Aalto University
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Using Monte Carlo Simulation to Support a Retail Real Estate Investment Decision

Master's Thesis

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Bachelor of Science in Technology
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Abstract of master's thesis

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Abstract

The academia and professional organizations in the field of real estate have raised discussion about adding probabilistic features into real estate valuations to take into account the uncertain characteristics of any valuation. Currently in the real estate sector the value of a property is usually calculated by an appraiser using a discounted cash flow model (DCF-model) to reach a single point valuation. The valuation of the appraiser is often falsely interpreted as an absolute truth, even though no cash flow model can be exactly certain unless the future can be correctly predicted.

A more sophisticated application of the DCF analysis can be used to achieve a probability distribution of single point valuations. This application uses a tool that simulates the valuation process multiple times. It includes defining the input variables as ranges of possible values to be used in the valuation. This method is called Monte Carlo simulation.

This master's thesis looks to clarify how DCF is used when evaluating potential real estate investments, what are its main disadvantages, and can the decision process be enhanced using Monte Carlo simulation. These questions are answered by conducting a literature study where the frame of reference for the theoretical study is built and a case study where the acquisition of Shopping Centre Arabia is reviewed. In the revision process people involved in the acquisition process are interviewed and the material available for the initial real estate investment analysis is examined and developed to create a Monte Carlo simulation model. The results created by the model are compared with the results produced with a traditional DCF model during the acquisition process.

The main disadvantage of using only DCF calculation to assess a real estate investment target is that DCF does not take into account the uncertainty that the input variables are subject to. In the empiric study it was recognized that a MCS model can support an initial analysis based on direct capitalization calculation or DCF calculation. MCS model provides numerical data about the uncertainty of the market value calculation results of a standard DCF calculation and therefore measures the level of comfort that the analyst has towards the DCF calculation.

Keywords Monte Carlo simulation, real estate valuation, appraisal, probability distribution, real estate investment, real property, investment decision making, real estate investment analysis

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Akateemikkojen ja kiinteistöalan ammattilaisten keskuudessa on herännyt keskustelu todennäköisyysominaisuuksien lisäämisestä kiinteistöarvioihin, jotta arvioissa voitaisiin ottaa huomioon niihin liittyvä epävarmuus. Yleisesti kiinteistöalalla arviot toteutetaan diskontatun kassavirran laskentamallilla, joka yleensä tuottaa yhden pistemäisen arvion kiinteistön arvolle. Arviomiehen tuottamaa arvio tulkitaan yleisesti absoluuttisena totuutena, vaikka todellisuudessa mikään kassavirtamalli ei voi tuottaa täydellistä arviota, jos tulevaisuutta ei voida täydellisellä tarkkuudella ennustaa.

Pidemmälle kehitetyllä versiolla tästä laskentatavasta voidaan muodostaa yksittäisten pistemäisten arvioiden sijasta arvion mahdollisten tulosten todennäköisyysjakauma. Tässä versiossa käytetään sovellusta, joka toistaa yksinkertaisen prosessin useita kertoja ja jossa mallin käyttämät muuttujat määritellään yksittäisten lukujen sijasta mahdollisina raja-arvoina. Tätä metodia kutsutaan Monte Carlo simulaatioksi.

Tämä diplomityö pyrkii selvittämään miten diskontatun kassavirran mallia käytetään potentiaalisten sijoituskohteiden arvioinnissa, mitkä ovat sen heikkoudet, ja voiko sijoituspäätöstä tukea Monte Carlo simulaation avulla. Näihin kysymyksiin vastataan kirjallisuuskatsauksen avulla, jossa luodaan viitekehys empiiriselle tutkimukselle, sekä case-tutkimuksella, jonka yhteydessä käydään uudelleen läpi kauppakeskus Arabian hankintaprosessi. Case-tutkimuksessa haastatellaan kauppakeskus Arabian hankinnassa mukana olleita ihmisiä, sekä analysoidaan hankintaprosessissa käytössä ollut materiaali. Materiaalianalyysin pohjalta luodaan Monte Carlo simulaatio-malli, josta saatavia laskelmia verrataan tuloksiin, jotka tuotettiin traditionaalisella kassavirtamallilla Arabian hankinnan yhteydessä.

Perinteisen kassavirtalaskelman heikkoutena voidaan pitää sitä, ettei se ota huomioon epävarmuutta, joka liittyy siinä käytettäviin lähtömuuttujiin. Empiirisessä tutkimuksessa havaittiin, että Monte Carlo simulaatio voi tukea perinteisen kassavirtalaskelman avulla saatavia tuloksia. Monte Carlo simulaatio tuottaa tietoa kassavirtalaskelman mahdollisien lopputulosten todennäköisyyksistä ja voi lisätä analyytikon luottamusta tuloksiin, joita saadaan perinteisen kassavirtalaskelman avulla.

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Thank you.

Helsinki, 12 November 2014

Ville Suhonen

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Terms and Abbreviations

APM Arbitrage Pricing Model

CAPM Capital Asset Pricing Model

DCF Discount Cash Flow

GRI Gross Rental Income

IVCS The International Valuation Standards Council

KTI The Institute of Real Estate Economics

NPV Net Present Value

MCS Monte Carlo Simulation

NOI Net Operating Income

Market Value *"The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion."*

RICS Royal Institution of Chartered Surveyors

SQM Square Meter

PART I: Introduction

1 Introduction

1.1 Background

The academia and the Royal Institution of Chartered Surveyors (RICS) have raised discussion about adding a quality measure to the valuation report to inform its reader about the degree of uncertainty of the valuation. This scale of quality (e.g. a grade from 1-5, where 1 is absolutely certain and 5 is very uncertain) would help the reader in indicating how certain or uncertain the valuation is in the appraisal's opinion (RICS, 2002).

Moreover RICS and the academia have requested for even more sophisticated application of valuation as they have wanted to introduce usage of probability distribution in valuations. This would enable the appraisal to present the probability of certain outcomes of the valuation to the reader. For example the appraisal could tell the range in which the value of the property will end up in with the probability of 95% and how probable it is for the property value to vary for 5% from the single point result of the valuation.

Currently in the real estate sector the value of a property is usually calculated by an appraiser using a discounted cash flow model (DCF-model) to reach a single point valuation. The valuation of the appraiser is often falsely interpreted as an absolute truth, even though no cash flow model can be exactly certain unless the future can be correctly predicted. Given that it is not possible one should read valuations with critical consciousness.

Although DCF-model gives an accurate estimation of property value it does not clearly enough disclose the degree of uncertainty that the valuation is associated with. The valuation is uncertain, because it consists of inputs that are unpredictable and therefore uncertain (e. g. inflation expectation, operational costs, capitalization rate used in discounting etc.).

An application of the DCF-model is sensitivity analysis which can be used to test how the result of the valuation varies when changing one of the inputs. This way the sensitivity analysis can be used to outline a spectrum of possible outcomes for the valuation.

A more sophisticated application of the discounted cash flow analysis can be used to achieve a probability distribution of single point valuations. This application uses a tool that simulates the valuation process multiple times. It includes selecting "the best" values of the variables used in the valuation. This method is called Monte Carlo simulation.

Monte Carlo simulation technique selects random values of the variables used in the valuation (from a selected range of values) and carries out the valuation, repeating this exercise until the requested amount of simulations achieved.

This exercise produces a wide enough range of results to be analyzed statistically (to produce an average, standard deviation etc.). These results can be graphically projected in the form of a discrete distribution or continuum projection.

The broad purpose of this thesis is to test whether Monte Carlo simulation could be used to enhance decision making by a real estate investor when acquiring new real estate assets.

One task of this thesis is to review the material used when acquiring shopping centre Arabia in 2011-2012 using Monte Carlo analysis to see whether Citycon's investment team would have made different choices when entering into tendering for the purchase. This is justified because probability is not used in property valuation in Citycon nor in the investment team.

The purpose of the study is to find out whether Monte Carlo simulation can be used to improve the decision making when acquiring new assets.

1.2 Objectives and research questions

The aim of the study is to examine whether discounted cash flow model is a sufficient tool to evaluate possible real estate investment targets, to suggest Monte Carlo simulation as a supporting tool for real estate valuation and to test the theory in an actual case study.

The objective of the case study is to find out whether the investment team would have had improved information about the acquisition target to help decision making regarding the acquisition of shopping centre Arabia.

The research problems can be clarified using the three following research questions and sub-questions:

How is discounted cash flow analysis model used to evaluate real estate investment properties?

> **What are the main disadvantages of the discounted cash flow analysis model?**

Can real estate investors make better decisions when using probability distribution when evaluating investment targets?

> **Can probability distribution help investors when analyzing retail assets especially?**

Should Monte Carlo analysis be used to enhance decision making by an investor?

In the first research question literature is reviewed to find out academia's attitude on DCF-valuation and to gather latest arguments supporting DCF-valuation and listing its shortcomings.

The second research question focuses on reviewing the academic literature from the angle that gives examples of the usage of probability distribution in real estate investments.

Third question will provide information through a case study to review methods used by an investor when acquiring new real estate assets.

1.3 Scope of the Research

The scope of the research is tied around using Monte Carlo as a tool when creating a probability distribution to be used in simulation for real estate valuation which is used in reviewing the case.

The case is a revision of the acquisition process of shopping centre Arabia using Monte Carlo Simulation. Shopping centre Arabia is chosen because it has been acquired by Citycon very recently (December 2012) and it was an investment of a size that is analyzed with a very standard procedure.

Arabia is also a very good target for analysis as it is not a very significant asset in Citycon's portfolio, so very specific information about the asset can be used to support this thesis.

