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Abstract

Purpose
The purpose of this paper is to exhibit the impacts of lease duration and lease break options on the optimal holding period for a real estate asset or portfolio.

Methodology/approach
We use a Monte Carlo simulation framework to simulate a real estate asset's cash-flows in which lease structures (rent, indexation pattern, overall lease duration and break options) are explicitly taken into account. We assume that a tenant exercises his/her option to break a lease if the rent paid is higher than the market rental value of similar properties. We also model vacancy duration stochastically using Poisson's law. Finally capital values and market rental values are simulated using specific stochastic processes, and are also assumed to be correlated. We derive the optimal holding period for the asset as the value that maximises its discounted value, which is the sum of the discounted free cash flows and the discounted terminal value.

Findings
We demonstrate that, consistent with existing capital markets literature and real estate business practice, break-options in leases can dramatically alter optimal holding periods for real estate assets and portfolios by extension. We show that, everything else being equal, shorter lease durations, higher market rental value volatility, increasing negative rental reversion, higher vacancy duration, more break options, all tend to decrease the optimal holding period of a real estate asset. The converse is also true.

Practical implications
Practitioners are offered insights as well as a practical methodology for determining the ex-ante optimal holding period for an asset or a portfolio based on a number of market and asset specific parameters including the lease structure.

Originality/value
The originality of the paper derives from taking an explicit modelling approach to lease duration and lease breaks as additional sources of asset specific risk alongside market risk. This is critical in real estate portfolio management because such specific risk is usually difficult to diversify.

Keywords: Real estate, Portfolio management, Simulation, Optimal holding period
JEL code: C60, G11, R39

I. Introduction

The optimal holding period in real estate portfolio management is a topic that has only recently drawn the attention of both investors and academics. Institutional investors have only recently realized the importance of appropriately setting a holding period for managing the risk of real estate assets or, more generally, real estate portfolios[1]. Traditionally, real estate investment had been a rather passive process, with investors adopting a buy-and-hold strategy to real estate, an asset class capable of generating relatively stable recurring cash flows derived from rental agreements. The strategy was to hold real estate for many years, a valid strategy given the large transaction costs and limited liquidity of real estate investments. Few institutional investors engaged directly in opportunistic or value-added investments that typically hold on to assets for relatively short periods. This latter type of investment style was the preserve of developers, opportunistic funds and specialized REITs. Given the increasing specialization and sophistication of the real estate industry and to some extent the general perception that real estate cycles tend to be shorter, investors are giving more attention to the notion of the ex-ante holding period when investing, essentially by systematically asking the question "*how long do I expect to hold this asset for?*".

But the critical point to make here is that if the predefined holding period is short, say five years, the weight of terminal value in net present value calculation is very important, and the expected risk reflected by this value is also more important. The impact of the terminal value is much less in a ten-year DCF. In practice, and often for purely technical reasons, a finite holding period (conventionally 10 years in corporate finance) is used in cash flow projections to avoid an infinitely long (>30 years) cash flow series. Thus holding periods continue to be generally treated as a simple parameter usually taken as given and dependent on the nature of the investor and factors such as

[1] The discussion below and the findings apply equally to a commercial real estate asset or a portfolio of assets, as long as that portfolio does not represent the market, ie is not totally diversified. Indeed, the key consideration here is to take into account lease events that can materially affect the asset or portfolio's stream of income cash flows. For the rest of the paper we will use the generic term of commercial "real estate asset" or simply "asset" to refer to either an asset or a non-totally diversified portfolio of assets.

transactions cost, taxes and investment style and risk management. Indeed, typically the choice of a holding period in cash flow projections usually fits either an institutional investors' objectives (duration and liability matching for example), the exit strategy say of a finite life close-ended fund, or tax or regulatory constraints (some funds or REITs in Europe have to hold on to assets for a minimum duration for tax purposes).

Investors also decide to sell an asset for three main reasons:

- The asset had been managed intensively and no further asset management is planned. Asset managers often argue that their work consists in managing an asset by securing tenants and undertaking the necessary works on the asset, such as a change in asset use or floor plan, energy consumption, security, parking, cleaning, etc.
- The asset belongs to a portfolio for which an exit strategy was defined initially. Depending on the portfolio management strategy chosen by the investor, the policy regarding resale may be different. Core investors that were once interested only in long-term leases without break-options sold all properties when the lease lengths were below a given duration (e.g., 5 years). An opportunistic investor who seeks large capital returns might be interested only in properties that require significant asset management, such as repositioning or refurbishment. This investor sells properties as soon as these initiatives are complete.
- The asset does not fit the portfolio sufficiently well. This might be the case when too many leasing risks are concentrated into the same period, or when market rental values are far lower or higher than the current rent.

All of these cases have one feature in common: the asset is sold when the period remaining before expiry of the lease is sufficiently long to make the asset attractive and liquid to the buyer. Selling an obsolete, vacant asset is never the objective in a business plan that optimizes portfolio value. An investor has to take this opportunity, which occurs during the holding period. The buyer must bear vacancy and redevelopment risks, and thus might offer a price that incorporates this risk (such as a large discount).

Lease structures and break options vary significantly from country to country. Information on lease structure is thus an essential component of any cash flow model. An asset may be vacant (sometimes partially) and may generate more costs[2] than revenues. Vacancy is an essential issue for real estate investment, particularly for cash flow forecasting. Previous academic studies of rental contracts such as Miceli and Sirmans (1999) suggest that landlords attempt to minimize vacancy and turnover costs by offering discounts to long-term tenants (such as rent-free periods, step rents, additional works in the premises). Landlords often try to dissuade a tenant from leaving at the dates fixed by the lease by offering discounts or rent-free periods. In this way, they minimize the number of break options.

Our approach here is that the holding period should rather be the outcome of a computation based on the combined expectations of the performance of the economy as a whole and of the real estate markets (e.g., initial yields, future developments and rental value dynamics) as well as the asset's lease structure. This behaviour has not yet been modelled in the existing real estate literature.

