a growth instrument. They find a positive relationship between leasing and other forms of credit, and refute other research by concluding that countries with better governance use more leasing, so this form of financing is not a workaround for complex or immature legal systems in terms of creditors' protection. Most companies provide either mixed assets or focus on auto leasing, and tend to be independent companies or owned by banks.

II.1: The Case of Car Leases

Cars are one of the most common assets in leasing contracts, as shown in Leaseurope (2012), where automotive assets accounted for 60% of the new finance leases. Therefore, most of the research has been conducted in this specific asset type. This has been one of the reasons for choosing the automotive market as the data source for this thesis. The current subsection analyses previous literature regarding auto leases.

Hendel & Lizzeri (2002) study car leasing to discuss whether leasing versus buying is a pure financing decision or if it is impacted by utilisation patterns. They state that since leased products are perceived as having higher quality, manufacturers can manipulate the second-hand market and reduce competition towards the new car market. Building on this study, Gilligan (2004) describes the relevance of information asymmetry in determining prices and trading volume. While in perfect markets an asset's price is directly related with its deterioration, under asymmetric information price declines are higher and trade volume is lower, due to the presence of adverse selection. This paper also presents residual value as a function of the depreciation rate along with industry-specific and economy-wide factors, where depreciation depends on value, qualitative uncertainty and leasing frequency.

Schmit (2005) studies the evolution of recovery rates throughout the length of the contract. The paper shows that lessors can take advantage of recovery rates above 100%, since as the contract approaches its end date the asset value might be greater than the amount due by the lessee. Therefore, recovery rates tend to increase as the contract approaches its end. Additionally, the author concludes that the distribution of default losses

arises as a combination of default frequency and loss severity, and that default probability can be subdivided into firm-specific diversifiable risk and a systematic component.

Pirotte, Schmit & Vaessen (2004) come to the same conclusions as the previous paper, adding two extra innovations: (i) loss given default computation includes a resale opportunity cost component, due to the delay between repossession and actual sale and (ii) recovery rates are dependent on the economic state of the second-hand market, although the net gain remains positive when amounts due are close to the residual value. This last conclusion means that lessors will tend to prefer when the purchase option is not exercised by the lessee. Using this same sample, Pirotte & Vaessen (2008) explore loss given default, concluding that more than 25% of the defaulted contracts resulted in a negative LGD (positive net gain). This is related to the fact that average collateral of cars is convex and the amortisation scheme is linear, which puts time as a significant variable for variations of LGD. It also hypothesises that as economic downturn usually means higher default rates together with an expansion of the second-hand car market, it allows lessors to keep high recovery rates.

The motivation for this thesis is close to that of Huisman (2008), who explores the concept of residual value in car leasing contracts and its impact on the lessor's profits. He finds out that car leasing companies use publicly available tables to compute residual values for their contracts. Any alternative valuation method can be seen as an opportunity to increase a company's competitiveness. The author uses explanatory variables such as car type, fuel consumption, mileage, among others, to come up with an alternative residual value computation.

This thesis extends the current literature by specifically addressing residual value within Portuguese leasing companies, focusing on the valuation of the purchase option available to the lessee at the end of the lease contract.

III: Concept Definition

This section provides intuition on the way leasing contracts work, clarifying the concepts that will be used throughout this thesis.

III.1: Leasing vs. ALD vs. Renting[1]

Since this thesis will focus on auto leases, it is relevant to distinguish between leasing and other similar financing options available to those wanting to purchase or use a car. Therefore, apart from leasing, I briefly describe two alternatives designed exclusively for vehicles, namely the ALD (Aluguer de Longa Duração – Long-term rental) and Renting.

ALD is a contract in which the user makes periodical payments, sometimes preceded by an upfront payment. The user is then obliged to purchase the vehicle at the end of the contract. Nevertheless, contract terms can usually be changed or transferred to another user throughout the contract.

Renting is similar to ALD, except for the fact that it includes vehicle maintenance and does not include the obligation to purchase.

It has been argued that the existence of these alternative forms of acquiring a vehicle have been a workaround for legal requirements of firms providing leases, topic that is out of scope of this thesis.

After these necessary distinctions, this thesis will resume focus on aspects related to leasing contracts.

III.2: Leasing

A leasing contract is a financing agreement in which the user (lessee) pays a rent to the owner (lessor) in exchange for the economic benefits of a given asset. In terms of rent computation, lease contracts usually work like constant rent loan payments[2]. Each (constant) payment at time t is composed of an amortisation component and an interest component, such that:

$$\bar{R} = A_t + I_t$$

Equation 1: Rent components

[1] ALD/Leasing/Renting, at http://www.flexivisao.pt/pt/produtos.asp?id=1525&mid=228&mm=256
[2] The alternative is constant amortisation plans, which are much less common in leasing contracts

Similarly to traditional financing sources, the amortisation component reimburses the lessor in the amount of principal owed while the interest component compensates the lender for the risk borne.

For a given interest rate i and a T-period lease contract on an asset worth V and with a residual value RV, the components of each payment are computed as[3]:

$$\begin{cases} \left(V_0 - \frac{RV_T}{(1+i)^T}\right) = \frac{\bar{R}}{i} * \left(1 - \frac{1}{(1+i)^T}\right) \\ I_t = \left(V_0 - \frac{RV_T}{(1+i)^T} - \sum_{j=0}^{t-1} A_j\right) * i, with\ A_0 = 0 \\ A_t = \bar{R} - I_t \end{cases}$$

Equation 2: Computation of rent components

This formula implies that the full amount of the loan is reimbursed after all periods, such that:

$$\sum_{t=1}^{T} A_t = V_0 - RV_T$$

Equation 3: Condition on rent computation

Putting these equations together, it is shown that each successive payment has a lower interest component and higher amortisation component than the previous one. Figure 1 presents an adaptation of Figure 1 in Pirotte, Schmit & Vaessen (2004), showing the relationship between principal and interest components of rent payments throughout the contract length.

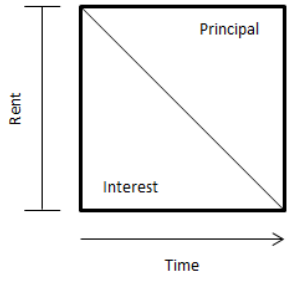

Figure 1: Relationship between interest and principal components of lease rents

[3] These formulae assume that the payments are made at the end of each period.

RESIDUAL VALUE

Since it plays a crucial role in this thesis, further detail will be put into the analysis of the residual value, also known as salvage value. It can be defined as the book value of the lease debt at the end of the contract, and simultaneously the price at which the lessee can transfer to him the ownership of the asset at the end date of the leasing contract. If the option is not exercised, this value is written off against the return of the asset to the lessor. Therefore, the residual value is an important variable in the pricing of such contracts. To illustrate this, Table 1 shows rent computations for a contract with the following characteristics:

- Acquisition value at t=0: €20,000
- Contract length: 5 years
- Monthly payments
- 10% annual interest rate
- Residual value: €0; €1,000; €2,000

Residual Value	Interest	Total Rent	Rent+RV
0.00	5,242.70	25,242.70	25,242.70
1,000.00	5,079.93	24,459.01	25,079.93
2,000.00	4,917.17	23,675.32	24,917.17

Table 1: Interest and rent amounts for different values of Residual Value

In this example, it is observable that a 5 percentage points increase in the residual value leads to a reduction in interest received of 0.8% of the asset value. In case the purchase option is not exercised, increasing the residual value by 5 percentage points reduces the total amount received by the lessor by 3.9%.

To find out the appropriate lease terms, Lee, Martin & Senchack (1982) suggest the usage of Equation 4:

$$S_0 = PV[L(1-t)] + PV(DTS) + ITC + PV(S_T)$$

Equation 4: Equivalence between asset value and leases

This means that the (after tax) lease payments – PV[L(1-t)] – have to be set so that they are equal to the asset purchase price – S_0 – minus the present value of tax shield on debt reimbursement[4], investment tax credit attributable to the asset purchase – ITC – and after-tax residual value – $PV(S_T)$. The authors state that both the lease payments and the tax

[4] The PV(DTS) part of the equation is no longer relevant, since regulations issued after the date of the abovementioned paper have determined that in finance leases the asset ought to be registered by the lessee, such that no depreciation tax shields accrue directly to the lessor.

shields can be seen as riskless, but the rate at which to compute the present value of the residual value is worth discussing.