The main limitation of the research is the fact that the research is based on only one asset. Therefore it is uncertain whether the findings of this thesis are relevant if projected to another project in the future (one objective being to find out whether Monte Carlo analysis can be used in the future to enhance decision making in Citycon's investment team).

1.4 Concepts

The theoretical concept is based on a new way of evaluating real estate investments based creating a range of probable "single point valuations" and reviews this range through probability analysis. This range can be created using Monte Carlo simulation and the range can be further analyzed using traditional probability tools.

1.5 Materials and Methods

This research consists of two parts: a literature study and an empirical study. In the empirical part both qualitative and quantitative research methods are applied. The empirical study covers both the literature and empirical part due to the nature of the research problem: DCF-modelling is currently being used in Citycon and Monte Carlo simulation has not been used before. Therefore it is important to use qualitative methods when making an argument for using Monte Carlo simulation. Quantitative methods are used when comparing the results of standard real estate analysis procedures of Citycon and results achieved using Monte Carlo simulation.

The literature study has three objectives. First objective is to find support from the academia to question the usage of DCF-model valuation as the only tool when analyzing real estate investments. Secondly to present academia's opinion about usage of probability distribution to support valuation reports. The third objective is to introduce Monte Carlo simulation as a tool and to find out how it can be used to support decision making when analyzing real estate assets.

The empirical study includes the case study where acquisition of shopping centre Arabia is quantitatively evaluated comparing the analysis results from 2011 and the Monte Carlo simulation results that are created for this thesis. The analysis made 2011 is based on basic discounted cash flow model used daily by Citycon. The discounted cash flow model used in the Monte Carlo simulation is the same model used in the acquisition of Shopping Centre Arabia, which based on the Citycon's original valuation model (Citycon Oyj, 2011).

1.6 Structure of the Research

Part	Content	Purpose
I	Introduction	To introduce the research topic
II	Literature Study	To build the frame of reference for the theoretical study
III	Case Study: Acquisition of Shopping Centre Arabia	To find out how decisions were made when acquiring a new shopping centre and to evaluate whether decision making can be improved using theory from literature study
IV	Summary of the research	To present the conclusions of the study and to give proposals for further research

Figure 1 Structure of the Research

This research is divided into four parts as described in Figure 1. The name of the first part is Introduction. It includes chapter 1, Introduction, which outlines to the reader the background, research questions, objectives, scope, concepts, materials, methods and structure of the research.

The second part is the Literature Study. This chapter builds the frame of reference for the theoretical study. It has three chapters. Chapter 2, DCF Valuation which presents discounted cash flow valuation in principle and lists its advantages its disadvantages, which in fact leads to chapter 3, Monte Carlo Simulation. In chapter 3 the basic idea of probability distribution as a supporting tool for DCF valuation is introduced. This principle is further explained to answer questions of why it should be used and how it is used to support real estate valuation.

After introducing basic principles of using probability distribution in real estate valuation, it is explained how Monte Carlos simulation is related to it. Furthermore the chapter discusses how Monte Carlo simulation works and how a Monte Carlo simulation model is constructed.

Chapter 4, Real Estate Investment Analysis presents academia's view of how real estate investments should be analyzed by a proper investor.

Part III, Empirical Research forms the empirical part of the study. It includes chapter 5, practical methods used in Citycon, where things researched in the literature are linked to practise used in Citycon.

Chapter 6 Case Study: Acquisition of Shopping Centre Arabia. In this chapter the acquisition process of shopping centre Arabia is analyzed comparing the results of pre-transaction valuations from 2011 and the results of the model built for this thesis using Monte Carlo simulation.

Part IV presents the conclusions of the study and gives topic proposals for further research.

PART II: Literature Study

2 DCF Valuation

2.1 Introduction

2.1.1 The Discounted Cash Flow Analysis

The International Valuation Standards Council (IVCS) lists discounted cash flow method as a suitable analysis method to be used when valuating property with the income approach. “In the absence of directly comparable sales evidence, the value has to be estimated using one or more market-based valuation approaches. Such approaches may use information from a variety of sources, including: discounted cash flow projections or income capitalisation supported by comparable market data on construction costs, lease terms, operating costs, growth assumptions, discount and capitalisation rates and other key inputs.” (IVSC, 2011)

Discounted cash flow is an income valuation approach where a discount rate is applied to a series of cash flows for future periods to discount them to a present value (IVSC, 2011).

Discounted cash flow (DCF) analysis is a method of valuing investments including equity, real estate, corporate projects and even entire companies. Discounting future cash flows is necessary, because the value of cash flow reduces over time as the money could be reinvested to earn additional income. DCF analysis was first invented by railroad engineer Arthur Wellington in the late 19th century. Today DCF valuations are widely used by companies to make budgeting decisions (Dulman, 1989).

DCF is defined as follows:

$$\mathrm{PV} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t},$$

Where PV = present (market) value;

C_t = forecasted incremental cash flow after corporate taxes – strictly speaking the mean of the distribution of possible $\widetilde{C_t}$ ‘s;

T = project life (C_t includes any salvage value);

r = the opportunity cost of capital defined as the equilibrium expected rate of return on securities equivalent in risk in the project being valued.

NPV equals PV less the cash outlay required (initial investment) at t = 0. (Myers, 1984)

The method above is commonly used when valuating projects of businesses that are based on cash flows only. To justify the use of DCF for real estate assets, the similarities and differences between real assets and financial assets are examined.

Real and financial assets have many similar characteristics. Their value is determined by the cash flows they generate, the underlying uncertainty of the cash flows and the expected increase of these cash flows. As other things remain equal, higher the level of cash flow growth and lower the underlying risk of the investment, the greater the value of the asset (Damodaran, 2002).

There are also remarkable differences between these two asset classes. First risk and return models used to evaluate financial assets cannot be used to evaluate real assets because of the difference in liquidity and types of investors between the two markets. Secondly there is a difference in the way financial assets and real assets create cash flow. More precisely put real assets usually have a finite life cycle whereas financial assets have an infinite life cycle (Damodaran, 2002).

To use discounted cash flow analysis to evaluate real assets it is necessary to (Damodaran, 2002; Myers, 1984):

- Measure the underlying risk associated with the real asset investment and to estimate an appropriate discount rate accordingly.
- Estimate future cash flows of the real asset for the life cycle of the real asset.

Furthermore, Kelliher and Mahoney (2000) list the following three critical components that must be estimated in an explicit valuation model:

- Amount of future cash flows
- Timing of future cash flow
- An appropriate discount rate

Additionally to the tasks listed earlier definition of depreciation/appreciation and obsolescence are also listed as tasks when conducting a discounted cash flow valuation (Adair, 1996).

Typical information requirements for a discounted cash flow analysis can be listed according to Figure 2 (Adair, 1996).

Type of information	Current information	Forecasts
Rents and yields	Estimated rental value Rents passing	Existing property rental value forecasts Location rental value forecasts Exit yield forecasts
Depreciation	Costs of redevelopment or refurbishment	Site depreciation/appreciation Inflation in building costs Timing of redevelopment or refurbishment
Current lease	Number of tenants Lease expiry dates Rent review dates	Future voids Structure and timing of future leases
Holding costs	Management costs Review costs Purchase and sale costs	
Client specific information	Discount rate Taxation Loan/finance	

Figure 2 Information Requirements to Conduct a DCF Valuation (Adair, 1996)

2.1.2 Measuring the Risk of a Real Asset

If the investment cash inflows were certain, one could use the risk-free rate as required rate of return. Given that this is not the case in real estate investments, which are uncertain by their nature the required rate of return must include an adjustment to take the uncertainty into account (Adair, 1996).

When calculating the opportunity cost of capital for financial investments the two basic models (the capital asset model and the arbitrage pricing model) both rely on the same principle to estimate the risk associated to the investment – the portion of asset´s variation that cannot be diversified away. This principle is based on the assumption that the marginal investor is well diversified and that the risk is measured by the variability of returns (Damodaran, 2002).

However, the academia and market analysts argue that real assets require investments of such great size that investors are bound to focus their investments into a selected group of assets, not being able to diversify doing so. Furthermore real estate investments often require certain local knowledge. As a consequence an investor doing as described notices that the two basic models mentioned in the previous chapter are not applicable as they are based on the principle of being well diversified and therefore unsuitable for calculating the investors cost of capital (Damodaran, 2002).

This reasoning though can be challenged simply by stressing that: 1) even the biggest real estate asset can be broken into smaller pieces to simultaneously hold financial assets with real assets and 2) as the investors are often institutional investors, with the sufficient ability and capital to diversify and minimize transaction costs (usually high in the field of real estate investments). Therefore it could be assumed that the marginal investor investing is well diversified and can use CAPM or APM models to estimate cost of equity (Damodaran, 2002).

The main difference in using CAPM or AMP models for real estate assets and stocks is that for stocks it is easy to estimate betas as the historic market data is available for extended time periods, returns are computed on a periodic basis and assets are constantly traded in a public market place. For real assets this is not the case. Real assets are only traded from time to time and not all types of properties are exchanged during a comparable time interval (Damodaran, 2002).

To counter this problem the industry has attempted to create indices and risk criterion for some real asset classes. This has been attempted by using the market information gathered from trading of real estate investment trusts (REITs) and commingled real estate equity funds (CREFs). This might not be suitable information as the transactions made by trusts and fund may not fully reflect the circumstances normal to the real estate market (Damodaran, 2002).