In fact the expectations in terms of performance and risk are modelled using a trend and a volatility but are supposed to represent the market and its systematic risk. Our objective is to also consider risks linked to lease structure, and break options in particular, in future cash flows, and to determine how taking theses specific risks into account alters the optimal holding period for a real estate asset. This is achieved through a combination of Monte Carlo simulations for the estimation of terminal values and market rental values, and option theory to simulate the exercise of break-options.

One of the contributions made by this paper is that it takes specific (or idiosyncratic) risk into account. This is fundamental, because real estate portfolios usually require a large number of assets in order to begin diversifying specific risk efficiently (cf. Brown, 1998; Byrne and Lee, 2001; Callender et al., 2007). If a portfolio is not totally diversified then the optimal holding period must take account of specific

[2] As with any commodity or product traded on a free market, supply and demand jointly determine price (here the rent). If a rental property is priced above the current market rental value, competitively priced properties are taken up quickly, while overpriced ones remain vacant. A property does not retain efficiency without a minimum level of ongoing capital expenditure. A vacant property often requires substantial investment in addition to recurrent costs (e.g., local taxes, security, technical control etc.). Vacancy costs can therefore be significant.

risks in the portfolio, such as leasing risk ad lease events such as tenant breaks. Therefore, the consideration of asset specific risk improves real estate portfolio management, and in particular impacts on the determination of the holding period. In this approach we do not take into consideration the utility function of each investor but we focus on the dynamics of the ex-ante holding period and its sensitivity to market parameters and to leases length conditions.

We use the model originally derived by Amédée-Manesme, Baroni, Barthélémy and Dupuy, 2013 and expand it using empirical simulations to highlight the way that break-options in leases dramatically alter optimal holding periods for real estate assets. We show how shorter lease durations, higher market rental value volatility, increasing negative rental reversion, higher vacancy duration, and more break options, all tend to decrease the optimal holding period of a real estate asset. The converse is also true.

Our findings are consistent with both the financial and real estate empirical and theoretical literature. In particular our results relate well with the literature on stocks and bonds, which postulates that the holding period usually decreases as the volatility of returns increases. These results help shed light as to why opportunity funds often try and maximise expected returns by focusing on shorter leased assets in the most volatile real estate markets. They also help explain why some investors look for long-term leases without break-options and subsequently decide to sell the asset after a few years.

The structure of the paper is as follows. The next section surveys the relevant literature and presents existing models. First of all, the literature on holding periods is presented. Secondly, we emphasise that the classical DCF method does not enable the optimal holding period to be computed. Thirdly, we present results from existing research (Baroni et al. (2007b)), in which the terminal value is treated as a diffusion process. This model provides a formula that can accurately determine the optimal holding period for a real estate asset. Fourthly, we present a model that can be used to determine the optimal holding period, taking into account the timing of lease breaks. In the final section, we offer empirical applications of our model and show how the optimal holding period responds to changes in various market parameters and lease structures.

II. The Literature and existing models

A. The Literature

The real estate holding period has long been an issue both for those who study and work in the real markets. The holding period is an essential element of investment in commercial real estate portfolios. However, calculations of the optimal holding period are nearly always empirical and the holding period is assumed to depend upon many factors, including market conditions, regulation, transactions costs and tax, types of property, lease length, and investment style.

The holding period is a classic topic in finance and has been the subject of numerous theoretical and empirical research studies. For a long time, the literature has focussed mainly on stocks. Demsetz (1968) and Tinic (1972) noticed that transaction costs influence holding periods. Amihud and Mendelson (1986) show that assets with high bid-ask spreads (a proxy for high transaction costs) are kept at equilibrium by investors who expect to hold assets for a long time. In an empirical study, Atkin and Dyl (1997) consider the effects of firm size, bid-ask spread and volatility of returns on holding periods of stocks from 1981 to 1993, for a sample of NASDAQ and NYSE firms. They demonstrate a positive correlation between holding period, transaction costs and firm size, and a negative one between holding period and price variability. Two assertions are generally accepted in the stock literature, namely that large transaction costs cause investors to hold assets for a long time, and that substantial volatility causes investors to hold an asset for a shorter period. Real estate assets exhibit these two features of high transaction costs and significant asset specific volatility, which is precisely why the optimal holding period, represents a challenge both for academics and practitioners in the field.

Real estate holding periods are the subject of many empirical studies, but no consensus has emerged and the literature is not particularly extensive in terms of the range of issues covered. For the USA, Hendershott and Ling (1984) and Gau and Wang (1994) argue holding durations are conditioned by tax laws. For the UK, the relationship between returns and holding periods appears to be complex. In a study based on interviews with investors, Rowley et al. (1998) show that investors and property developers have a specific holding period in mind from the start. They conclude that, for office space, a holding period decision is linked to depreciation and obsolescence. For retail property, the decision is more empirical, depending on active asset management and the prevailing situation in the commercial property market. In a more recent paper, Collett et al. (2003) highlight the fact that setting a holding period for the investor is important for any decision to invest in commercial real estate portfolios. Investment valuation requires a specified analysis period, and asset allocation depends on the variances and covariances of assets influenced in turn influenced by a reference interval. Using the UK database of properties provided by IPD over an 18-year period, they observe that the median holding period is about seven years. Sales rates vary across the holding period (probably due to rent cycles and lease structures), and the holding period varies by property type. The larger and more expensive the properties, the longer the holding period. If the return is greater, the holding period is shorter. However, even if Collett et al. (op. cit.) suggest a link between price volatility and holding period, they fail to highlight a proxy for measuring the relationship. For small residential investments, Brown and Geurts (2005) offer an empirical response to the following questions: how long does an investor own an apartment building, and why do investors sell some properties more frequently than do others? Using a sample of apartment buildings of between 5 and 20 units over the period 1970 to 1990 in San Diego, California, they found the average holding period to be approximately five years. They conclude that investors sell their assets earlier, when values rise faster than rents.

Using a microeconomic framework, Brown (2004) shows that consideration of risk that is specific to real estate investments explains why private investors actually own real estate, and also their buying and selling behaviour, which is more driven by entrepreneurial decision criteria than by financial ones used for other assets. Consistent with this conclusion, applying the Capital Asset Pricing Model (CAPM) for individuals as a way of understanding portfolio management does not lead to relevant results, as demonstrated by Geltner et al. (2006). However, for residential real estate, Cheng et al. (2010) demonstrate that higher illiquidity and transaction costs lead to longer holding periods, while higher return volatility implies shorter holding periods. These latter results are consistent with previous papers on financial assets.