The salvage value can be written as the combination of a long call option and a short put option on the underlying asset of same maturity and strike, plus the present value of the strike, as in Equation 5 (corresponding to Equation 3 of Lee, Martin & Senchack (1982)):

$$PV(S_T) = PV[Max(0, S_T - X)] + PV(X) - PV[Max(0, X - S_T)]$$

Equation 5: Salvage Value as a combination of options

Since solving Equation 4 for PV[L(1-t)] yields a negative sign on $PV(S_T)$, a lessor engaging in a lease contract is, in terms of residual value, equivalent to holding a short call and a long put on the asset, with the same maturity as the lease and a strike price equal to the salvage value plus borrowing the present value of the exercise price.

Whenever the residual value is misstated, if it is set too high, it will reduce the amount of amortised principal and, *ceteris paribus*, the amount of rent. Additionally, at the end of the contract, it will not be profitable for the lessee to use the purchase option, and the lessor ends up with an overvalued asset on its balance sheet. This will lead to a necessary provision and reduction in the company's net profit.

On the other hand, if the residual value is set too low the rent is significantly increased but, at the end of the contract, the lessee will have an option to purchase the asset at a price that is lower than its market value, producing an opportunity cost for the lessor. Nevertheless, it shall be noted that this loss has been (at least partially) offset by the higher rent charged.

III.3: Alternatives at Lease Termination Date

After the contracted lease period has ended, the lessee must choose between two alternatives: (i) purchase the asset by paying the residual value or (ii) not exercise the purchase option and return the asset.

The companies contacted during this thesis's research phase have agreed that their objective is to avoid the bothersome case of having the asset returned to them. Being financial companies, the presence of the used assets on their balance sheet has a negative influence on their performance ratios. Therefore, they use two main mechanisms to reduce the chance of ending up with the possession of the asset: (i) agree with the asset supplier or

other third-party the sale of the asset in case the lessee does not exercise the purchase option and (ii) set the residual value of the contracts safely below the expected market value at maturity, encouraging the lessee to exercise the purchase option.

The consequence of the strategies outlined above, particularly (ii), is that the lessees exercise the purchase option on nearly 100% of the cases. The value of this option is an amount that the lessors are willing to forego to ensure that the asset is not returned and that the debt value is under control by being significantly below the value of the underlying asset. Hence, one of the objectives of this paper is to determine how much money is being left on the table by the lessors to ensure that (ii) is met.

III.4: Accounting for the Residual Value

This section discusses the accounting impact of the residual value of leasing contracts. As a starting point, a distinction ought to be made between operating leases and finance leases. The former were created as a way to suppress needs of expensive assets with long economic lives for short periods of time, while the latter ensures that the lessor has support in terms of collateral for its financing.

In an accounting perspective, the difference is based on the distribution of risk between the lessor and the lessee, such that an agreement in which most risk is borne by the lessee is considered a finance lease, while it is an operating lease if most risk is borne by the lessor. Indications of the classification of leases as finance or operating are detailed in IAS 17.10 and IAS 17.11. This analysis is based on the substance of the agreement rather than on its form, such that a lease can have different classifications on the lessor's and lessee's side (IAS 17.9).

In a finance lease, the asset is registered by the lessee, together with a liability corresponding to the lease payments. In this case, the residual value should be added to the amount due (as a liability to the lessee and as an asset to the lessor) if it is sufficiently lower than the fair value to make the exercise of the purchase option very likely (IAS 17.4). That being the case, the lease will most likely be classified as a finance lease (IAS 17.10b).

In the case of an operating lease, the residual value is not explicitly present in either balance sheet, since the asset is registered by the lessor and lease payments are registered as

income and expense (to the lessor and the lessee, respectively) in the period to which each payment refers to[5].

A relevant distinction to be made at this point is between amortisation and depreciation. The former refers to the reimbursement by the lessee of the amounts due to the lessor, while the latter corresponds to the reduction in the carrying amount of the asset as a consequence of its usage and deterioration. The study carried out in Huisman (2008) shows that depreciation tends not to be linear, but greater in the first quarters of asset usage. On the contrary, Figure 1 explains that (in constant rent contracts) amortisation is lower in the first years and progressively increases. This exemplifies that depreciation and amortisation represent two different aspects of the asset and should as such be treated separately.

[5] For instance, if the payments have to be done one month in advance, they will come up as a cash-flow and as a differed cost/income when they occur but will be included in the income statement only in the month the payments refer to (accrual basis).

IV: LEASING IN PORTUGAL

Since the previous chapters have dealt with leasing in an international context, this section will introduce the characteristics of the leasing market and its regulation in Portugal.

IV.1: MARKET DESCRIPTION

Financial leases have an important role in financing the Portuguese economy. Total financial leases amounted to 6.7 billion Euros in 2007[6], corresponding to between 2% and 4% of the country's GDP in the last 15 years. Despite the consistent growth between 2003 and 2007, the country's economic context led to a subsequent reduction on the amount of leasing, with the amount of total production in 2012 being less than half of that of 2003 and less than a quarter of the 2007 figure.

In terms of asset types, it has remained relatively constant throughout the 2003-2012 period. One third of the value of new lease contracts is related to real estate (industrial buildings, shops and supermarkets, hotels, among other), another third related to vehicles (cars and trucks) and the remaining third related to other assets (mainly industrial equipment).

This evolution is depicted in Figure 2:

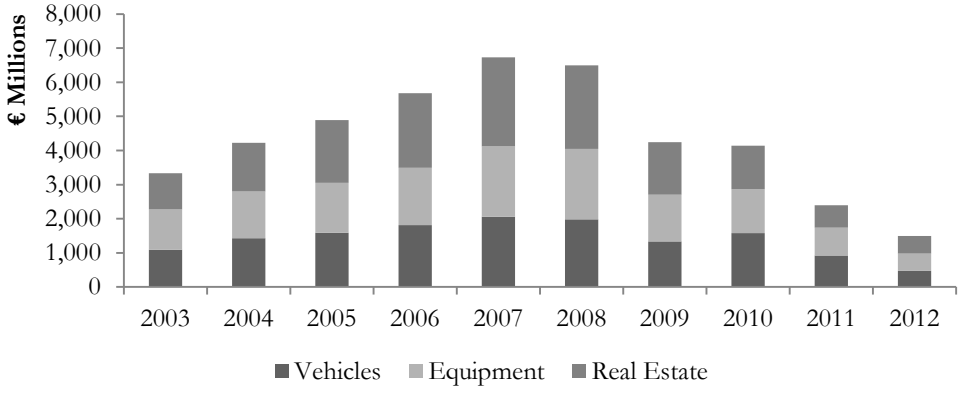

Figure 2: Evolution of leasing production in Portugal by asset type

IV.2: REGULATION

Financial leasing activities in Portugal can only be performed by banks, finance lease companies and credit-authorised financial institutions (IFIC – Instituições Financeiras de

[6] Data for the section kindly provided by ALF (Associação Portuguesa de Leasing, Factoring e Renting)

Crédito). The resulting contracts are subject to several regulations, namely those determined by Decree-Law 149/95 and its successive changes.

I call particular attention to Banco de Portugal's Notice of 28th June 1983, which further regulates financial lease contracts. It stipulates that rents can be paid before or after the period to which they respect, and should be either constant or variable. The formulae to be used are, respectively[7]:

$$\bar{R} = \frac{V_0 - V_R * (1+i)^{-n}}{\frac{1-(1+i)^{-n}}{i}}$$

Equation 6: Rent computation for constant rent leases

$$R_t = \bar{A} + (V_0 - V_R * (1+t)^{-n} - \sum_{k=1}^{t-1} \overline{A_k}) * i$$

Equation 7: Rent computation for constant amortisation leases

The first formula presented is equivalent to the first one in Equation 2. The second one provides an alternative method, where the amortisation is constant, leading to variable interest charges and consequent variable (decreasing) rent. This second approach only seldom appears in leases contracted in Portugal.

Regarding the classification of leases, despite IAS 17.9 referred above, Order no. 16368/2013 determines that the classification of the lease (financial or operational) has to be explicitly written in the leasing contract.

Portuguese legislation used to impose restrictions on the residual value. Decree-Law 149/95 determined that this value should be between 2% and 25% of the acquisition cost. The above-mentioned Notice narrowed this interval to between 2% and 6%. Although this determination was revoked in 2001 (Decree-Law 285/2001), residual values in Portugal are usually low in comparison with the value of the second-hand asset, as will be shown further on.

[7] Notation adapted to reflect the one used in previous equations.

V: HYPOTHESIS, DATA AND METHODOLOGY

Given the role of the residual value in leasing contracts, I hypothesise that in order to achieve abnormally high exercise percentages the lessors are transferring value to the lessees. They set very low salvage values to encourage the lessee to exercise the purchase option.

In order to analyse the hypothesis, the valuation technique known as real options will be used. This is explained by Lee, Martin & Senchack (1982), who argue that calls transfer the costs of monitoring the condition of the asset from the lessor to the lessee, which generally leads to cost advantages.