Another solution to the problem has attempted by The Frank Russell Company Index of real estate values that is based on valuations of properties owned by real estate funds. This method has its main limitation in the fact that the appraisals may be based on "smoothed" appraisals and it may understate the volatility and overstate the liquidity of the assets. (Damodaran, 2002)

In Finland KTI has been gathering transaction information and calculating KTI Index annually since 1998 to be able to come up with a real estate index for the Finnish real estate transaction market. ”The KTI Index measures total return of directly held property investments in Finland. Index divides total return into capital growth and income return components. In addition to the three return figures several other key figures are published. The KTI Index figures are published for over 80 different segments." (KTI Finland, 2014)

2.1.3 The Survey Method

Earlier academics proposed the use of a uniform technique to add a risk premium to the risk-free rate to arrive at a suitable rate of required return. In practice this is an intuitive process where the appraiser uses available market information to properly adjust the required rate of return to reflect market conditions (Adair, 1996).

Later as historic yields have been collectively been stored by advisor companies and information businesses particularly serving the field of real estate investment and valuation as described in the previous chapter, the estimation of risk has developed into a more sophisticated direction.

The problems associated with estimating the risk of real estate with the traditional methods has led to an alternative way of determining the discount rate for the DCF analysis. In the field of real estate the discount rate is often determined by surveying potential investors in the real estate sector on what rate of return they are expecting for a certain types of real estate investments (Damodaran, 2002).

The survey approach to determining risk of real estate can be justified on the following grounds (Damodaran, 2002):

- These surveys are not based on hypothetical models for determining risk that may overlook special characteristics of real estate investing, but on actual investors' view on what should be the return of a real estate investment
- The survey approach allows for estimating discount rates for different types of real estate assets (retail, offices, etc.) in different locations, without having to depend on historic prices like APM and CAPM models
- There are relative few (and homogenous) large investors who act in direct real estate investments (this is true especially for the Nordic/Baltic real estate market)

These surveys are undertaken by large real estate consultancy companies (Cushman & Wakefield, Jones Lang LaSalle, CBRE etc.) who use the survey results to determine market risks for real assets in their valuation.

The survey method is also described in various other sources. An appropriate range of historic sales for yield analysis is approximately 20 observations. Such amount should form a solid foundation for judgment of suitable required return for the target property. This process is not mathematical but experimental weighting the observations by comparability to the target property by location, specification and time of transaction. If the market is strong and there is a lot of demand for similar properties, the appraiser can be more confident about the analysis and vice versa in a weaker market (French & Gabrielli, 2004).

2.1.4 Estimating Cash Flows

Another important task when evaluating a real asset is to estimate the future cash flows of the real asset. The future cash flows consist of cash inflows, cash outflows, expected growth of the two previous items and the terminal value of the property (Damodaran, 2002).

In common literature academics suggest that the forecasts of future cash flows are single point values but there are also other opinions: "It is impossible to forecast most projects' actual cash flows accurately. DCF calculations do not call for accurate forecasts, however, but for accurate assessments of the mean of possible outcomes" (Myers, 1984).

Cash Inflows

The cash inflows from real assets consist of rental income paid by the tenants occupying spaces in the real asset. When estimating future rental in come the investor must look into past trends in rental levels, consider changes in supply and demand of relevant space and overall economic situation (Damodaran, 2002).

Forecasts of the market trends can be extracted at national, regional or local level. The information is usually based on econometric modelling of the property market and economy, identifying relationships between different factors affecting the economy and trying to produce an estimate of the market rents of the future. Same method can also be used to determine other variables (Adair, 1996).

Sometimes the market information is defective due to availability, quality or quantity. As these problems occur, appraiser must make adjustments to the variables to enable them to be used at the single property level (Adair, 1996).

In multi-tenant real assets it possible that not all space is rented at a certain point of time. Accordingly a vacancy rate (the percentage of total gross leasable area that the vacant area accounts to) must be taken into account and must be projected with market rents to find out how much of potential cash inflow will be lost due to vacancy (Damodaran, 2002). The opposite of vacancy rate is occupancy rate, which is 1-vacancy rate, or leased space / leasable space. Even in markets where there is a strong demand for rental space there are times when spaces cannot be rented or are left vacant for various reasons (tenant changes, tenant improvement etc.). Therefore vacancy is inevitable (periodically at least) and no investor can ever expect a 100% occupancy rate (Damodaran, 2002).

Cash Outflows

Real assets also have cash outflows which consist of items like real estate tax, insurance payments, reconstruction and maintenance. These mentioned costs are not related to occupancy and are accordingly called fixed expenses. There are though also costs related to occupancy such as utilities, which are proportional to the amount of space being used and are so fluctuating (Damodaran, 2002).

Other costs related to an investment property may also include management costs, purchase and sales costs, loan/finance costs and taxation (Adair, 1996).

In many countries real estate taxes produce the largest single expenditure of owner’s expenses. Real estate tax payments can also be a fluctuating expenditure not only as real estate taxation can change, but also because real estate taxation is usually based on the book value of the property, which can increase (or decrease) (Damodaran, 2002). In Finland though, real estate taxation is relatively lower than in other similar economies due to a different system to appreciate the taxation value of real assets (Lyytikäinen, 3/2012). Also e.g. in the United States and Great Britain real estate taxation is the main form of tax income for the states or local municipalities (Kauko, 55/1993).

Expected Growth

To be able to predict the future inflows of cash, investor needs to find out approximations for the forecasted rates of increase in rental income and operational costs. Inflation plays an important role in this prediction as usually in a stable market this forecasted rate should follow the rate of inflation closely. Of course rental prices follow common rules of supply and demand resulting to a situation when the real estate market is facing limited supply in rental space, the rental income growth may be somewhat higher than the expected inflation and vice versa in a situation of limited demand (Damodaran, 2002).

In lease terms possible changes in the amount of lease payments are usually described in high detail. A way to hedge against negative inflation and possible unexpected losses in cash flows (deflation) is to tie the lease agreement into an index reflecting on the increase of inflation, but ignore changes in a time of decrease (Damodaran, 2002).

As mentioned earlier it is possible to give an estimation of might happen in the future, but it is impossible to accurately forecast the future. Therefore some growth in the market rents is impossible to be forecasted, for example it is hard to explain how technological change might affect use of certain space types. This must be taken into account when assessing past data to build forecasts of future performance (Adair, 1996).

Residual value

In a discounted cash flow analysis a major part of the result comes from the expected residual value (or terminal value), which is the expected sales value of the property at the end of the investment period. There are many ways to estimate the terminal value (to expect property value to follow inflation from the price of the initial investment, to use direct capitalization), but usually the most common way used in a discounted cash flow analysis is to expect the cash inflows of the last year of the investment period to continue to grow at a stable rate towards infinity. With this assumption the residual value of the asset is (Damodaran, 2002):

$$\text{Residual value of real asset} = \frac{\text{Forecasted Cash Flow}_{n+1}}{r-g},$$

Where r = the capitalization rate;

CF_{n+1} = expected cash inflow for the next year after the investment period has finished;

g = rate of inflation

Another practitioner suggests that after the sale period the inflated rent will be capitalized with an appropriate capitalization rate. It is noted that the appropriate yield level is suggested not necessarily be equal to the current required return as the building might be in a different condition at the time of sale (Martin, 1991).

In other words, the yield requirement at the end of the investment period must separately be evaluated according to the way yield requirement was defined for the investment period as described earlier in this thesis.

2.2 Advantages

In the academia there are arguments for and against the use of DCF. It is commonly accepted by appraisals and academics as it is simple economically rational and easy to use. Additionally it's discounting feature takes into account time-value of money (Hoesli;Jani;& Bender, 2006).

The advantage of the DCF model (an explicit model compared to an implicit model) is that it makes the process more distinct as it takes into account variables that affect the value of an investment asset that the implicit ignores. The DCF model makes predictions for increase in rental income and operational costs, length of the investment period, depreciation, repair costs, refurbishments, management costs, transaction costs and costs of financial arrangements & taxation. By taking into account these assumptions, the model allows an investor to also question the certainty of these inputs (French & Gabrielli, 2005).

DCF method fits investment valuations as it overcomes problems caused by direct capitalizations simplistic nature. Direct capitalization is a simplified method where present income is capitalizes into infinity based on knowledge of historic returns and lacks the attributes to estimate future cash flows of a multitenant real asset in fluctuating economic conditions. In the demanding world of real estate investment an investor requires an intelligent analysis method to predict the outcome as real estate investments usually are characteristically long-term (Kishore, 1996).

A rational argument to support the use of the DCF analysis is the results of the market practice surveys. This is because, if investors are using the DCF method to make property investment decisions, then can DCF analysis simulate the behavior of property market participants and thus be the correct approach in determining the value. Journal paper from Kishore (1996) compiled data from various surveys undertaken in different markets to find out market practices concerning the use of DFC. The paper shows that 75 percent of Australian investors always used and 25 percent usually used DCF analysis in valuation of real assets worth over $ 25 million. When asked about investment decisions, all respondents reported to always use the DCF method.

With modern technology, spreadsheet software and educated practitioners, calculations required for a DCF valuation are no longer difficult and should be more widely used (Martin, 1991).

Accordingly to these mentioned statements made by academics who have further researched the industry of real estate investment it can be confirmed that the DCF analysis is an accepted method to be used when evaluating a real estate investment decision.

2.3 Disadvantages

In the academia there is a broad spectrum of specialists who have criticized the discounted cash flow model. Firstly the model makes multiple deterministic suppositions, and so it does not take into account the uncertainty of the cash flow. This may cause the whole process to fail if any of the input figures are manipulated at all. Secondly, if opportunity cost of capital is being used as capitalization rate, analysis leads into a circular reasoning (to determine opportunity cost of capital one needs to know asset value, but in the analysis asset value is the target output). Thirdly capitalization rate is assumed to remain constant throughout the investment period, although asset values are rather fluctuated by the change of the capitalization rate than changes in the expected cash flows (Hoesli;Jani;& Bender, 2006)

Not only continuity of the capitalization rate is criticized, but also changes in inflation should also be taken into account: “A surprising number of firms treat inflation inconsistently in DCF calculations. High nominal discount rates are used but cash flows are not fully adjusted for future inflation. Thus accelerating inflation makes projects – especially long-live ones – look less attractive even if their real value is unaffected” (Myers, 1984).