Taking a different approach, Baroni et al. (2007a) set out to determine the optimal holding period, using dynamic cash flows for rental incomes and capital values in real estate portfolio management. These dynamics are considered as simple diffusion processes in which the corresponding parameters are, respectively, rental income, capital value trends and volatility. The parameters have been estimated from a rental index and a real estate price index using French data for Paris, considering the correlation between these two indices. This approach suggests that the role played by the holding duration in determining asset value is significant. Baroni et al. (2007b) determine the optimal holding period ex ante (for example for closed funds, when the initial investment is realized). They model terminal values as diffusion processes, and derive a closed formula for the optimal holding period. Barthélémy and Prigent (2009) also compute an optimal ex ante time to sell or holding period for a diversified portfolio in three cases, assuming the investor knows the following: the distribution probability of the real estate price index, each possible path of the market dynamics, and at any time, the maximum value he/or she can expect from the portfolio. Finally, Barthélémy and Prigent (2011) consider the issue of the holding period in real estate from the perspective of risk aversion. But their optimization problem corresponds to the maximization of a concave utility function defined on the terminal value of the portfolio, and does not take into account lease breaks.

To the best of our knowledge, the existing academic literature on holding periods does not consider lease structure to be an essential factor in decision-making. However, many investors do in fact select a strategy as a function of the lease, and not only of the market or the state of the economy. We therefore consider how the lease structure determines the optimal holding period for a fund. The next sections review extant models on real estate portfolio holding periods, after which we present a model for determining the optimal holding period if lease durations are considered.

B. Optimal holding period with traditional discounted cash flow (DCF)

Most investors originally used the Discounted Cash Flow (DCF) framework to evaluate investment opportunities. It is easy to demonstrate that this framework is inappropriate for computing an optimal holding period for real estate assets.

The traditional and deterministic DCF model calculates net present value as the sum of all future cash flows generated by the asset, discounted by a discount rate. Let us denote $V_{0,T}$ the net present value of the asset sold at date *T*.

$$V_{0,T} = \sum_{t=1}^{T} \frac{FCF_t}{(1+k)^t} + \frac{P_T}{(1+k)^T}$$

where *k* is usually the weighted average cost of capital (WACC) used to discount the various free cash flows FCF_t, and P_T is the terminal value computed as:

$$P_T = \frac{FCF_T\,(1+g_\infty)}{k - g_\infty}$$

where the free cash flow (FCF) after time *T* grows infinitely at the constant rate g_∞. If we denote g as the growth rate of the free cash flows before time *T*, the equation becomes:

$$V_{0,T} = \sum_{t=1}^{T} \frac{FCF_1 (1+g)^{t-1}}{(1+k)^t} + \frac{FCF_1 (1+g)^{T-1} (1+g_\infty)}{(k-g_\infty)(1+k)^T}$$

Baroni et al. (2007b) demonstrate that the pricing behaviour can be studied by computing $V_{0,T+1} - V_{0,T}$.

$$V_{0,T+1} - V_{0,T} = FCF_1 \frac{(1+g)^{T-1}}{(1+k)^T} \left(\frac{g-g_\infty}{k-g_\infty} \right)$$

As $k > g_\infty$, the sign on the right of the equation corresponds to the sign of $g - g_\infty$. We then have the following states:

If $g > g_\infty$ then $V_{0,T+1} - V_{0,T} > 0$ and the price grows infinitely;

If $g = g_\infty$ then $V_{0,T+1} - V_{0,T} = 0$ and the price remains stable;

If $g < g_\infty$ then $V_{0,T+1} - V_{0,T} < 0$ and the price decreases infinitely.

Consequently, the traditional DCF framework does not enable an optimal holding period for an asset to be determined according to the asset present value, whatever the rates of expected growth. Given this issue, Baroni et al. (2007b) developed a model that leads to a closed-form formula.

C. Deriving and optimal holding period when risk is incorporated in the terminal value (Baroni, Barthélémy and Mokrane, 2007b)

Baroni et al. (2007a) propose a Monte Carlo simulation of valuation, and their contribution is to model terminal value. They consider that the real estate price of the assets follows a geometric Brownian motion (versus an infinite growth rate with traditional DCF):

$$\frac{dP_t}{P_t} = \mu_P dt + \sigma_P dW_t$$

This equation assumes that real estate returns can be modelled as a simple diffusion process, where parameters μ_P and σ_P are the trend and volatility. They propose this model to improve the DCF method, and to allow for an optimal holding period. They then compare this new approach with the discrete case derived in the previous section.

Following Baroni et al. (2007a), the expected present value of the asset sold at date T is:

$$\mathrm{E}\left(V_{0,T}\right)=\sum_{t=1}^{T}\frac{FCF_t}{\left(1+k\right)^t}+\frac{P_T}{\left(1+k\right)^T}$$

with P_T computed with the Brownian process (μ_P,σ_P) and

$$E(P_T)=P_0\left(1+\mu\right)^T$$

The expected growth rate of the present value is:

$$\mathrm{E}\left(V_{0,T+1}-V_{0,T}\right)=\frac{1}{\left(1+k\right)^{T+1}}\left[FCF_1\left(1+g\right)^T+P_0\left(1+\mu\right)^T\left(\mu-k\right)\right]$$

They conclude that two cases be considered:

- $\mu=k$, hence there is no optimal holding period;
- $\mu\neq k$, an optimal selling date (under existing conditions) may exist and is obtained by a closed formula:

$$T^*=\frac{\ln\left(\dfrac{FCF_1}{V_0\left(k-\mu\right)}\right)}{\ln\left(\dfrac{1+\mu}{1+g}\right)}$$

This formula determines the conditions under which an optimal solution exists. The conditions can be summarized by:

$$\max\left(g,k-\frac{FCF_1}{P_0}\right)<\mu<k$$

An optimal holding period for a real estate asset can be thus derived. Please note that the optimal holding period does not depend on the standard deviation parameter (σ_P)

For example if $k=8.40\%$, $g=3\%$, $\mu_P=4.5\%$, σ_P = 5%, $P_0=100$ and $FCF_1=4.8$, an optimal holding period of about 14 years is derived (here, the free cash flow periodicity corresponds to one year – see Figure 1).