To ensure comparability and increase data availability, I focus this thesis on the Renault Clio, the most sold car model in Portugal[8], computing the value of the real option at the inception of the lease.

V.1: REAL OPTIONS

Real options are a valuation method for projects that are in essence equivalent to the financial instrument "options". In the words of Copeland & Antikarov (2001), p. 5:

> *A real option is the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time – the life of the option.*

In the case of the leasing purchase option, it can be compared to a European Call, corresponding to the value of the right to acquire the asset at the end of the lease contract for a predetermined price. If, at that time, the market value of the asset is lower than its residual value, the lessee will opt not to exercise the option and obtain a payoff of zero. On the other hand, if the asset is worth more than the strike price, the option will be exercised and the lessor will have the obligation to sell the asset for its residual value, instead of for the (higher) fair value. Therefore, the asset owner has a short position on this option.

While financial options have as underlying a written or traded security, real options have a tangible asset as the underlying. Consequently, the analysis of the asset price and its volatility is more complex in the case of real options in comparison with financial ones.

[8] Most sold car in the 1st semester 2013, according to http://autoviva.sapo.pt/news/renault_clio_modelo_mais_vendido_no_1_semestre/11134

In order to compute the fair value of an option, the following parameters are needed:

- Value of the underlying asset;
- Exercise price;
- Risk-free rate;
- Time to Maturity;
- Volatility of underlying asset value.

In the case of leasing, the underlying asset is the leased object at maturity. I use the data made available by *Usados AutoHoje*[9] and *StandVirtual*[10] to gather the information about all second-hand Renault Clio up to ten years old available online between 29th November 2013 and 2nd December 2013 and use it as the options' S_T. For the asset price at the beginning of the contract (S_0), I use the "reference price" (detailed further on in the Volatility Estimation section) as the expected value of the asset at maturity.

The exercise price is the amount by which the lessee has the option to acquire the leased asset at the end of the contract. In the context of this analysis, it corresponds to the asset's residual value. This data was obtained through contacts held with *Caixa Leasing e Factoring* and *Santander Totta*.

As per the risk-free rate, the 6-month EURIBOR rate will be used, as this is the industry standard in leasing contracts[11]. Based on this rate, financial institutions add their own spread to adjust for the lessee's risk and come up with the interest rate implicit in the lease contract.

Time to maturity is the time difference between the moment at which the option is valued and the lease termination date.

VOLATILITY ESTIMATION

Volatility of the underlying asset corresponds to the price fluctuation that the underlying asset is subject to. At this point, two sources of uncertainty affecting the value of the options can be identified: (i) the market value of the asset at maturity and (ii) the condition of the asset at maturity date. The difference between these is that whereas (i) affects all assets of the same category, (ii) refers only to the asset underlying a specific contract. Whenever the leased asset is unique or its market value cannot be determined due to lack of available information, only (ii) is relevant for the analysis.

[9] http://usados.autohoje.com/carros-usados/marca-renault/modelo-clio/ano-2003,2012/ordenar-ano,desc/
[10] http://www.standvirtual.com/carros/anuncios/?fsub=1&op=search&aktion=find&rub=0&ma=51&mo=1086&ez=2003&ezb=2012&front=carros&list=30&sort=44
[11] I consider this rate to be 0.331%, corresponding to the Euribor 6M rate as of the 2nd December 2013.

To estimate the volatility, I adopt the approach of Huisman (2008). By collecting quotes of used cars from *AutoHoje* magazine[12], I obtain reference prices for Clios between one and ten years old. For each used car, I compute the natural logarithm of the ratio between the selling price and the reference price. The standard deviation to be used in option pricing corresponds to the standard deviation of the above-mentioned logarithms for each year-fuel combination.

V.2: SUMMARY STATISTICS

The data collection presented above led to 389 different used Renault Clio, 240 of which carrying Diesel engines and the remaining being Petrol engines. This is a relevant distinction, since sample Diesel cars produced in a given year can cost up to 44% more than the Petrol cars of the same year.

Detailed description of the sample is provided in Table 4 in the Appendix.

V.3: VALUE OF THE PURCHASE OPTION

After this, I try to estimate the cost to the lessor of defining low residual values. Using the data described above, I apply standard Black-Scholes formula to value the purchase options. However, to be able to purchase the asset below market value, the lessee has to comply with the contractual obligations, namely paying the amortisation and the corresponding interest. To account for this, I compare simulations of two different contracts: one where the residual value equals the figures commonly used by financial institutions and one where the residual value is equivalent to the expected market price of that car. By subtracting the cash-flow difference between these two scenarios to the call value, I arrive at the estimated cost to the lessor of the purchase option.

In these simulations, there is an additional required variable, which is the interest rate. I use a 5.5% annual nominal interest rate as a starting point, since this is coherent with the practice of most financial institutions, according to data provided in their official pricing documents[13]. The impact of this variable will be tested in the VI.2: Sensitivity Analysis.

[12] No. 1255, 28th November 2013-4th December 2013, page 81

[13] http://www.bes.pt/sitebes/cms.aspx?plg=3a1e6ebc-648a-48d7-966b-3d0cfaa6a434 (page 5), http://www.clf.pt/SiteCollectionDocuments/CLF_Precario.pdf (page 29), http://ind.millenniumbcp.pt/pt/Articles/Documents/precario2/021_018.pdf (page 3) and https://www.particulares.santandertotta.pt/ficheros/PRE_FT_20131205.pdf (page 8)

As residual values can be negotiated, I set up the purchase option valuation considering an upper and a lower bound on the contracted residual values.

V.4: ASSUMPTIONS

The above data description carries a critical assumption concerning the equivalence between different cars across time. As technology evolves, newer cars tend to have better equipment without a price increase. To overcome this, I assume that cars with equivalent engines have the same price when new, regardless of their year of production.

Additionally, it is necessary to assume that previously leased cars and regular second-hand cars are equally valuable. This contradicts the conclusions of for example Hendel & Lizzeri (2002), but it is a necessary assumption to come up with prices for second-hand cars and will be nevertheless used as a proxy.

Finally, there are assumptions implicit in the Black-Scholes formula that will be used to value the options. Firstly, the formula assumes that the logarithm of the price ratio is normally distributed. The data samples are too short to provide fully reliable results, but Jarque-Bera normality tests indicate that normality is not rejected in the majority of the cases. Whenever normality is rejected, returns tend to be leptokurtic (current variance is overestimated, leading to overvalued calls) and there are mixed results in terms of skewness. The other significant assumption is that volatility is constant throughout the life of the option.

VI: RESULTS

After applying the methodology described in the previous section, I am able to arrive at the cost to the lessor of each leasing contract, depending on its maturity. As a function of maturity, considering the minimum and maximum contractual residual values defined, this cost is as depicted in Figure 3[14].

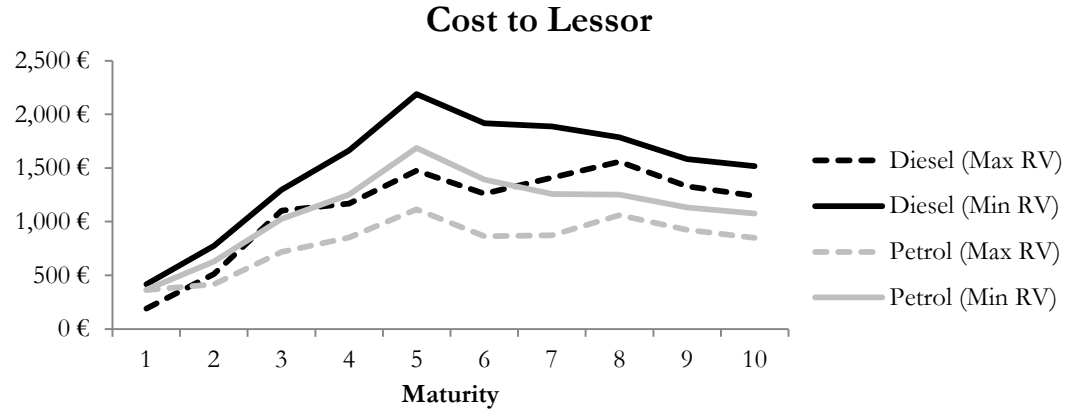

Figure 3: Cost to lessor of the leasing purchase option, with RV intervals for diesel and petrol vehicles

Regarding the cost to lessor for different maturities, it is observable that it increases in the first five years and then has a slight decrease in the following maturities. Due to a lower price, the cost to lessors for Petrol cars is usually lower than for Diesel cars. The former fluctuates between €365 and €1,115, while the latter fit in the range between €415 and €1,328.