Another problem of the capitalization rate is related to the start-up phase of a project (in the field of real estate this could be a project not yet stabilized as location might not be established in the first years of the investment period or the tenant mix is not right at the start of the investment period). Some projects are unusually risky at inception, but reach a normal risk category after the start-up phase. The required rate of return should be adjusted after this period is over (Myers, 1984).

Also DCF is not very good model when there is a lot of growth potential in the project or intangible assets (in the field of real estate the growth potential could be related to unused buildings rights etc.), in other words the DCF cannot take into account options related to the worth of part of the project value (Myers, 1984).

DCF analysis is also regarded demanding to be used by appraisers as it requires use of information that is complex. Questions have been raised whether practitioners are equipped with required knowledge to undertake appraisals (Adair, 1996).

Another academic continues: “DCF analysis may fail in strategic applications even if it is properly applied” (Myers, 1984). Even when properly used a random error might very strongly affect the outcome of a valuation. There is a 50 percent chance that a truly border line investment gets a positive NPV. Therefore a result of a discounted cash flow analysis should always involve some kind of checking routine. In other words managers should never accept positive net present values unless they can explain them (Myers, 1984).

Use of single point estimates as inputs can be dangerous for the outcome of the valuation as required rate of return plays such an important role in the DCF model. A number of property firms publish research results that show historic performance and predict long term trends that can be useful guidance for the future. Even though a practitioner may have an idea of what should happen in the future, the view might not be accurate enough. How often can one see well-respected analysts change their views over time and how often have they been proven wrong by economical events (Martin, 1991). Experts can change their view on the economic future, but it does not help an investor who has made an investment on the long-term relying on this view.

Other academics have also stressed the shortcoming of reporting / indicating uncertainty in valuations. An appraisal figure should be interpreted as an expert opinion and an estimation of the possible value of the asset. Regardless, customers requesting valuations often misinterpret valuation figures as an absolute truth without questioning the results, although there is always an element of uncertainty embedded to the valuation figure (French & Gabrielli, 2004).

Often a practitioner only has a range of possible values for uncertain inputs. The wider the range of the inputs is, the greater the uncertainty pertaining to the results of the valuation. While the practitioner ignores this uncertainty pertaining to the input figures and makes naïve assumptions, the results may be very unrealistic and subjective. If the input figures are not balanced and realistic the result gives and overly optimistic or conservative solution (Kelliher & Mahoney, 2000).

The process of DCF analysis can be strengthened by taking into account its characteristic of uncertainty. This will be further discussed in the next chapter.

2.4 Discounted Cash Flow and Probability

Before discussing uncertainty it should be addressed that risk and uncertainty are often incorrectly regarded as meaning the same thing, although this is not the case. The concept of risk and uncertainty has been discussed widely in the academia, but they can be defined as follows (Byrne & Cadman, 1984) (French & Gabrielli, 2004):

- Uncertainty. This is anything that is not known about the outcome of a venture at the time when the decision is made.
- Risk. This is the measurement of a loss identified as a possible outcome of the decision.

Uncertainty of the DCF analysis process is caused by poor or imperfect information about the input figures of the analysis. If one is not certain about the input figures, then the resulting outputs are exposed to uncertainty. Although if an investor is able to assign probabilities for the input figures ranges of output results can be determined. Therefore the possible risk of output results can be measured (Byrne & Cadman, 1984) (French & Gabrielli, 2004).

Also it should be addressed that variance and uncertainty of a valuation result should neither be used interchangeably. If a valuation is carried out by two independent appraisers at a same point in time, the difference of their valuation results is the variance of the valuations. The main reason for this is that as there are conceptual differences between the appraisals, the values will be different. Whereas the variance of valuation is the difference of results of different appraisals, uncertainty of valuation is caused by uncertainty of input figures resulting in uncertainty of output results (French & Gabrielli, 2004).

Given that it is impossible to predict the future accurately, there will always be an element of risk pertaining to the outcome result and an actual value of the property. A single point valuation without an outlook to the uncertainty of the input figures will only produce one value that does not take a stand on underlying risk of the potential value. To improve this method, one could repeat this procedure to be able to analyze the results with changing input figures. (French & Gabrielli, 2004).

There are more sophisticated techniques available to test the variation of outcomes of the DCF model caused by the uncertainty in the input figures and therefore affecting the future cash flows of the property. Most of them look to assign probabilities to the input values of the DCF. After receiving a multitude of outcomes, the results can used to make an investment decision (Adair, 1996).

3 Monte Carlo Simulation

3.1 Introduction

Monte Carlo simulation (MCS) was developed by scientists for different purposes e.g. to calculate phenomena of physics and to solve problems related to medicine, chemistry, astronomy and agriculture. The mathematical basis using probability density functions for MCS was introduced by John von Neumann and Stanislaw Ulam (Fishman, 1996; Hoesli;Jani;& Bender, 2006). MCS has also been used in finance to simulate prices of derivatives and to predict future stock prices (Hoesli;Jani;& Bender, 2006).

The main reason why simulation techniques have not been used in the past is that technological constrains have forced appraisals to use single point valuations, but with current hardware and software available, appraisers should advance to using simulation technologies. The use of simulation technology should result in better understanding of the uncertainty related to the valuations and hence more sophisticated, accurate valuations and more effective investment decisions (Kelliher & Mahoney, 2000).

The technological leaps have affected in the use of MCS: “CREAS (Computerized Real Estate Appraisal Simulation) can be set to perform any number of simulations (of Monte Carlo). A 100 simulations run requires about two minutes and 15 seconds of processor time on a Xerox Sigma computer…” (Wofford, 1978). “10,000 iterations of the MCS were run in under two minutes on a Pentium, 300-megaherz, IBM-compatible computer” (Kelliher & Mahoney, 2000).

In real estate the use of MCS seems to be fairly limited supposedly due to its demand for mathematical and statistical understanding (Hoesli;Jani;& Bender, 2006). Although the limited use, some academics have made some important research on the topic. Stephen Pyhrr introduced a simulation model to measure risk of a real estate investment. The research combined traditional real estate investment analysis with probabilistic assumptions to the input variables of the DCF model. Much of the later research on the topic is based on his initial research (Pyhrr, 1973). Hoesli et al. used MCS to predict property values with discount rate varying over the investment period (Hoesli;Jani;&

Bender, 2006). French et al. has used MCS to analyze uncertainties related to investment forecasting (French & Gabrielli, 2005).

Most importantly the use of MCS has also been researched to be used to improve long-term investment decision making (Kelliher & Mahoney, 2000) (French & Gabrielli, 2004) (Pyhrr, 1973), which is very close to the scope of this thesis. The introduction of this theory is thus mainly done through the experiences presented by French & Gabrielli and Pyhrr.

3.2 Basic Monte Carlo Simulation Model

"Real estate decision makers claim that they take calculated risks, but few of them make very clear just how they calculate these risks. Although some of the risk consideration is explicit, most of the mathematics of risk was left to the four horsemen of the implicit decision-making apparatus: judgment, hunch, instinct and intuition." (Pyhrr, 1973).

The foundation of the usage of MCS in the field of real estate investment was laid by Stephen Pyhrr who in 1973 introduced a real estate investment risk simulation model which utilized MCS. A lot of the later research on the topic is based on this foundation.

The main conceptual difference in the model developed since the 1970's relates to the definition of risk: "Risk and uncertainty is the same thing, and they exist in real estate because investors are unable to make perfect forecasts" (Pyhrr, 1973).

A basic assumption in a 1978 study was that all variables used were independent. This assumption meant that the value selected from a probability distribution for one variable is not dependent on the value selected for any other variable. It was recognized that such dependencies exit, are often very important, but the ability of an appraiser to handle and specify the direction and magnitude of such dependencies was questioned and not found suitable for the initial model (Wofford, 1978).

In contrast the authors of the 2000's have taken these interconnections into account and risk and uncertainty have been more precisely defined: "The process involves the identification of the input variables, defining their probability distributions and, if there is any, their correlation (or inter-relationship)" (French & Gabrielli, 2004)

The basic concept of MCS is to repeat a certain process multiple times with fluctuating input figures. In the case of a real estate investment the process is a direct capitalization or a DFC analysis where the calculation is repeated with given parameters. Instead of giving single inputs as the calculation parameters, one assigns probability distributions or value ranges as input parameters for each input figure. MCS then randomly selects the input values from these assigned ranges or probability distributions and carries out the process. The process is repeated until the desired amount of results is reached. As a result, there will be a multitude of possible outcomes that can be analyzed using statistical tools (e.g. mean, range, standard deviation). The results can also be presented as a discrete distribution or a continuous distribution (French & Gabrielli, 2004) (Pyhrr, 1973). This process is described in Figure 3 (French & Gabrielli, 2005).