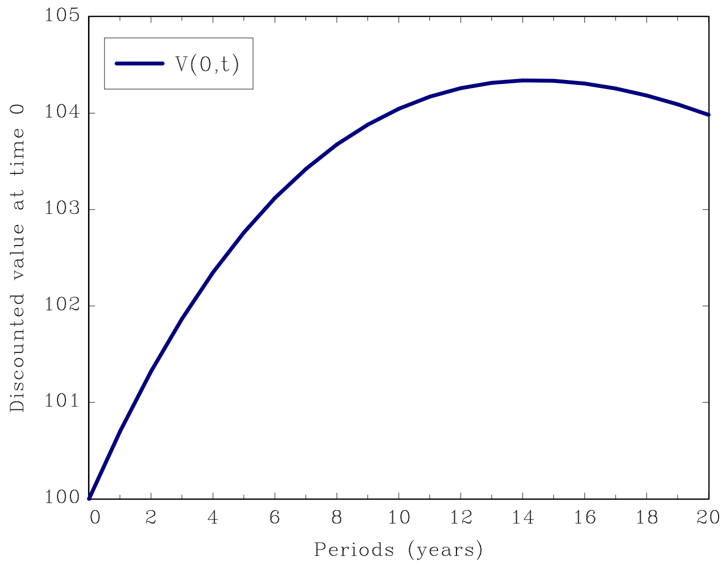

Figure 1 - Optimal holding period for when the terminal value is simulated

Risk can also be incorporated similarly in the market rental value. And to simulate the risk of vacancy in the cash flows, the lease structure must be taken into consideration. This is presented in the next section.

D. The break-option: optimal holding period incorporating risk in terminal value and lease structure (Amédée-Manesme, Baroni, Barthélémy and Dupuy, 2013)

Amédée-Manesme et al. (2013) develop a model that considers lease structure (and therefore the break-options) of a real estate portfolio or asset. The aim of the authors is to improve existing commercial real estate valuation methods by introducing uncertainty and risk into the valuation process. This issue had already been discussed in French and Gabrielly (2004, 2005), Hoesli et al. (2006) and Baroni et al. (2007a), but their analysis is improved by considering break-options in leases. The model takes into account the exercise of such options with the induced vacancy period[3] and considers the

[3] The unit may be let or not let. If let, depending on the terms of the contract, the tenant enjoys the possibility of leaving at a predetermined date during the length of the lease (the break option). When the lease terminates, both tenant and landlord decide either to continue with the lease, or not to do so, possibly. The end of the lease is also a break option,

risk underlying the lease structure and more precisely, the risk of the rent at the exercise date of the break-option exceeding the market rental value. Obviously, relocation costs (e.g., moving costs, transaction costs etc.) must also be considered. Thus, Monte Carlo simulation and option theory are used to model a tenant's decision, and to simulate future cash flows. The model integrates uncertainty into the determination of terminal value. Both the price of the asset (P) and market rental values (MRV) are simulated as diffusion processes:

$$\frac{dP_t}{P_t} = \mu_P dt + \sigma_P dW_t^P$$

$$\frac{dI_t^{MRV}}{I_t^{MRV}} = \mu_{I_t^{MRV}} dt + \sigma_{I_t^{MRV}} dW_t^{I_t^{MRV}}$$

These equations assume that real estate prices and market rental values can be modelled as Brownian diffusion processes, where parameters μ_P and $\mu_{I_{t,j}^{MRV\,j}}$ are the price and market rental value index trends σ_P and $\sigma_{I_{t,j}^{MRV\,j}}$ the price and market rental value index volatilities. The correlation between market rental values and capital values is also taken into account[4]. Market rental value is modelled as index I_t^{MRV}, but the size of the lettable units and other characteristics can also be considered. Generally, two lettable units located in the same property follow the same index, but differ by rent, size and specifications (e.g., floors, A/C system, orientation etc.). However, the rent charged is not necessarily equal to the market rental value, so the model compares rent currently paid with simulated market rental values. We assume a rational tenant exercises a break-option as soon as the rent currently paid is too high in relation to the market rental values available for similar lettable units. Therefore, the tenant leaves the unit at the time of a break-option when rent is much higher than the market rental value. This is written as:

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but is symmetric, since both tenant and landlord can exercise it, even if doing so results in additional costs. Uncertainty regarding changes in rent over time arises from the possibility that a break option will be exercised, and from the duration of vacancy periods.

[4] Following Amédée-Manesme et al. 2013,this correlation is estimated from available indices, both for prices and MRVs

$$\frac{Rent_{t,i}}{MRV_{t,i}} > 1+\alpha, \text{ then } Rent_{t+1,i} = 0$$

where α is a decision-making criterion ($\alpha \geq 0$ if the tenant is rational and includes possible moving or transaction costs, for instance), $Rent_{t,i}$ is the rent of the unit *i* at time *t*, and $MRV_{t,i}$ is the market rental value of unit *i* at time *t*.

The model considers differences that arise between the dynamics market rental values (MRVs) and rent in place (usually contracted into years before a break-option). Three factors are thus considered: rental income indexation (ie the way in which rents in leased units are periodically revised –inflation in many countries); the evolution of market rental values; and the evolution of possible vacancies. Indeed as soon as a tenant vacates a unit, the landlord faces a void period: this vacancy duration is modelled using Poisson's law.

$$X \sim P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

where *k* is the duration of vacancy and λ is a positive real number equal to the expected number of occurrences during a given interval. In this case, it is equal to the average duration of vacancy.

For each simulated scenario (we undertook 10,000 simulations in the examples to follow), an asset value is computed and analysed with respect to all paths for each market rental value of each leased unit in the asset (all of them being correlated). Simulated values are used in the discounted cash flow model as terminal values. For each unit let and at the time of a break-option (if any), passing rent is compared with the simulated market rental value (MRV) for similar available units. If the passing rent is higher than the MRV, the tenant vacates the property and the landlord may face a gap (zero income assumed here) in cash flows for the unit. Vacancy duration is determined randomly using Poisson's law, which parameter equals the average vacancy length in the market (see Figure 2). If a unit starts by being vacant, the vacancy duration is also determined using Poisson's law. By assuming that both tenants and landlords act rationally, new leases are contracted at MRV (see also Figure 3).