The amplitude between the cost for maximum and minimum residual values can be explained by two factors: (i) the size of the range of admissible residual values is not constant throughout maturities, tending to decrease as length increases; (ii) the value of used cars (reference price) decreases in a quasi-linear fashion, whereas the contracted residual values have a more convex shape. This originates a smaller cost to lessor range on the extremes of the length and larger on the middle lengths.

To frame these figures in terms of magnitude, Figure 4 presents the same data as Figure 3 but as a percentage of the loan amount:

[14] Details in Table 5 (low residual value, upper bound) and Table 6 (high residual value, lower bound)

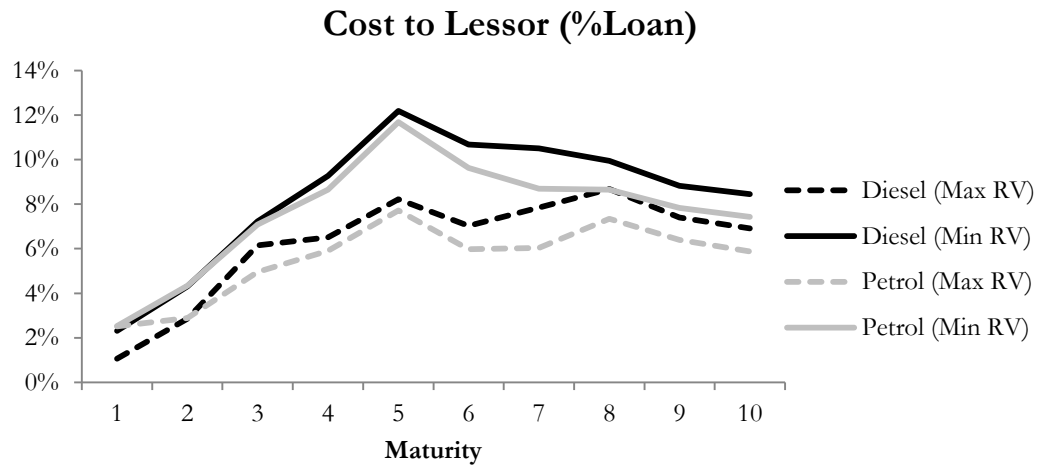

Figure 4: Cost to lessor of the leasing purchase option, as a percentage of the amount of the loan

As expected, the pattern is equivalent in the last two figures, but when considering the cost as a percentage, the difference between Diesel and Petrol engines still exists but is much less significant.

The cost to lessor can be decomposed into the cost of the purchase option (call) and the cash-flow benefit of contracting a higher residual value.

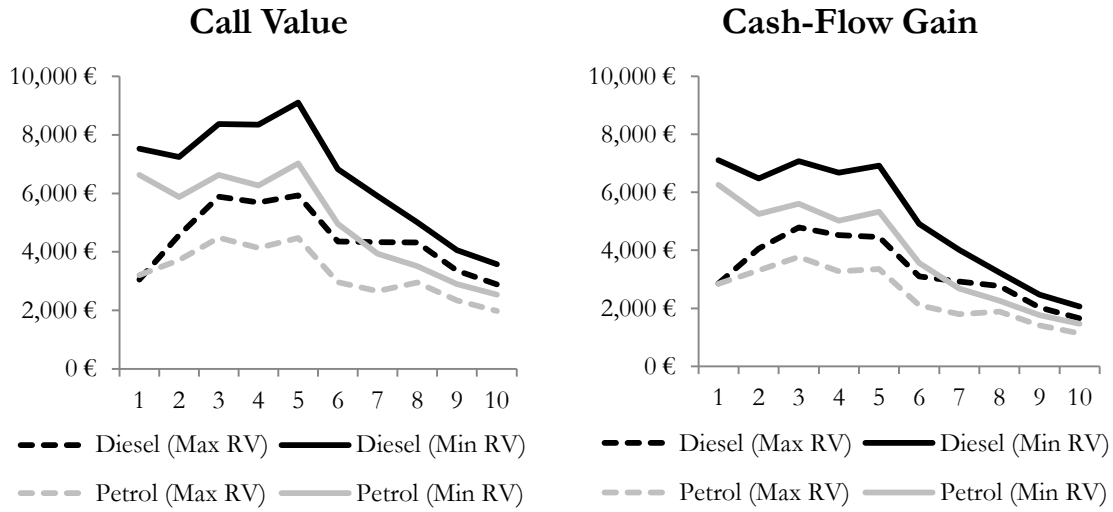

Figure 5: Decomposition of the cost to lessor between call value and cash-flow gains

Figure 5 shows that the increase in cost to lessor between years 1 and 5 happens because the call value slightly increases while the residual value gain (cash-flow difference of contracting a low residual value) decreases. In the subsequent years, both the call value and the RV gain decrease, with the latter decreasing more than the other and leading to a slight decrease on the overall cost to lessor.

VI.1: GREEKS

When valuing options, measures known as the "Greeks" can be used to assess the sensitivity of the options to their composing factors. However, since the calls under analysis are deeply in-the-money, i.e., the actual asset price is way above the call's strike price, all Greeks are very close to their upper bound values, such that:

Delta	Gamma	Theta
1	0	$-rXe^{-r\Delta t}$

Table 2: Greeks for the options under analysis

This means that small changes in asset price lead to directly proportional changes in call value (Delta), that no correction is needed to Delta when asset price changes are greater (Gamma) and that the passage of time consistently decreases the value of the option in its maximum amount (Theta).

VI.2: SENSITIVITY ANALYSIS

To account for the limitations of the sample used, sensitivity analyses are performed to check the consequences of deviations between the sampled values and the actual values.

To improve the readability of the data, the analyses below include two graphs each, one for Diesel engines and one for Petrol engines. Instead of using upper and lower residual value bounds, I use an average of both so that the graphs include only three lines: base case, positive scenario and negative scenario.

Results are condensed in Table 7.

CONTRACT INTEREST RATE

The interest rate of a leasing contract is dependent on two main variables: (i) the base rate, which depends on the macroeconomic factors that influence the EURIBOR rate and (ii) the client risk, which determines the spread applied to a given contract. In the current financial environment, the interbank rates are particularly low, so the major source of uncertainty is the client risk. Starting from the base case of a 5.5% interest rate, I recalculate the cost to lessor for 4% and 7% interest rates.

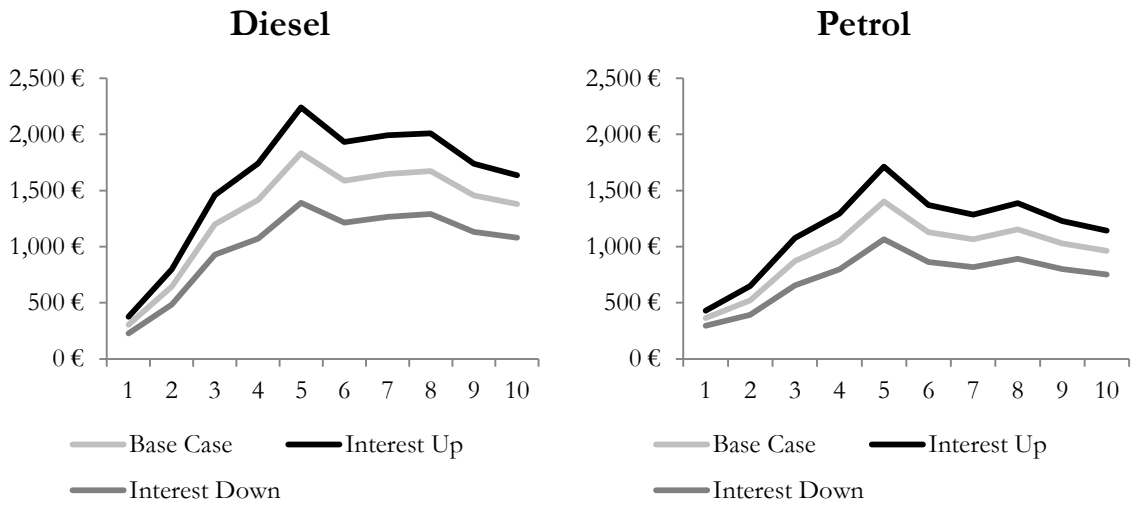

Figure 6: Sensitivity of the cost to lessor relative to the contract interest rate

In this case, increasing the interest rate increases the cost to the lessor, while a lower interest rate reduces this cost. This happens since the call analysis is done in a risk-free environment, leading to the impact only happening on the cash-flow difference between the contracts. When the contract interest rate is higher, the cash-flow gains of low residual values are reduced and the cost to the lessor increases. The effects are greater as the maturity of the contracts increases.