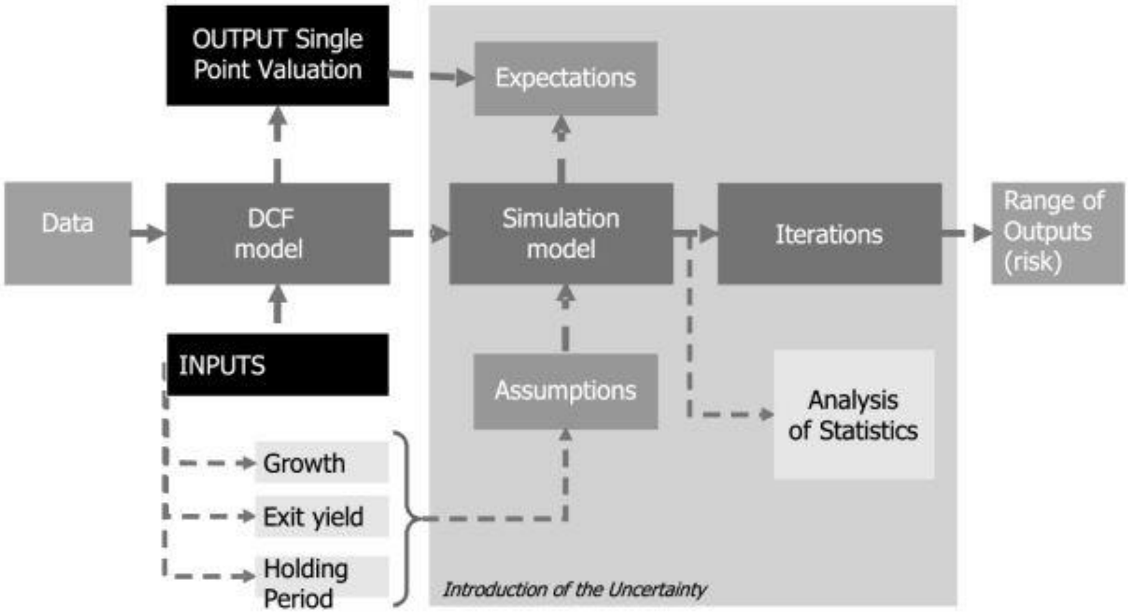


Figure 3 Iteration Process of MCS (French & Gabrielli, 2005)

The variability of valuation depends on the variability of the input figures. As a result, the process depends on the definition of the distributions of the input variables and - if interrelated – on the correlations of the input variables. The accuracy of the MCS model depends on the quality of the data used in to define the input variables. The main challenge in using MCS is related to the specification of the input variable ranges, their probability distributions and correlations between the inputs (French & Gabrielli, 2004). Earlier input variables were classified into two categories, control variables, which remain single-point estimates (e.g. holding period and square meter dimensions of the asset valued) and state variables, which required estimation of probability distributions (Pyhrr, 1973). This approach has been abandoned in the later work on MCS as all variables are closely defined.

Also a main difference between the original models introduced in the 70's and the models developed by academics after the change of the millennium is that the latter models give property values as outputs, but earlier models have property values and resale values as estimated inputs, giving rate of returns or yield as output results. This can be seen in Figure 4 (Pyhrr, 1973).

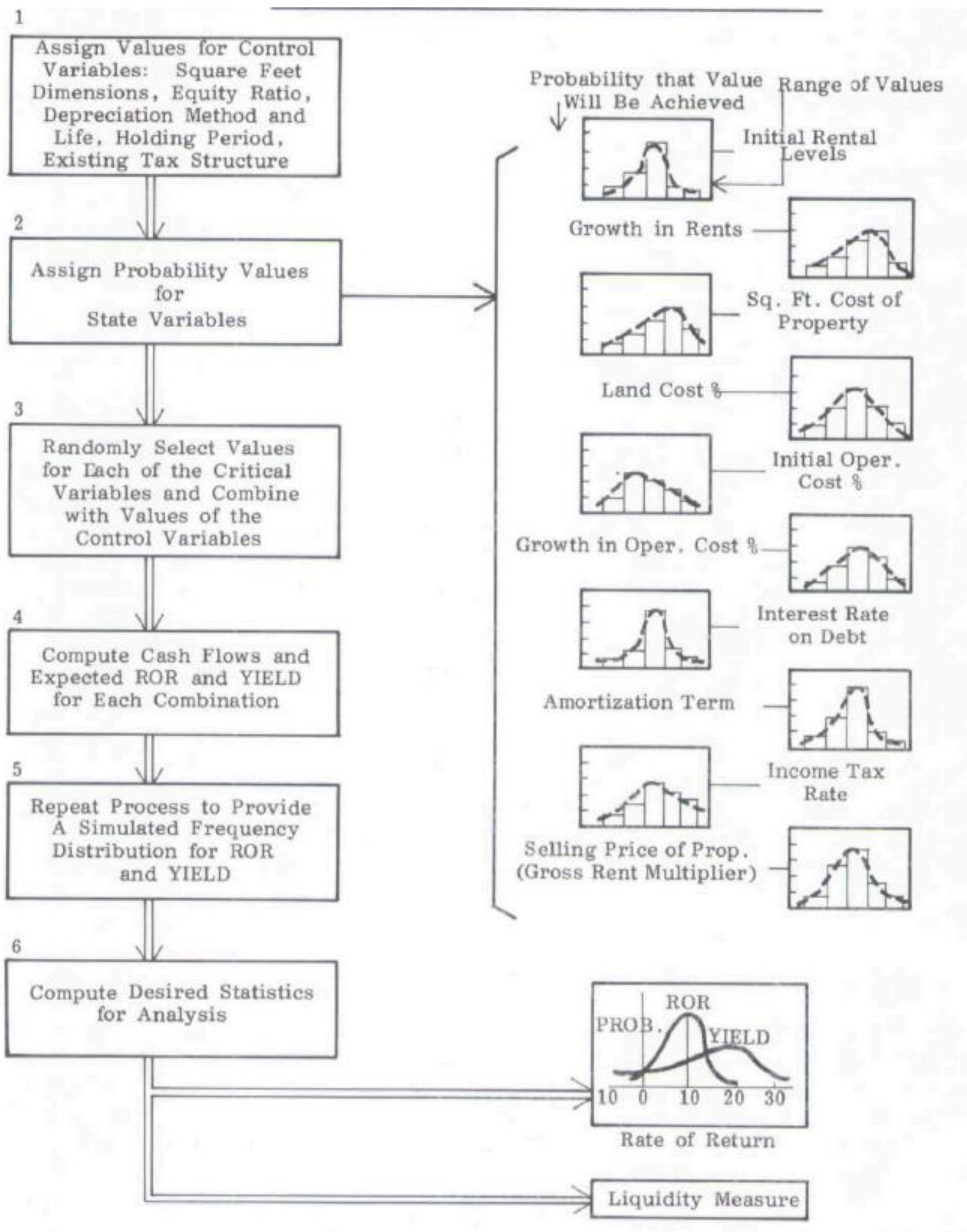


Figure 4 Operation of the MCS (Pyhrr, 1973)

To define the input figures the literature presents advice of a variable degree. “The process is not a science; it is a process of judgment and expert analysis.” It is suggested that the appraiser intuitively assesses the market for comparable sales to find out appropriate yield requirements for the target property (French & Gabrielli, 2004). Kelliher et al. suggests that there is no universal truth to the way the variables should be defined but information can be found in published market surveys for rent prices, operating costs, yields and other trends. Internal and external sources should be used to find all available relevant data. Statistical tools need to be used to find out correlation between the input figures and to find out to which extent the data found is useful and applicable (Kelliher & Mahoney, 2000). Hoesli et al. use even more sophisticated equations fitted especially to be used for these certain variables. Input figures are defined with using one of normal, triangular or equal probability distribution depending on the characteristics of the variable (Hoesli;Jani;&

Bender, 2006). The strength of the probabilistic simulation model is that it requires the decision maker to bring together experts (engineers, economists, lawyers etc.) of different fields to provide information on essential issues affecting the investment process to reach the most accurate estimation of the property value (Pyhrr, 1973).

3.3 Example 1: Building a Monte Carlo Simulation Model

This example shows how a probability based MCS is built based on the framework introduced by Stephen A. Pyhrr 1973. The improvements to this basic framework are further suggested from later research also presented in this thesis.

3.3.1 Defining the Input Variables

Building of the simulation model starts with a specification of which variables are subject to uncertainty, a sensitivity analysis to find out which variables have the most significant impact on the cash flows and rates of return and to decide which variables are selected as "state variables" and "control variables". Control variables are those variables that can be defined with certainty or are uncertain but have little effect on the results. State variables on the other hand are uncertain and therefore need to be defined as probability distributions (Pyhrr, 1973). As mentioned earlier in this thesis the categorization of the variables has later been abandoned. As all variables are subject to uncertainty and can be defined as probability distributions, this is also done in practice (Kelliher & Mahoney, 2000) (French & Gabrielli, 2005).

Input variables used by different academics vary as models take financial arrangements and taxes into account by various degrees and use variables such as loan to value (LTV), interest rate of debt, income tax rate etc. Although the following input variables are used uniformly by most papers reviewed (Pyhrr, 1973) (Wofford, 1978) (Kelliher & Mahoney, 2000) (French & Gabrielli, 2005):

- Rental income
- Growth rate of rents
- Operating costs
- Growth rate of operating costs
- Selling price of the asset at the end of the lease term

As also mentioned earlier the initial models of the 1970's calculated rate of return as an output of the model: "The computer selects one value from one distribution, combines it with another and another, and calculates the rate of return on total property cost (ROR) and equity invested (yield) from that particular combination" (Pyhrr, 1973). More modern applications of the model calculate values of the asset as output figures. "The basis of the discounted cash flow valuation is that the value of the property investment will be equal to the gross present value (GPV) of the projected rental income flow, at the market's rate of return (discount rate) (French & Gabrielli, 2005). In this thesis also the model is used to estimate market values of the target property.