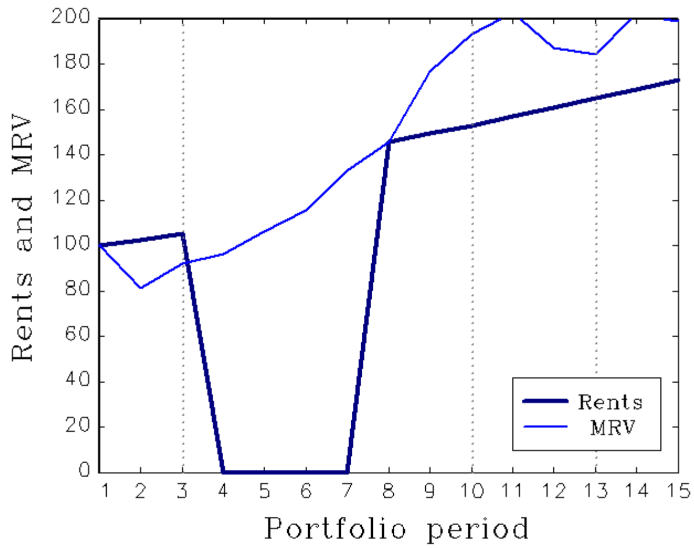

Figure 2 - 3/6/9-year lease, in-place rent indexation: 2.5%/year, I^{MRV} ~ *N*(2%,10%). The break-option is exercised and leads to a gap in cash flow

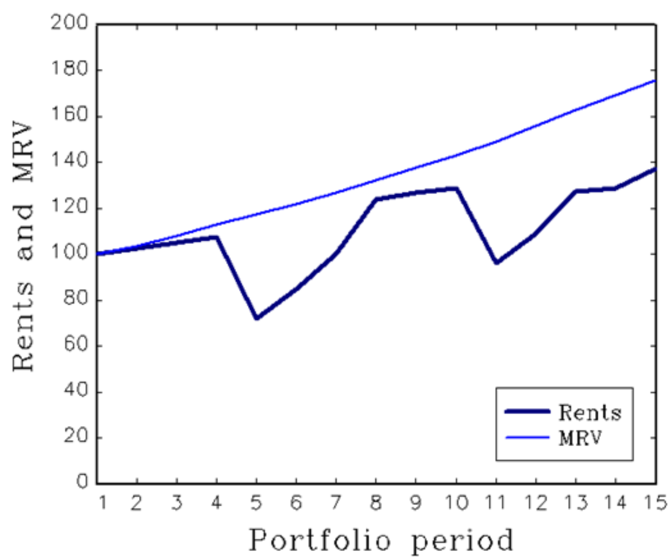

Figure 3 - Indexation 2.5%/year, I^{MRV} ~ *N*(2%,10%). Rental income exhibits unsteady paths for a 3/6/9-year lease

The originality here is that this model based on a stochastic approach, incorporates both systematic (through simulation of market rental values) and specific (structure of lease) risk for each cash flow and is much richer than the classical DCF method. This approach is able to take account of the tenant's behaviour regarding break options included in a lease, and can be tailored for real-world portfolio managers managing portfolio risk. We consider this issue in the next section, where we apply the model in order to determine an optimal holding period.

III. Optimal holding period: using Monte Carlo simulation to derive influential factors

It is prohibitively complex to determine an analytical formula for the optimal holding period of a real estate portfolio when options embedded in the lease are considered. Following the reasoning of Baroni et al. (2007b) and the model of Amédée-Manesme et al. (2013), we use Monte Carlo simulations to derive optimal holding periods that which maximize the discounted asset's value.

At each period, the value of the asset is calculated from the cash flows produced by the units. The value of the asset can then be computed for each holding period. The procedure is replicated several thousands of times to obtain a portfolio price for various holding periods. We thus obtain both the mean of all scenarios and a distribution of values for each holding period.

To demonstrate the relevance of the model and changes undergone by the optimal holding period when the lease structure is examined, we use the same numerical parameters as in Baroni et al. (2007b): $P_0 = 100$, $FCF_0 = 4.8$, $\mu_P = 4.5\%$, $\sigma_P = 5\%$, $k = 8.4\%$, $g = 3\%$. To illustrate more easily how to determine an optimal holding period with this example, the asset is assumed to have only one lease. In addition, the lease is assumed to start at the beginning of the first period.

For the base case, we add the following parameters that refer to market rental values and to the lease: $MRV_0 = 4.8$ (= FCF_0), $\mu_R = 3\%$ (= g), $\sigma_R = 0$, $\lambda = 0$[5], lease structure = 3/6/9 years (nine-year lease with possible break options at year 3 and 6). Note

[5] Average lease length.

that the rental path is assumed to be exactly the same as the MRV dynamics (the rent growth rate equals the MRV trend and the volatility of market rental values is set to 0). Finally, the asset is considered as a whole, with no possibility of rebalancing or of arbitrage.

Using 5,000[6] replications, we first simulate all possible values of the asset for the base case. We then analyse the sensitivity of the value by changing selected parameters through five cases, in order to demonstrate their influence. These parameters are the MRV volatility (σ_R studied in case 1), the vacancy duration (λ studied in case 2), and the lease structure (in cases 3, 4 and 5) where the possible differences between the rents indexation (g) and the MRV growth are taken into account (μ_R). All these cases are summarized in Table 1.

Moreover, for all cases, the rental yield (FCF_0/P_0), price growth and volatility (μ_P and σ_P), the decision criteria (α) and the cost of capital (WACC) are assumed to remain constant. Their corresponding values are the following (from Baroni et al. (2007b)):

$$FCF_0\ /P_0 = 4{,}8\%,\ \mu_P = 4.5\%,\ \sigma_P = 5\%,\ MRV_0 = FCF_0 = 4.8,\ \alpha = 0,\ \text{WACC} = 8.4\%$$

Setting α to 0 means that the break option is exercised as soon as the rent exceeds the market rental value: $Rent_{t,i} > MRV_{t,i}$ at the time of the break-option.