REFERENCE PRICE

Due to the lack of information regarding the used car market, it is possible that the estimations of the value of the used cars each year are not fully accurate. Therefore, a sensitivity analysis is performed, increasing and decreasing the reference price by 10% to check the impact on the cost to lessor.

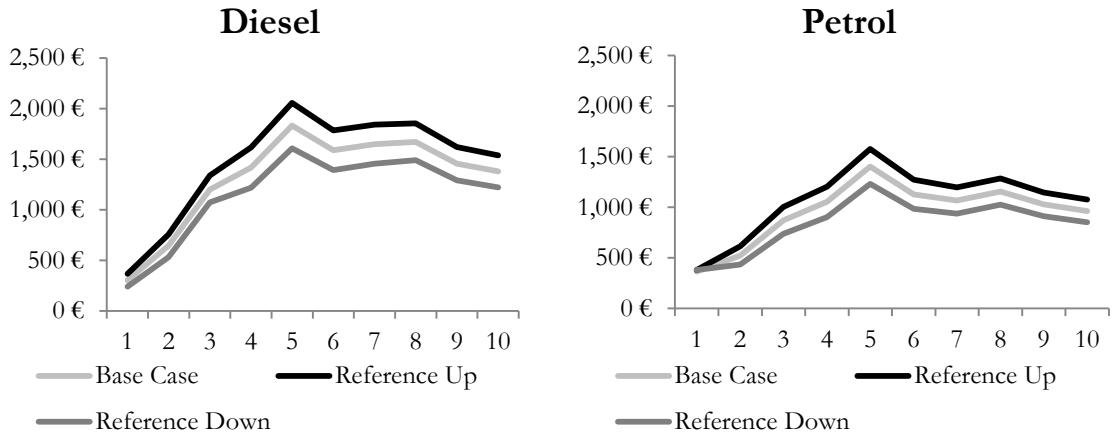

Figure 7: Sensitivity of the cost to lessor relative to the used car price

Increasing (decreasing) the reference price for used cars increases (decreases) the value of the call more than it increases (decreases) the cash-flow gains of low residual values, resulting in an increase (decrease) of the cost to lessor. These impacts increase up to five years maturity, after which they slightly decrease.

NEW PRICE

Finally, I test the sensitivity of the cost to lessor relative to the price of new cars. Assuming that the used cars keep their value unchanged but the new ones become more (less) expensive, an inverse reaction is observed in the cost to lessor, meaning that a 10% increase (decrease) in the price of new cars leads to a decrease (increase) in the cost to lessor, although these differences are rather small.

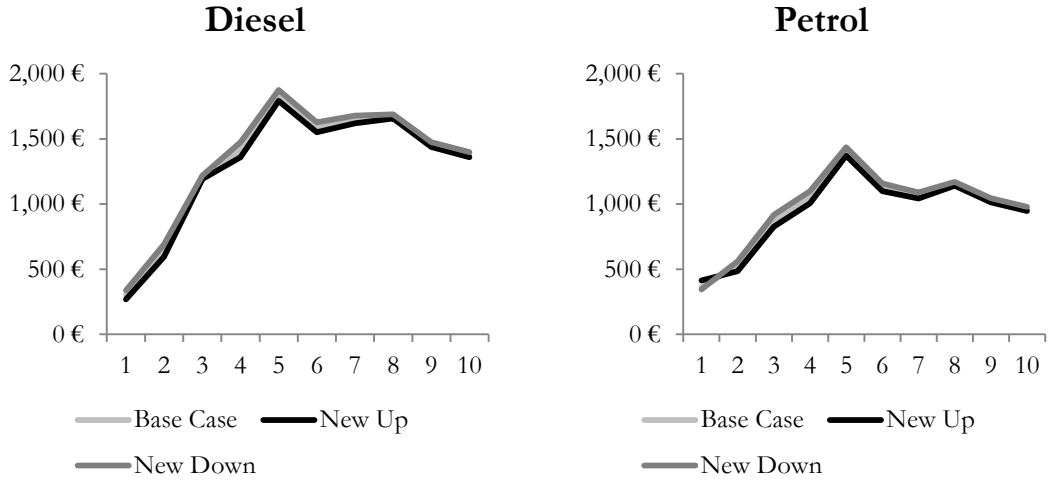

Figure 8: Sensitivity of the cost to lessor relative to the new car price

Changing the price of the car barely affects the cost to lessor, since the change in the call value is almost perfectly offset by the cash-flow gains.

VI.3: ALTERNATIVE CONTRACTS

At this point, I have computed the value of the purchase option considering the lessors' current policy of setting low residual values.

An alternative would be setting the residual value equal to the expected market value of the asset at maturity. This means that the purchase option is now represented by a nearly at-the-money call. However, the cost of disposing the returned asset is now much more relevant, since the probability of such return is significantly increased.

Based on the current sample, I compute the percentage of used cars put for sale below the reference price. This will be the proportion of cars that would be returned, and using an expected value logic, I add P(return)*disposal cost to the call value to come up with the cost to lessor of this scenario. Using the reference prices from *AutoHoje*, the percentage of returns is still fairly low, with an average of 30%, 7 cases (out of 20) with no returns and 5 cases above 50% of returns. As seen in Figure 9, returns of Diesel cars are particularly high in medium-term contracts (3-6 years), while on Petrol cars the pattern seems more random.

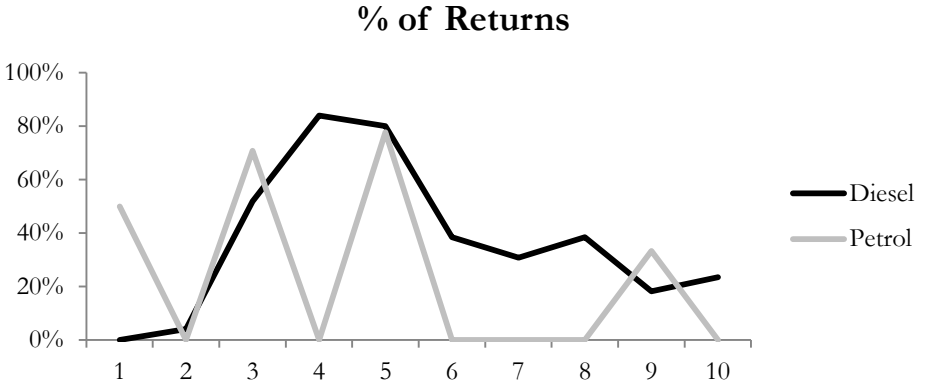

Figure 9: Percentage of returned cars for the RV=E(MV) scenario

With a contract of this type, when the option is not exercised, lessors have two alternatives at maturity: (i) sell the asset for its residual value to a third-party that will be responsible for its sale or (ii) sell the asset and bear the cost. Each of these is analysed below.

THIRD-PARTY SALE

The disposal cost is the expense related to preparing the car to be sold, and is reported to amount to €250. This cost has been ignored in the previous analysis since the probability of asset return was negligible.

The analysis of this alternative leads to a cost to lessor between €230 and €2,620, which as a percentage of the loan amount is represented as follows[15]:

[15] Detailed in Table 8

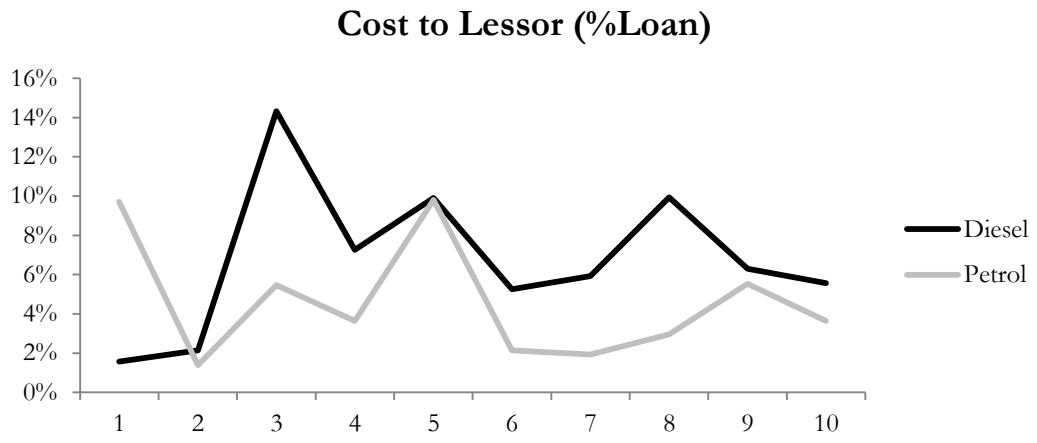

Figure 10: Cost to lessor as a percentage of loan amount for the 3rd party sale

LOSS-BEARING SALE

The lessor may also sell the car autonomously, in which case the unrealised residual value ought to be added to the call price. In this case, this cost to lessor fits between €200 and €3,660, represented as a percentage of the loan amount in the following figure[16]:

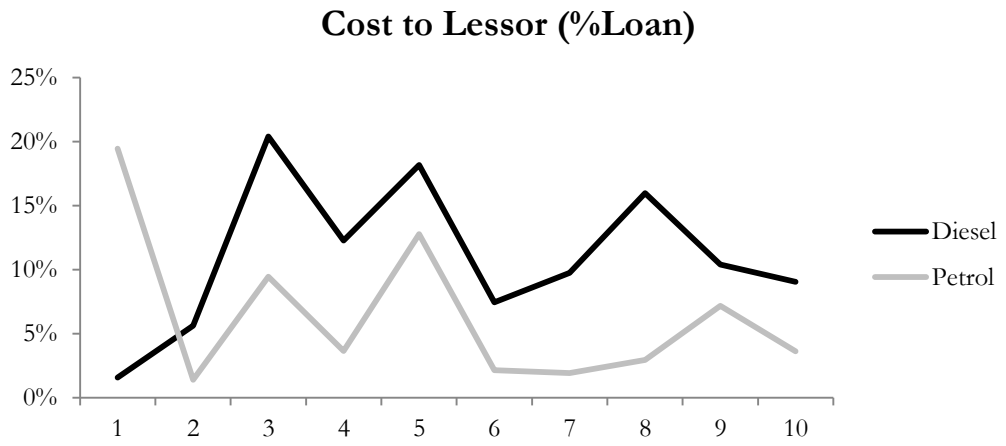

Figure 11: Cost to lessor as a percentage of loan amount for the loss-bearing sale

VI.4: RESULTS' COMPARISON

Comparing the cost to lessor of the different strategies (upper and lower bound of residual value and the RV=E(MV) alternatives)[17], the 3rd party sale is the best in 12 out of 20 cases. Still, we should take into account that increasing the residual value will reduce the ability of the third-party to make a profit, so they might increase the fee charged to the lessor.

[16] Detailed in Table 9
[17] Detailed in Table 10

Nevertheless, two main factors significantly reduce the viability of the third-party sale: (i) the return percentages would make lessors act like car dealers more than financiers, which is not their strategic objective and (ii) a high residual value implies that the lessee will have an expensive final payment, and he or she might prefer to spread such payments throughout the length of the contract. Financial leasing is targeted at consumers that are almost certain that they want to keep their vehicle at maturity and there are other available solutions tailored to objectives different from this.

VII: CONCLUSION

The residual value is a critical component of leasing contracts, impacting on the amount of amortisation and subsequently on the amount of interest. Associated with the residual value is the option to purchase the leased asset for that price. Since companies have reported nearly 100% of contracts with the option exercised, I studied the value of such option and whether it was being taken into account by lessors.

The literature review highlights the relevance of the topic, showing that the lease vs. buy decision has been a matter of concern for companies and that the real options approach has been widely used to describe leasing contracts and assess their usefulness. Furthermore, it shows that accounting standards and their worldwide adoption has changed the way companies view financing through leasing. The distinction between finance and operational leases forced companies to abandon the use of leasing as an instrument to promote off-balance sheet items and eliminated the ability for lessors to benefit from asset depreciation.

In Portugal, leasing has shown an increasing relevance in the economy, although negatively impacted by the recent crisis. Based on contacts with two financial institutions providing leasing, they argue that residual values have to be set safely below the expected market value of the asset at maturity, to avoid the risk of having the asset returned, incurring in transaction costs and damaging financial ratios due to the increased asset amount, while keeping the face value of debt below asset value.

Following the investigation of the existing literature and the characteristics of finance leases in Portugal, I focus on the residual value and its role within leasing contracts. By setting low residual values, lessors are forced to forego some value at maturity. I use real options analysis and a comparison between current contracts and contracts where the residual value equals the expected market value to assess the implicit costs of current pricing policies. For the Renault Clio, one of the most common cars on Portuguese roads, the cost to lessors can be as low as €190 and as high as €2,200, corresponding to between 1% and 12.2% of the financed amount. The higher the residual value the lower the cost to lessor, with this cost tending to be higher for Diesel engines compared to Petrol ones.

Considering vehicles between one and ten years old, separated by fuel type, the cost to lessor considering the lower and upper limits of the contracted residual value is presented

in the following table, both in its absolute amount and as a percentage of the financed amount:

Age	Fuel	Low RV	%	High RV	%
1	Diesel	415.71	2.32%	190.93	1.06%
	Petrol	365.30	2.53%	362.60	2.51%
2	Diesel	774.56	4.32%	512.46	2.85%
	Petrol	627.85	4.34%	416.86	2.88%
3	Diesel	1296.98	7.23%	1103.21	6.15%
	Petrol	1024.73	7.09%	717.16	4.96%
4	Diesel	1663.38	9.27%	1168.76	6.51%
	Petrol	1251.25	8.66%	852.59	5.90%
5	Diesel	2189.07	12.20%	1474.56	8.21%
	Petrol	1688.23	11.68%	1115.19	7.72%
6	Diesel	1916.47	10.68%	1261.15	7.03%
	Petrol	1391.66	9.63%	863.92	5.98%
7	Diesel	1887.24	10.51%	1409.41	7.85%
	Petrol	1257.46	8.70%	872.45	6.04%
8	Diesel	1785.05	9.94%	1558.74	8.68%
	Petrol	1250.60	8.65%	1060.33	7.34%
9	Diesel	1583.52	8.82%	1327.93	7.40%
	Petrol	1131.31	7.83%	925.03	6.40%
10	Diesel	1516.41	8.45%	1240.66	6.91%
	Petrol	1074.47	7.44%	849.87	5.88%

Table 3: Cost to Lessor summary

These conclusions confirm those in papers such as Huisman (2008) and Lee, Martin & Senchack (1982), who point out the worthiness and relevance of the purchase option within the context of leasing contracts.

Furthermore, sensitivity analyses have shown that interest rate, reference price and new price have significant impact on the cost to the lessor, with a positive relationship in the first two and a negative relationship in the latter.

An alternative strategy would be setting the residual value equal to the expected market value of the asset at maturity. Setting up these contracts and selling the returned assets to a third-party is comparatively cheaper in most cases, but differs in substance from the business purpose of the lessors and the customers' objective when opting for this financing instrument.

VII.1: Limitations and Further Research

Given the complexity of the real world, several aspects have to be assumed or left behind to allow the conclusions to be focused on a given variable.

The analysis carried out here can therefore be expanded. Being focused on a single car model, for cars available for sale within a narrow period of time, both sample ranges can be expanded. On the one hand, using multiple car models would show whether the conclusions obtained for the Renault Clio are valid for other cars and if the cost to the lessor is equivalent. On the other hand, performing the valuations for cars available for sale in other moments would reduce the effect of factors specific to a given period, where the cars could be particularly under- or overvalued.

Another significant assumption is the use of current used car prices and current new car prices. For the conclusions to be valid, it is assumed that in X years a car bought today will have the same price as the price that a car bought X years ago has today. The same is valid for new cars, where cars with equivalent engines have the same price when new, regardless of their year of production.

Other limitations have been discussed throughout the document, namely the lack of price discrimination between leased and acquired cars and the assumptions of the Black-Scholes valuation model.

VII.2: Final Remark

To conclude, I hope that this thesis has contributed to raise awareness towards the relevance of the residual value in the context of leasing contracts, contributing to the correct understanding of the consequences of setting low residual values and promoting the discussion regarding the worthiness of bearing such cost.