3.3.2 Quantifying Uncertainty

Once the variables have been selected and the significance of the variables to the outcome has been determined, it is time for the most important phase of the model construction. This is the phase where the decision maker quantifies the uncertainty related to the variables by applying the respective probability distributions of the variables. This process was quickly mentioned in the previous chapter but it should be more precisely defined. There are many ways to assessing the probability distributions. One can simply select a range of values that seem probable future outcomes for the respective variable. Historic values can be used to justify these ranges and their probabilities. Different types of probability distributions are shown in Figure 5Figure 5 Example Probability Distributions . If the appraiser is very uncertain about the variable the probability distribution looks as in b) in Figure 5. Again if the appraiser is very certain about the variable the probability distribution should look as in a) in Figure 5 (Pyhrr, 1973).

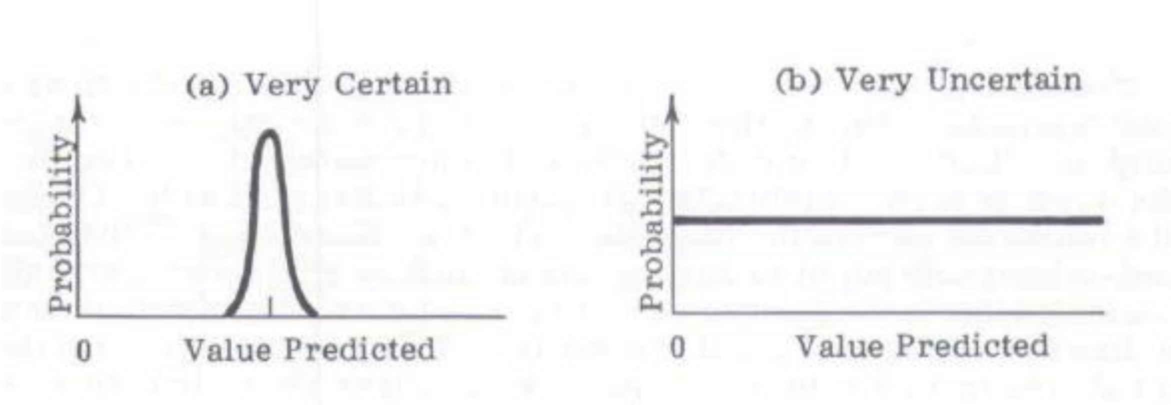


Figure 5 Example Probability Distributions (Pyhrr, 1973)

For a real estate professional not very accustomed to probability distributions one practical way of creating a probability distribution is the Schlaifer-Raiffa method, where the results of an interview round of possible outcomes for rental growth rates are processed to create a probability distribution. From the interview results of say hundred inputs only the mean needs to be calculated. Then the assumed lower and upper limits are estimated from the results. Those are the values that the rest of the results will be higher and lower with 99 times more often. The conductor of this study then counts how many hits fall between one percent changes of the possible growth rates to estimate the probability of each sub-range of the distribution. An example of the resulting probability distribution where the estimated mean growth is 4% is illustrated in Figure 6 (Pyhrr, 1973).

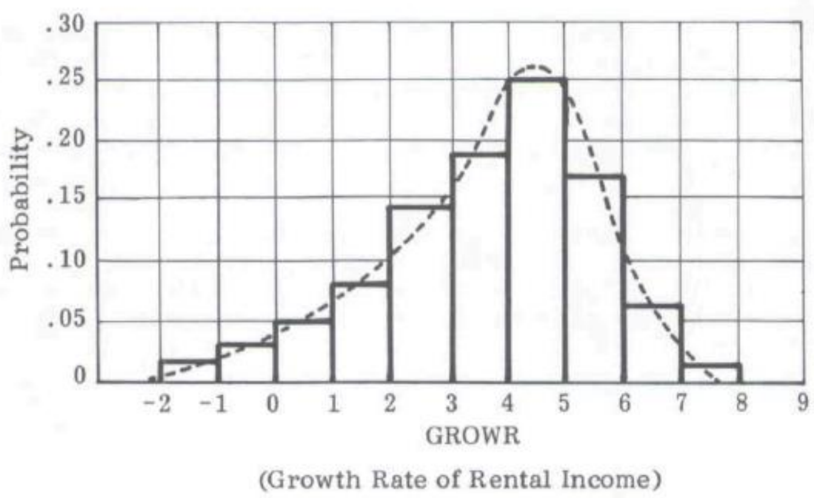


Figure 6 Probability Distribution Derived with Schlaifer-Raiffa Method (Pyhrr, 1973)

3.3.3 Interrelations of the Input Variables

"The inclusion of conditional probability distributions in a model such as this may become feasible when the quality of information in real estate improves, and when researchers learn more about the interdependencies among variables over time" (Pyhrr, 1973). Although correlation is not calculated between variables important linkages between some variables have been included in the model. Operating costs have been stated as a function of annual rental income, with the operating cost percentage increasing at a specified rate over the investment period. Residual value of the property is also strongly linked to the rental income and rental income growth rate as the resale value is provided by direct capitalization of rental income using required rate of return (Pyhrr, 1973) (Damodaran, 2002) (French & Gabrielli, 2005) (Kelliher & Mahoney, 2000).

More recently real estate practitioners are able to calculate correlations between variables and these correlations can also be included in the model. Correlations should be calculated at least between the following variables (Hoesli;Jani;& Bender, 2006). (Kelliher & Mahoney, 2000):

- Rental income and operating expenses
- Growth rates of rental income and operating expenses

3.3.4 Simulation of the Outputs

A less demanding phase of the process is the actual simulation of the outputs as the software runs the desired amount of simulations as the variables are carefully assigned before. The computer simply selects values from the assigned ranges defined and runs the DCF model as long as it is required to reach the set amount of simulations. The results are then presented in a graphical view or as ranges of outcomes (Pyhrr, 1973) (Wofford, 1978) (Kelliher & Mahoney, 2000) (French & Gabrielli, 2004) (Hoesli;Jani;& Bender, 2006).

3.3.5 Analysing the Results

The simulation creates valuable financial information for an investor. For example the investor can compare different projects and their risk profiles. To find out which project includes the most risk compared to expected range of returns. This way an investor can select the best scenario to invest in. In Figure 7 project 3 dominates projects 1 and 2 stochastically – that is – that project 3 has a higher probability of exceeding the required rate of return and therefore dominates over projects 1 and 2 (Pyhrr, 1973).

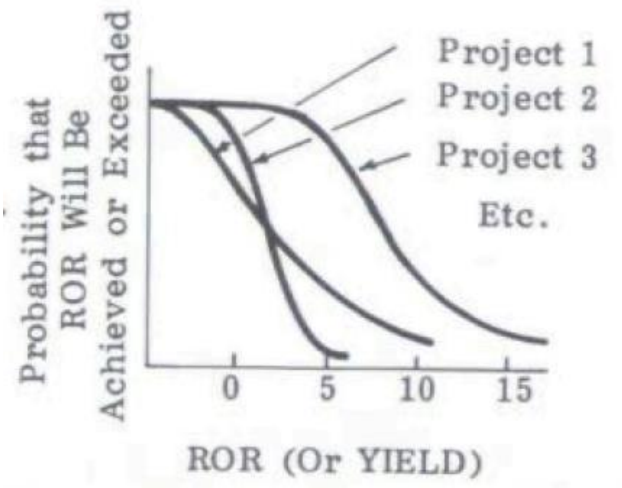


Figure 7 Risk Profiles of Comparable Investments (Pyhrr, 1973)

Another way to evaluate a project is to find out how probable it is to yield loss or the probability of not reaching the required return. This is presented in Figure 8. The investor can eliminate projects that are not expected to return some specified rate of return and then choose among remaining projects by finding those which are expected to produce the highest amounts of return for any given level of risk or the lowest amounts of risk for any given level of returns desired by the investor (Pyhrr, 1973) (Kelliher & Mahoney, 2000).

Additionally it might be very interesting for an investor to know how probable it is to reach a certain value for the investment or at what probability will the investment fit into a certain probability range. Moreover the investor should want to know how the probability distribution of the investment values is skewed to know whether the values are focused on the positive or the negative side of the mean. In other words, does the project include upside or downside risk (French & Gabrielli, 2005).