At this stage, it is worth noting that the general interpretation of results remains valid, even though obtained for a particular set of parameters. The analysis of various cases enables us to decide whether the variation of one parameter of interest has a positive or negative impact on the optimal holding period (T^*).

For each case, we compute $V(0,t)$, the discounted value of the asset at time 0 for a holding period of t years.

Case #	$\boldsymbol{\sigma_R}$	$\boldsymbol{\lambda}$	$\boldsymbol{g}$	$\boldsymbol{\mu_R}$	**Lease**

[6] This is sufficient for the estimation of expectations in our case.

					structure
Base case	0	0	3%	3%	3/6/9
Case 1	Varies	0	3%	3%	3/6/9
Case 2	0.1%	Varies	3%	3%	3/6/9
Case 3	10%	0	3%	3%	Varies
Case 4	10%	0	2%	4%	Varies
Case 5	10%	0	4%	2%	Varies

Table 1 – Summary of all cases

Base case: Passing rent and MRV have the same dynamics

The base case illustrated in Figure 4 presents the case where no volatility of MRV is considered.

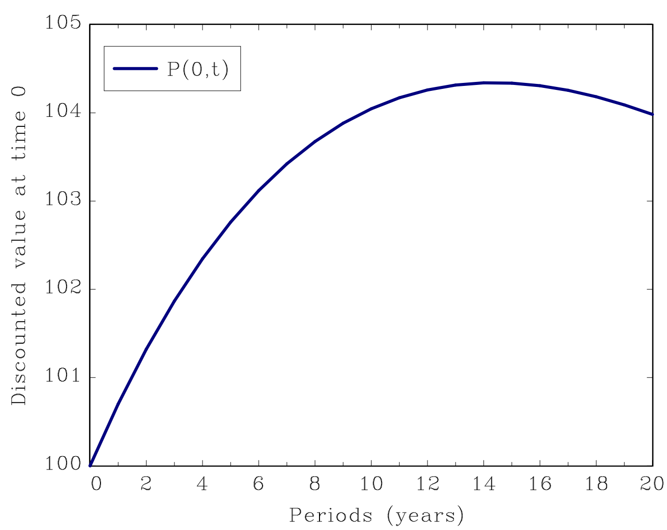

Figure 4 - Optimal holding period without volatility of market rental values

In this case, we obtain as expected the same results as Baroni et al. (2007b), in which the rent follows a deterministic process. This is consistent with the assumption of no volatility for the MRV:

$$\left.\begin{array}{l} MRV_0 = Rent_0 \\ g = \mu_R \\ \sigma_R = 0 \end{array}\right\} MRV_t = Rent_t$$

Combining the absence of volatility and an MRV trend equal to indexation leads to the same rent and MRV in each period. Therefore, no break-options are exercised, since the rent never exceeds the market rental value. We obtain an optimal holding period of 14 years. In fact, a model without market rent volatility is equivalent to a model in which rent is indexed and only the capital value is volatile. It is important to note that the absence of exercised options renders the average vacancy length meaningless for the model.

For all the following cases, the MRV volatility will be strictly positive. This allows the difference between the market rental value and the rental income to be taken into account at each step of the simulation.

Case 1: Sensitivity of holding period to MRV volatility (Figure 5)

Figure 5 illustrates the sensitivity of the optimal holding period to MRV volatility, by using different values of σ_R, specifically 5%, 10% or 15%. The base case is represented by the solid line. The vacancy duration (λ) is set at 0, which enables us to focus solely on the effect of MRV volatility on the optimal holding period. For instance, the dashed blue line, corresponding to a MRV volatility of 5%, leads to an optimal holding period of 12 years (instead of 14 for when σ_R equal to 0). With a MRV volatility of 15% (the dashed red line), the optimum is at year 6. In addition, discounted asset values decrease as MRV volatility increases. What's more the optimal holding period is negatively correlated with MRV volatility. These findings are consistent with the empirical findings highlighted in the literature review. In particular these results relate well with the literature on stocks and bonds, which argues that the holding period usually decreases as the volatility of returns increases. These results also explain why opportunity funds often try and maximise expected returns by focusing on shorter leased assets in the most volatile real estate markets.

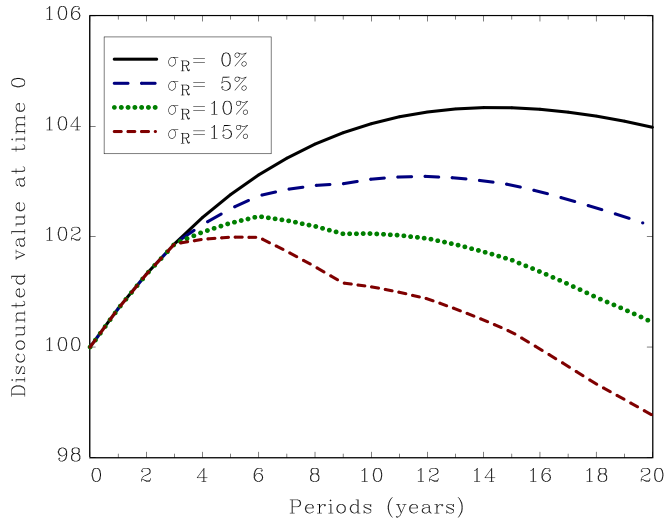

Figure 5 - Optimal holding period with market rent volatility

Case 2: sensitivity of holding period to vacancy duration

In order to consider the effect of the vacancy length, the market rent volatility is set to 0.1%, high enough to allow the exercise of options. Note that minimum volatility is mandatory. Without volatility, no options are exercised and we are back to the deterministic case presented above (Figure 6).