APPENDIX

	Average Price	StDev of Price	Sample Size	Reference Price
2003				
Diesel	4281.12	812.54	17	3882.50
Petrol	3533.75	576.33	16	2767.50
2004				
Diesel	5248.18	1077.37	11	4356.67
Petrol	3636.58	704.13	12	3128.00
2005				
Diesel	5460.00	1375.75	13	5329.17
Petrol	5125.00	530.33	2	3751.43
2006				
Diesel	6633.77	978.60	13	6226.00
Petrol	5604.29	350.66	7	4172.00
2007				
Diesel	7606.92	925.40	13	7138.57
Petrol	6512.50	405.94	12	5197.14
2008				
Diesel	8397.08	1469.10	40	9615.00
Petrol	7502.74	1796.73	27	7426.67
2009				
Diesel	9499.20	1252.56	25	10250.00
Petrol	8775.00	757.74	4	7800.00
2010				
Diesel	10833.15	1659.57	52	11136.00
Petrol	8535.42	969.13	24	8865.00
2011				
Diesel	12024.13	730.98	24	10885.71
Petrol	9318.29	384.02	35	8805.00
2012				
Diesel	13415.63	815.32	32	12035.00
Petrol	9832.90	2176.27	10	10260.00
2013 (New)				
Diesel	-	-		17950.00
Petrol	-	-		14450.00
Grand Total	**8575.80**	**2950.59**	**389**	

Table 4: Summary statistics for the sample of used cars and reference prices

Cost to Lessor – Minimum RV

Type	DeltaT	S0	RV%	Strike	Vol	Call	RV Gain	Cost to Lessor	Cost/Loan	Strike/S0	RV Gain/Call
2012Diesel	1	11995.30	25%	4487.50	0.059	7,522.62 €	7,106.91 €	415.71 €	2.32%	37.41%	94.47%
2011Diesel	2	10814.01	20%	3590.00	0.061	7,247.69 €	6,473.14 €	774.56 €	4.32%	33.20%	89.31%
2010Diesel	3	11026.15	15%	2692.50	0.324	8,365.69 €	7,068.71 €	1,296.98 €	7.23%	24.42%	84.50%
2009Diesel	4	10115.41	10%	1795.00	0.136	8,344.01 €	6,680.64 €	1,663.38 €	9.27%	17.75%	80.07%
2008Diesel	5	9457.44	2%	359.00	0.189	9,104.33 €	6,915.26 €	2,189.07 €	12.20%	3.80%	75.96%
2007Diesel	6	6998.43	1%	179.50	0.124	6,822.46 €	4,905.99 €	1,916.47 €	10.68%	2.56%	71.91%
2006Diesel	7	6083.63	1%	179.50	0.155	5,908.25 €	4,021.01 €	1,887.24 €	10.51%	2.95%	68.06%
2005Diesel	8	5190.13	1%	179.50	0.296	5,015.32 €	3,230.27 €	1,785.05 €	9.94%	3.46%	64.41%
2004Diesel	9	4229.00	1%	179.50	0.218	4,054.77 €	2,471.25 €	1,583.52 €	8.82%	4.24%	60.95%
2003Diesel	10	3756.30	1%	179.50	0.202	3,582.64 €	2,066.23 €	1,516.41 €	8.45%	4.78%	57.67%
2012Petrol	1	10226.15	25%	3612.50	0.315	6,625.81 €	6,260.51 €	365.30 €	2.53%	35.33%	94.49%
2011Petrol	2	8747.00	20%	2890.00	0.041	5,876.07 €	5,248.22 €	627.85 €	4.34%	33.04%	89.32%
2010Petrol	3	8777.55	15%	2167.50	0.101	6,631.47 €	5,606.73 €	1,024.73 €	7.09%	24.69%	84.55%
2009Petrol	4	7697.58	10%	1445.00	0.086	6,271.58 €	5,020.33 €	1,251.25 €	8.66%	18.77%	80.05%
2008Petrol	5	7304.97	2%	289.00	0.189	7,020.71 €	5,332.48 €	1,688.23 €	11.68%	3.96%	75.95%
2007Petrol	6	5095.11	1%	144.50	0.062	4,953.45 €	3,561.80 €	1,391.66 €	9.63%	2.84%	71.91%
2006Petrol	7	4076.60	1%	144.50	0.065	3,935.41 €	2,677.96 €	1,257.46 €	8.70%	3.54%	68.05%
2005Petrol	8	3653.55	1%	144.50	0.104	3,512.83 €	2,262.23 €	1,250.60 €	8.65%	3.96%	64.40%
2004Petrol	9	3036.34	1%	144.50	0.200	2,896.08 €	1,764.78 €	1,131.31 €	7.83%	4.76%	60.94%
2003Petrol	10	2677.54	1%	144.50	0.157	2,537.75 €	1,463.28 €	1,074.47 €	7.44%	5.40%	57.66%

Table 5: Cost to Lessor and its components for the lower bound of contracted Residual Value

Cost to Lessor – Maximum RV

Type	DeltaT	S0	RV%	Strike	Vol	Call	RV Gain	Cost to Lessor	Cost/Loan	Strike/S0	RV Gain/Call
2012Diesel	1	11995.30	50%	8975.00	0.059	3,049.95 €	2,859.02 €	190.93 €	1.06%	74.82%	93.74%
2011Diesel	2	10814.01	35%	6282.50	0.061	4,572.96 €	4,060.50 €	512.46 €	2.85%	58.10%	88.79%
2010Diesel	3	11026.15	30%	5385.00	0.324	5,888.11 €	4,784.90 €	1,103.21 €	6.15%	48.84%	81.26%
2009Diesel	4	10115.41	25%	4487.50	0.136	5,687.53 €	4,518.77 €	1,168.76 €	6.51%	44.36%	79.45%
2008Diesel	5	9457.44	20%	3590.00	0.189	5,934.11 €	4,459.54 €	1,474.56 €	8.21%	37.96%	75.15%
2007Diesel	6	6998.43	15%	2692.50	0.124	4,359.11 €	3,097.97 €	1,261.15 €	7.03%	38.47%	71.07%
2006Diesel	7	6083.63	10%	1795.00	0.155	4,330.18 €	2,920.77 €	1,409.41 €	7.85%	29.51%	67.45%
2005Diesel	8	5190.13	5%	897.50	0.296	4,326.13 €	2,767.39 €	1,558.74 €	8.68%	17.29%	63.97%
2004Diesel	9	4229.00	5%	897.50	0.218	3,361.01 €	2,033.09 €	1,327.93 €	7.40%	21.22%	60.49%
2003Diesel	10	3756.30	5%	897.50	0.202	2,892.12 €	1,651.46 €	1,240.66 €	6.91%	23.89%	57.10%
2012Petrol	1	10226.15	50%	7225.00	0.315	3,203.50 €	2,840.90 €	362.60 €	2.51%	70.65%	88.68%
2011Petrol	2	8747.00	35%	5057.50	0.041	3,722.87 €	3,306.01 €	416.86 €	2.88%	57.82%	88.80%
2010Petrol	3	8777.55	30%	4335.00	0.101	4,485.39 €	3,768.23 €	717.16 €	4.96%	49.39%	84.01%
2009Petrol	4	7697.58	25%	3612.50	0.086	4,132.59 €	3,280.00 €	852.59 €	5.90%	46.93%	79.37%
2008Petrol	5	7304.97	20%	2890.00	0.189	4,470.79 €	3,355.59 €	1,115.19 €	7.72%	39.56%	75.06%
2007Petrol	6	5095.11	15%	2167.50	0.062	2,970.23 €	2,106.32 €	863.92 €	5.98%	42.54%	70.91%
2006Petrol	7	4076.60	10%	1445.00	0.065	2,664.70 €	1,792.25 €	872.45 €	6.04%	35.45%	67.26%
2005Petrol	8	3653.55	5%	722.50	0.104	2,949.93 €	1,889.60 €	1,060.33 €	7.34%	19.78%	64.06%
2004Petrol	9	3036.34	5%	722.50	0.200	2,337.08 €	1,412.05 €	925.03 €	6.40%	23.80%	60.42%
2003Petrol	10	2677.54	5%	722.50	0.157	1,979.25 €	1,129.38 €	849.87 €	5.88%	26.98%	57.06%

Table 6: Cost to Lessor and its components for the upper bound of contracted Residual Value

Cost to Lessor – Sensitivity Analysis

Type	Base Case	Interest Up	Interest Down	Reference Up	Reference Down	New Up	New Down
2012Diesel	303.32	377.13	228.31	367.37	239.33	269.64	337.04
2011Diesel	643.51	798.37	483.75	755.91	531.11	595.46	691.56
2010Diesel	1200.10	1459.57	928.40	1339.58	1072.88	1192.18	1220.08
2009Diesel	1416.07	1740.53	1071.21	1615.20	1217.47	1359.03	1473.61
2008Diesel	1831.82	2240.72	1390.67	2056.91	1608.53	1791.59	1873.78
2007Diesel	1588.81	1931.55	1213.48	1785.06	1392.75	1551.61	1626.18
2006Diesel	1648.32	1992.58	1265.65	1842.24	1454.57	1619.39	1677.41
2005Diesel	1671.90	2009.35	1291.15	1855.10	1489.19	1656.35	1687.93
2004Diesel	1455.72	1738.76	1131.57	1620.02	1291.74	1437.29	1474.46
2003Diesel	1378.54	1636.21	1078.99	1536.50	1220.97	1358.80	1398.66
2012Petrol	363.95	431.35	295.45	378.73	378.70	413.29	343.46
2011Petrol	522.35	648.12	392.62	613.27	431.44	483.67	561.04
2010Petrol	870.95	1076.16	656.06	1004.17	737.74	824.83	917.08
2009Petrol	1051.92	1292.39	796.33	1203.62	900.22	1005.42	1098.43
2008Petrol	1401.71	1714.03	1064.76	1575.05	1230.17	1370.22	1434.94
2007Petrol	1127.79	1370.50	861.99	1270.72	984.85	1097.63	1157.94
2006Petrol	1064.95	1286.64	818.53	1194.97	934.93	1041.42	1088.48
2005Petrol	1155.46	1389.06	891.90	1285.28	1025.65	1141.19	1169.73
2004Petrol	1028.17	1227.79	799.55	1146.14	910.44	1013.24	1043.33
2003Petrol	962.17	1141.87	753.27	1075.10	849.39	945.60	978.88