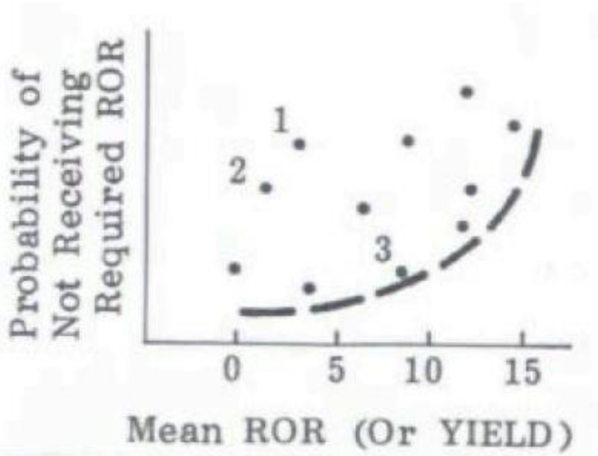
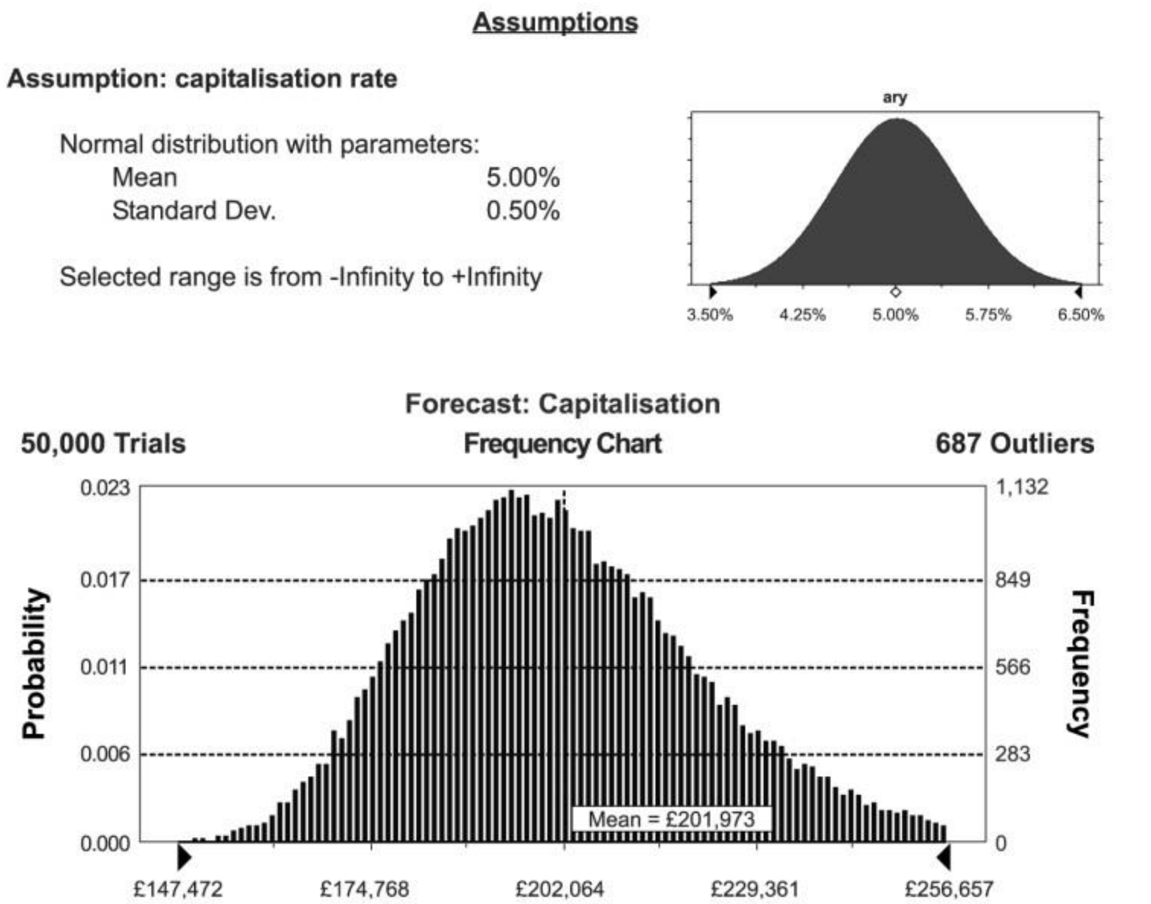


Figure 8 Probability of Loss (Pyhrr, 1973)

3.4 Example 2: Monte Carlo Simulation with Direct Capitalization

This is an example of a direct capitalization appraisal where the appraiser has determined an all-risk yield of 5% that would reflect all risks and growth potential for the target property. However, this all risk yield is also under the influence of risk and the appraiser must determine how confident he is about the all-risk yield. In a strong market the appraiser should be more confident about the figure and in a weaker market the appraiser should be less confident about the figure. In terms of probability this can be reflected in the range or standard deviation of possible yields used in the analysis. (French & Gabrielli, 2004).

Presented in Figures 9 and 10 there is an example of the MCS being used to simulate a direct capitalization of a property with net operating income of 10,000£ and yield requirement of 5%. In figure 9 yield requirement is defined as a standard distribution with a mean of 5% and standard deviation of 0.5%. In figure 10 yield requirement is defined as a triangular distribution with a minimum at 4.5%, likeliest value of 5.0% and maximum at 5.5%. In both cases the simulation repeats the process 50,000 times. The outcomes can also be seen in the graphs presented in the figures. As a result standard deviation produces (figure 9) a mean of 201.973£, minimum of 147.472£ and maximum of 256.657£. Triangular deviation generates a mean of 200,369£, minimum at 182.611£ and maximum at 220.262£. Both resulting distributions have positive skewness, which means that the tail of the outcome values is longer on the positive side of the mean (French & Gabrielli, 2004).



Forecast: capitalisation
Summary:
Display range is from £147,472 to £256,657
Entire range is from £137,000 to £335,738
After 50,000 trials, the standard error of the mean is £93

Statistics	Value
Trials	50,000
Mean (£)	201,973
Median (£)	199,944
Standard deviation (£)	20,871
Skewness	0.63

Figure 9 MCS with Continuous Density Function (French & Gabrielli, 2004)

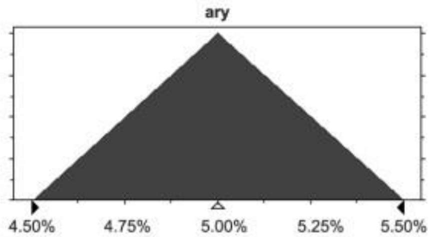
Assumptions

Assumption: capitalisation rate

Triangular distribution with parameters:

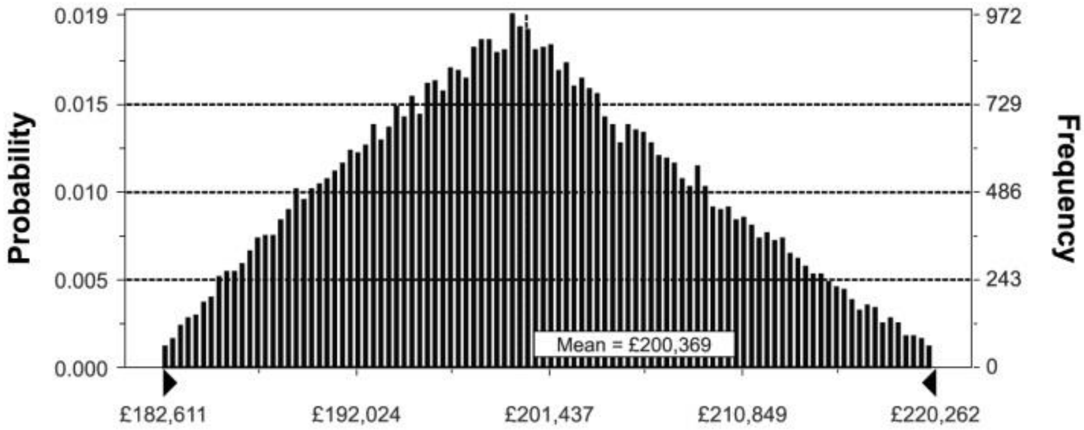
Minimum	4.50%
Likeliest	5.00%
Maximum	5.50%

Selected range is from 4.50% to 5.50%



Forecast: Capitalisation

50,000 Trials **Frequency Chart** **213 Outliers**



Forecast: capitalisation
Summary:
Display range is from £182,611 to £220,262
Entire range is from £182,053 to £222,066
After 50,000 trials, the standard error of the mean is £37

Statistics	Value
Trials	50,000
Mean (£)	200,369
Median (£)	200,051
Mode	–
Standard deviation (£)	8,181
Skewness	0.17

Figure 10 MCS with Triangular Distribution (French & Gabrielli, 2004)

3.5 Example 3: Monte Carlo Simulation with Discounted Cash Flow

This paragraph shows an example from French & Gabrielli's next paper where they have introduced usage of MCS for a more complex property with more input variables and the process needed to produce such model. French et al. use the term of implicit model for direct capitalization method and explicit model for discounted cash flow (French & Gabrielli, 2004) (French & Gabrielli, 2005).

Direct capitalization and DCF should result in the same value with accurate inputs however DCF technique has been developed to patch up for the shortcomings of direct capitalization. As mentioned earlier in this thesis, the foundation of the DCF valuation is that the value of the asset will be equal to the gross present value of the projected rental income flow, at the required rate of return determined using market evidence. The advantage of the DCF analysis (compared to direct capitalization) is that it takes into account more variables influenced by uncertainty and hence making the valuation more transparent in terms of making uncertainty more easily examined (French & Gabrielli, 2005).

The foundation of MCS with an explicit model is similar to the implicit model, although in the case of the explicit model there are more parameters to be defined. The next example shows the process of running a MCS with the explicit model (DFC). In the example a simulation of a valuation is run with the following inputs. The net rental income in year one is 10,000£ increasing by 3.3 percent pa. The cash flows are discounted with the market equated yield of 8 percent. The investment period is 10 years. The simulation is run 10,000 times. Whist it was discovered by French et al. that the normal distribution is the most statistically robust probability function from the two models presented earlier in this thesis, triangular distribution seems to better represent the though process of the appraiser. This is because the appraiser is most likely to think about the uncertainty as best and worst case scenario around the most likely figure (minimum, maximum and the likeliest value). The triangular distribution fits this thought process best. (French & Gabrielli, 2004). Figure 11 shows how the ranges and correlations of the input figures have been determined using market evidence. The range of inputs (minimum, maximum and the likeliest value) is the appraiser's expert opinion on these variables. Also in the figure the correlations between the input variables set out based on historic correlations of the same variables adjust according to the appraisers opinion of their interrelation during the investment period used in the analysis (French & Gabrielli, 2005).

The results can be seen from the Frequency Chart also presented in Figure 11. The mean of the simulations is 203,662£, median 202,489£ and standard deviation 9,068£. The distribution is skewed to the right (skewness 0.53), which means that the values are more densely distributed to the positive side of the mean (potential upside in the valuation during a higher market for example). The kurtosis of the distribution is 3.08 which means that the distribution is very close to the normal distribution (3 is normal, a value over 3 means that the distribution is peaked and anything under 3 means that the distribution is flat). Lowest value produces by the simulation is 182,013£, highest 227,369£ (French & Gabrielli, 2005).