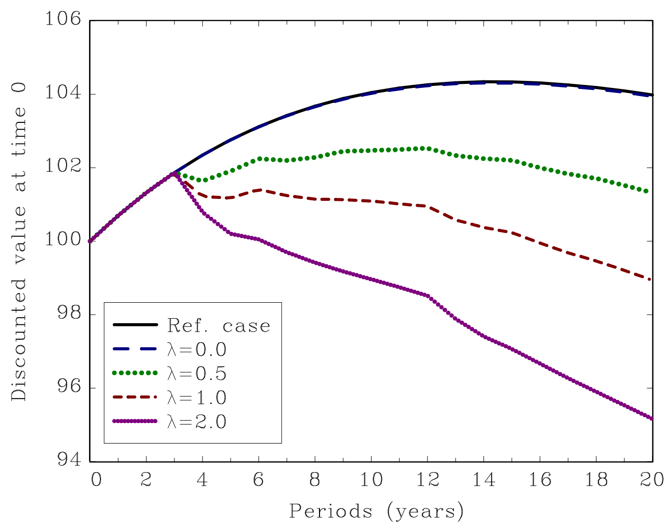

Figure 6 - Optimal holding period with increasing vacancy length

In this case, when the average vacancy duration increases (λ is expressed in years), the optimal holding period decreases. A zero average vacancy length, combined with minimal market rent volatility, yields almost the same optimal holding period (the discounted asset values are almost the same – see the solid black line and the dashed blue line). This can be explained by the fact that low rent volatility brings the rental value close to the market rental value. An average vacancy of 6 months (λ=0.5 year), leads to T^*= 12 years (the green dotted line), whereas a value of 1 year or more, gives T^*= 3 years, the break option date. The optimal holding period decreases when vacancy length increases.

This demonstrates that it is important to consider the impact of vacancy length. Sensitivity is particularly high when break-options are multiple, or when secured cash flows are of short duration. This behaviour explains why closed funds, which have contractual holding periods, seek to secure cash flows by negotiation with the tenant, proposing to exchange a lower rent for the exclusion of break options, in order to avoid vacancy.

Case 3: sensitivity of holding period to lease length when rent and MRV growth rates are equal

Figure 7 shows many lease structures, from a 9-year lease contract without any break-options to a lease that can be terminated each year. We observe that a 9-year contract with the option of breaking at year 6 (blue dashed line) yields a lower optimal holding period (T^* = 12 years) than a 9-year contract (solid black line) without any break-options[7] (T^* = 14 years). Adding more break options results in an even smaller holding period, as demonstrated by the green dotted line and the red dashed line.

The number of possible break options thus has a very significant impact on the optimal holding period: the longer the length of secured cash flow, the longer the holding period. In comparison with the reference case, we observe that the more risky the lease structure, the shorter the optimal holding period (and the lower the asset values).

These results corroborate both the classical and practical literature dealing with stocks and bonds. The literature concludes, as do we, that riskier assets are expected to be held for shorter periods. Real estate practice also exhibits similar results: risky assets (higher leasing risk in this instance) are generally bought by opportunistic investors who hold them for a shorter period of time. Our results are thus in line with empirical observation. However this finding does not take into account the possible impact of a long lease on the asset price. In practice, a long unexpired lease may provide an incentive to sell when the market maximizes the value of such a lease; ie usually when risk aversion is high.

[7] The absence of frictions at the end of the lease is due to the assumptions underlying the model. The new starting rent is set at market rental value. Average vacancy is assumed to be zero in the present case. Hence, we obtain the same expected curve as the reference case.

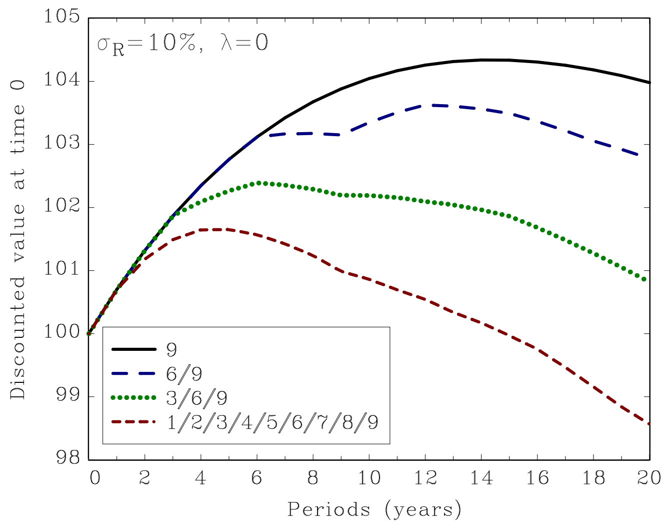

Figure 7 - Optimal holding period with various lease structures

Case 4: Sensitivity of holding period to lease duration when passing rent increases more slowly than MRV[8]

Figure 8 is generated using an assumed rent-in-place indexation rate of 2% and an MRV growth rate of 4%. If the rent in place at a lower average rate than the MRV, a tenant is less induced to vacate the property, compared with the reference case. Here, we present simulations conducted under the assumption of zero average vacancy length, knowing that positive values for λ lead to similar results. Therefore, the few break options simulated are instantaneously released.

The dips observed in Figure 8 correspond to the end of each lease, when the tenant and the landlord readjust the rent to the rental value (this is an assumption of the model that can be relaxed).

The 9-year lease contract with no break-options (the back solid line) embeds two particular dates: years 9 and 18. These two dates correspond to lease expiries, the one contracted at time 0 which ends at t = 9, and the other contracted at t = 9 which ends at t = 18. According to the model's assumption, a new lease is contracted at MRV at the end

[8] This case happened between 2003 and 2008 in many European markets when market rental values increased quite strongly.

of the contract. It is assumed that on average market rental growth is higher than the rental indexation growth.

The 9-year lease contract with a break-option at year 6 leads to more kink points at years 6, 9, 12, 15 and 18. For instance, at year 6, the option may be exercised. In this case, a new 6/9 lease is contracted until year 15, with a possibility to break at year 12. Hence, the green line is below the blue one.

We conclude that a rent in place growth rate lower than the market rental value growth, which de facto leads to decreasing negative rental reversion, fosters a longer holding period, due to fewer break-options being exercised. Note that the higher the gap between these two growth rates, the greater the impact on the optimal holding period T^*.