Table 7: Cost to Lessor in the different sensitivity analysis scenarios

RV=PV(E(MV)) – 3rd party sale

Type	DeltaT	S0	Strike	Vol	Call	% Returns	TransCost	Cost to Lessor	Cost/Loan
2012Diesel	1	11995.30	12035.00	0.059	281.64 €	0%	0.00 €	281.64 €	1.57%
2011Diesel	2	10814.01	10885.71	0.061	372.27 €	4%	10.42 €	382.68 €	2.13%
2010Diesel	3	11026.15	11136.00	0.324	2,439.76 €	52%	129.81 €	2,569.57 €	14.32%
2009Diesel	4	10115.41	10250.00	0.136	1,093.16 €	84%	210.00 €	1,303.16 €	7.26%
2008Diesel	5	9457.44	9615.00	0.189	1,576.15 €	80%	200.00 €	1,776.15 €	9.89%
2007Diesel	6	6998.43	7138.57	0.124	847.92 €	38%	96.15 €	944.08 €	5.26%
2006Diesel	7	6083.63	6226.00	0.155	985.47 €	31%	76.92 €	1,062.40 €	5.92%
2005Diesel	8	5190.13	5329.17	0.296	1,686.38 €	38%	96.15 €	1,782.53 €	9.93%
2004Diesel	9	4229.00	4356.67	0.218	1,086.12 €	18%	45.45 €	1,131.57 €	6.30%
2003Diesel	10	3756.30	3882.50	0.202	940.11 €	24%	58.82 €	998.94 €	5.57%
2012Petrol	1	10226.15	10260.00	0.315	1,278.28 €	50%	125.00 €	1,403.28 €	9.71%
2011Petrol	2	8747.00	8805.00	0.041	201.50 €	0%	0.00 €	201.50 €	1.39%
2010Petrol	3	8777.55	8865.00	0.101	612.38 €	71%	177.08 €	789.46 €	5.46%
2009Petrol	4	7697.58	7800.00	0.086	525.78 €	0%	0.00 €	525.78 €	3.64%
2008Petrol	5	7304.97	7426.67	0.189	1,222.22 €	78%	194.44 €	1,416.66 €	9.80%
2007Petrol	6	5095.11	5197.14	0.062	309.57 €	0%	0.00 €	309.57 €	2.14%
2006Petrol	7	4076.60	4172.00	0.065	278.95 €	0%	0.00 €	278.95 €	1.93%
2005Petrol	8	3653.55	3751.43	0.104	425.91 €	0%	0.00 €	425.91 €	2.95%
2004Petrol	9	3036.34	3128.00	0.200	716.69 €	33%	83.33 €	800.02 €	5.54%
2003Petrol	10	2677.54	2767.50	0.157	524.87 €	0%	0.00 €	524.87 €	3.63%

Table 8: Cost to Lessor and its components for the 3rd party sale scenario

RV=PV(E(MV)) – Loss-Bearing Sale

Type	DeltaT	S0	Strike	Vol	Call	% Returns	Loss	Cost to Lessor	Cost/Loan
2012Diesel	1	11995.30	12035.00	0.059	281.64 €	0%	0.00 €	281.64 €	1.57%
2011Diesel	2	10814.01	10885.71	0.061	372.27 €	4%	635.71 €	1,007.98 €	5.62%
2010Diesel	3	11026.15	11136.00	0.324	2,439.76 €	52%	1,220.30 €	3,660.06 €	20.39%
2009Diesel	4	10115.41	10250.00	0.136	1,093.16 €	84%	1,108.10 €	2,201.25 €	12.26%
2008Diesel	5	9457.44	9615.00	0.189	1,576.15 €	80%	1,685.81 €	3,261.96 €	18.17%
2007Diesel	6	6998.43	7138.57	0.124	847.92 €	38%	488.57 €	1,336.49 €	7.45%
2006Diesel	7	6083.63	6226.00	0.155	985.47 €	31%	763.50 €	1,748.97 €	9.74%
2005Diesel	8	5190.13	5329.17	0.296	1,686.38 €	38%	1,181.17 €	2,867.55 €	15.98%
2004Diesel	9	4229.00	4356.67	0.218	1,086.12 €	18%	781.67 €	1,867.79 €	10.41%
2003Diesel	10	3756.30	3882.50	0.202	940.11 €	24%	682.50 €	1,622.61 €	9.04%
2012Petrol	1	10226.15	10260.00	0.315	1,278.28 €	50%	1,532.20 €	2,810.48 €	19.45%
2011Petrol	2	8747.00	8805.00	0.041	201.50 €	0%	0.00 €	201.50 €	1.39%
2010Petrol	3	8777.55	8865.00	0.101	612.38 €	71%	754.41 €	1,366.79 €	9.46%
2009Petrol	4	7697.58	7800.00	0.086	525.78 €	0%	0.00 €	525.78 €	3.64%
2008Petrol	5	7304.97	7426.67	0.189	1,222.22 €	78%	624.57 €	1,846.79 €	12.78%
2007Petrol	6	5095.11	5197.14	0.062	309.57 €	0%	0.00 €	309.57 €	2.14%
2006Petrol	7	4076.60	4172.00	0.065	278.95 €	0%	0.00 €	278.95 €	1.93%
2005Petrol	8	3653.55	3751.43	0.104	425.91 €	0%	0.00 €	425.91 €	2.95%
2004Petrol	9	3036.34	3128.00	0.200	716.69 €	33%	318.25 €	1,034.94 €	7.16%
2003Petrol	10	2677.54	2767.50	0.157	524.87 €	0%	0.00 €	524.87 €	3.63%

Table 9: Cost to Lessor and its components for the loss-bearing sale scenario

	3rd party	Own Sale	Min RV	Max RV	Cheapest	Most Expensive
2012Diesel	281.64 €	281.64 €	415.71 €	190.93 €	Max RV	Min RV
2011Diesel	382.68 €	1,007.98 €	774.56 €	512.46 €	3rd party	Own Sale
2010Diesel	2,569.57 €	3,660.06 €	1,296.98 €	1,103.21 €	Max RV	Own Sale
2009Diesel	1,303.16 €	2,201.25 €	1,663.38 €	1,168.76 €	Max RV	Own Sale
2008Diesel	1,776.15 €	3,261.96 €	2,189.07 €	1,474.56 €	Max RV	Own Sale
2007Diesel	944.08 €	1,336.49 €	1,916.47 €	1,261.15 €	3rd party	Min RV
2006Diesel	1,062.40 €	1,748.97 €	1,887.24 €	1,409.41 €	3rd party	Min RV
2005Diesel	1,782.53 €	2,867.55 €	1,785.05 €	1,558.74 €	Max RV	Own Sale
2004Diesel	1,131.57 €	1,867.79 €	1,583.52 €	1,327.93 €	3rd party	Own Sale
2003Diesel	998.94 €	1,622.61 €	1,516.41 €	1,240.66 €	3rd party	Own Sale
2012Petrol	1,403.28 €	2,810.48 €	365.30 €	362.60 €	Max RV	Own Sale
2011Petrol	201.50 €	201.50 €	627.85 €	416.86 €	3rd party	Min RV
2010Petrol	789.46 €	1,366.79 €	1,024.73 €	717.16 €	Max RV	Own Sale
2009Petrol	525.78 €	525.78 €	1,251.25 €	852.59 €	3rd party	Min RV
2008Petrol	1,416.66 €	1,846.79 €	1,688.23 €	1,115.19 €	Max RV	Own Sale
2007Petrol	309.57 €	309.57 €	1,391.66 €	863.92 €	3rd party	Min RV
2006Petrol	278.95 €	278.95 €	1,257.46 €	872.45 €	3rd party	Min RV
2005Petrol	425.91 €	425.91 €	1,250.60 €	1,060.33 €	3rd party	Min RV
2004Petrol	800.02 €	1,034.94 €	1,131.31 €	925.03 €	3rd party	Min RV
2003Petrol	524.87 €	524.87 €	1,074.47 €	849.87 €	3rd party	Min RV

Table 10: Comparison of alternative contracts and cheapest and most expensive option

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