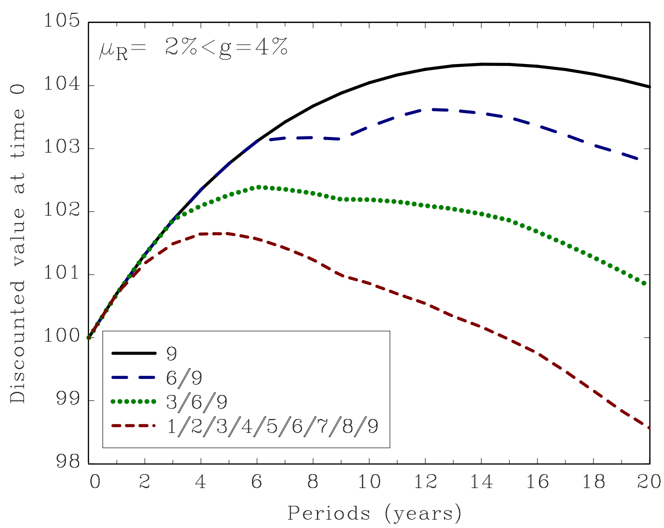

Figure 8 - Optimal holding period with rent growth rate lower than market rental value trend

Case 5: Sensitivity of holding period to lease duration when MRV grows more slowly than passing rent

If in-place rents increase at a higher rate than the market rental value, tenants may exercise break-options whenever it becomes possible. Hence, the optimal period until selling decreases, due to lower cash flows generated on average (Figure 9).

The 9-year lease contract with no break-options (the solid black line) displays two specific kinks at years 9 and 18. At these two dates, a new lease is contracted at the market rental value. It is expected that on average the new agreed rent will be equal to MRV, hence lower than the then rent in place.

The 9-year lease contract with a break-option at year 6 leads to more points than we obtain in Case 4. For instance, at year 6, the option is exercised quite often.[9] Since the MRV is lower on average, the green curve is beneath the blue one. The more frequent the break options, the shorter the optimal holding period.

We conclude that a rent growth rate higher than the market rental value results in a shorter optimal holding period for the asset. This case is consistent with observations in a bear market, in which tenants move more often to reduce occupational costs.

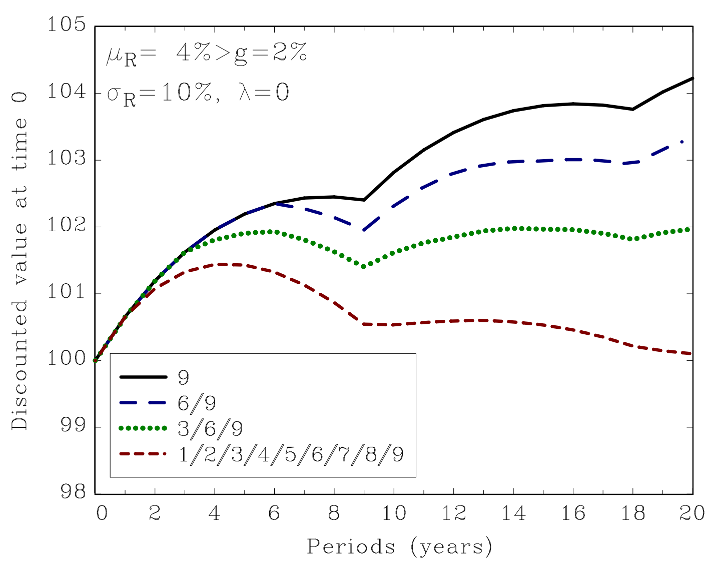

Figure 9 - Optimal holding period with rent growth rate higher than the market rental value trend

[9] The discrepancy between the two growth rates is high and the rent volatility low.

IV. Conclusion

We have shown in this paper how the optimal holding period for a real estate asset or portfolio can be estimated by simulation, considering the specific risks linked to the lease structures in place. By using the model originally derived by Amédée-Manesme et al. (2013) and expanding it using empirical Monte Carlo simulations and option theory we are able to take into account many additional factors such as passing rent and rental value dynamics and volatilities, vacancy duration and the time structure of break options in leases. These simulation techniques are a valid and accurate means of simulating the main risks in real estate cash flows, combining systematic risks (on the terminal value and on the MRV – as well as their correlation over time) as well as specific risks (the vacancy duration at which the rent becomes higher than the MRV and the tenant decides to leave the premises). The optimal holding period is then derived as being the one associated with the maximum discounted value for the asset.

Using illustrative values to simulate the asset value, our main findings suggest that a higher volatility of the MRV shortens the optimal holding period. Similarly, the longer the duration of the average expected vacancy, the shorter the holding period. And finally, a large number of break options increases the risk of vacancy, and the volatility of the cash flows also reduces the optimal holding period. This risk is more acute when rent grows faster than the MRV.

Our results are consistent with literature on stocks and bonds, which argues that the holding period usually decreases as the volatility of returns increases. These results also explain why opportunity funds often try and maximise expected returns by focusing on shorter leased assets in the most volatile real estate markets.

Our findings also help shed light on some market practices by real estate portfolio managers. For instance, to avoid vacancy, landlords tend to negotiate a lower rent in exchange for foregoing the break option and ideally a lease duration extension. We illustrate how and under what circumstances this behaviour can increase the value of the asset or portfolio and the optimal holding period.

Our results also help explain why many investors look for long-term leases without break-options, because they do not want to carry leasing risk. Depending on the local market, they look for long-term leases (e.g., 10-year leases) and sell the asset after a few years (e.g., 5 years) to an investor interested in the opportunities asset management may offer, including the renegotiation and marketing of assets. They thus adapt the holding period strategy to the lease structure.

Finally, if such simulations of cash flows are possible, they are also a pragmatic way to analyse the risk associated with all measurable factors. The model is open and various sources of risk can be introduced into the model. Similarly, the number of assets is not limited. One rather straightforward application of the paper would be to analyse how a fund or portfolio manager would need to adapt his/her expected holding period strategy to changes in market conditions such as rental values or yield volatility, expected void period duration, or structural changes such as average lease lengths and number of break options

A possible extension of the model would be to take investors' risk aversion into account and the way holding periods would change. Future work could also improve the model, introducing the time at which it would be necessary to sell the asset, and the liquidity of the market.

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