Another interesting piece of information produces by the simulation is the range of certainty. The appraiser can do this in two ways, either to ask the simulation to tell how probably the value of an asset will fall into a given percentage range around the mean, or to ask what are the minimum and maximum values with a desired probability (French & Gabrielli, 2005).

Probability distributions of chosen variables

Input	Distribution	Mean	Minimum	Maximum
Rental growth (%)	Triangular	3.30	4.5	2.5
Exit yield (%)	Triangular	5	4	6
Holding period (years)	Triangular	15	5	25
Equated yield (%)	Triangular	8	7.75	8.25

Correlations between the chosen variables

	Rental growth	Exit yield	Holding period	Equated yield
Rental growth		−0.50	+0.20	−0.30
Exit yield	−0.50		+0.40	0.10
Holding period	+0.20	+0.40		
Equated yield	−0.30	0.10		

Output distribution

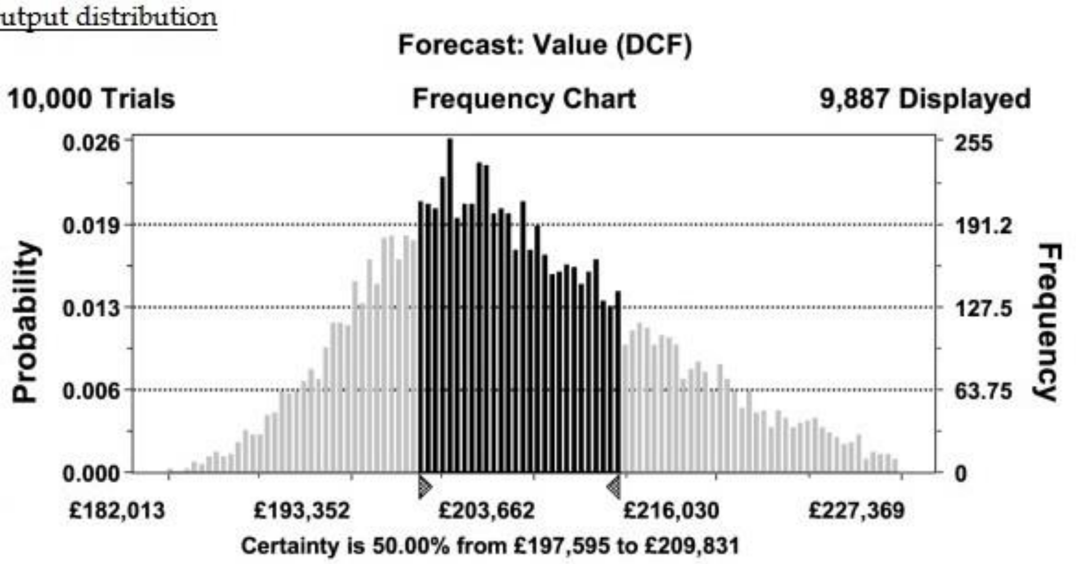


Figure 11 Explicit Model with Monte Carlo Simulation (French & Gabrielli, 2005)

4 Real Estate Investment Analysis

A real estate investment is described as the assigning of capital by an individual or a company in order to maintain or to increase the value of capital committed and to earning return to capital. The investment also represents giving up on present advantage of liquidity in anticipation of a future benefit (Oprea, 2010).

A real estate investment analysis is similar to a real estate appraisal report. The main difference related to these tasks is the additional depth of study required from an investment analysis. An investment analyst must consider the client's investment criteria at all times, especially when reviewing the analysis results. The main focus in an investment analysis must be in the long term opportunity of the asset. The results of the study include advice and counsel on carrying out the plan suggested in the results in addition to the factual report (Bailey, 1984).

Generally real estate investment analysis should help answer the following questions (Oprea, 2010):

- Should the property be purchased?
- How should the investment be financed?
- How long should it be held?
- How risky is the investment?
- Will it work?

Real estate financial feasibility analysis determines whether an investment project is financially viable. This is to determine whether the investment project is likely to reach the individual's or company's investment objectives, given the available resources and respective limitations (Oprea, 2010).

To avoid investments in or lengthy evaluation processes of clearly unprofitable real assets, an investor should use a simplified process for identifying such assets early on. "It is prudent to use a screening technique to identify with minimum cost projects that obviously are not feasible" (Oprea, 2010). A way to conduct this simple feasibility analysis is to subtract the estimated expenses of the asset from the estimated revenue to find out profit or loss. If the outcome is a loss then the investment analysis can be terminated at an early stage to avoid creating dead deal costs with a clearly unprofitable project (Oprea, 2010).

After passing the initial analysis key issues must be analyzed more closely. Key issues to be analyzed are discussed by many academics and certainly there are more similarities than differences.

At a more general level the key issues are the legal issues, physical issues and financial viability of the investment project. Feasibility takes a stand on the highest and best use of a property, the most appropriate site for a predetermined use, or the most appropriate target for committing earmarked investment capital (Oprea, 2010).

When more closely defined, the issues that must be taken into account in a real estate investment analysis can be divided into four categories (Bailey, 1984):

1. Physical attributes: the location, the functional fitness for the planned use, the age and physical condition of the property, need for capital expenditure and competitive position in the current marketplace.
2. External economic factors: economic base and demographic characteristics of the community the property is located in, inflation, present and future market competition, and trends of the local real estate market.
3. Internal Economic factors: possibility and probability of increased revenue due to built-in lease terms, turnover of tenants, availability of and finance in place.

Specific risks related to an investment that should also be considered early on in a real estate investment analysis are: illiquidity, limitation/difficulty of management, depreciation of value, government controlling, real estate cycles or legal complexity (Oprea, 2010).

Real estate investment analysis process can also be constructed as a five step plan accordingly (Pyhrr, 1973):

1. investment target model specification
2. information gathering and specification
3. calculation (using MCS)
4. project evaluation
5. decision

Alternatively feasibility analysis is repetitive and continuous. It is conducted following the eight steps listed (Oprea, 2010):

1. Assessing the physical and legal aspects of the site
2. Estimating demand for the space
3. Analyzing competitive space
4. Estimating costs of acquisition, construction or rehabilitation
5. Estimating the cost and availability of borrowed funds
6. Estimating absorption rates
7. Developing cash-flow schedules
8. Evaluating the estimated cash flows in terms of acceptability of the expected outcome

To answer the question “Will it work?”, rather than finding a single solution real estate investment analysis may produce several alternatives for the course of action and therefore looks to determine whether all, some or none of the alternatives will produce the outcome applying to the minimum investment objectives. The answer is yes, if the analysis can anticipate that there is a moderate likelihood of satisfying the investment objectives by one of the alternative courses of action (Oprea, 2010).

PART III: Empirical Research

5 Practical methods used in Citycon

5.1 Discounted Cash Flow Analysis in Citycon

According to Citycon's Annual Report 2013 valuation is carried out as follows:

"Using International Valuation Standards (IVS), an external professional appraiser conducts the valuation of the company's properties at least once a year. During 2013 and 2012, Citycon had its properties valued by an external appraiser on a quarterly basis.

A ten-year (discounted) cash flow analysis based on the net rental income is used to determine the fair value of investment properties. The basic cash flow is determined by the company's lease agreements valid at the valuation date. Upon a lease's expiry, the market rent assessed by an external appraiser is used to replace the contract rent. Gross rental income less operating expenses and investments equals cash flow, which is then discounted at the property-specific discount rate comprising of yield requirement and inflation assumption. **Yield requirements are determined for each property by taking into account property specific risk and market risk.** The total value of the property portfolio is calculated as the sum of the individual properties' values, which are based on the cash flow method." (Citycon Oyj, 2014)

The key parameters of the (discounted) cash flow analysis are the following items (Citycon Oyj, 2014):

1. Market rents, which affect rental income in the cash flow analysis, are determined by market supply and demand. The external appraiser defines the market rents for each property.

2. The occupancy rate denotes the part of the leasable space (Gross Leasable Area, GLA) that is leased. The occupancy rate is determined by the lease agreements valid on the valuation date. Upon a lease's expiry, measuring the occupancy rate involves the management's assumptions. The occupancy rate affects the annual rental income.

3. Operating expenses comprise costs resulting from a property's management, maintenance, heating, electricity, water supply etc. Operating expenses are determined according to actual or budgeted operating expenses.

4. The yield requirement includes risk-free interest as well as property-specific risk and market risk. The property-specific risk is defined by Citycon and this definition involves the management's judgment and assumptions. Market risk is defined by an external appraiser. The yield requirement added by an inflation assumption is used as the discount rate in the cash flow analysis. When the yield requirement decreases, the fair value of the investment property increases.

5. The residual value at the end of the 10-year cash flow period is calculated by using the exit yield to capitalize the 11th year bottom level cash flow. The value of the property is calculated as the sum of the annually discounted net income stream, the discounted residual value at the end of the calculation period and any other assets increasing the value (e.g. unused usable building right).

An interview with Citycon's valuation analyst shed light on the methods how the elements of property specific risk and market risk are determined.

Citycon's required returns used in valuations are determined with the survey method and adjusted with the property-specific risk premium derived from in-house local knowledge by the external appraisal (Nordberg, 2014).

5.2 Valuation Uncertainty in Citycon

The certainty of Citycon's valuations is loosely scored according to the certainty of the valuation. Although ranked, all valuations are ranked according to the lowest level of certainty. This is mainly because there aren't many comparable sales for shopping centres and other assets owned by Citycon. Citycon uses valuation techniques that are appropriate under the circumstances, and for which sufficient data is available to measure fair value, maximizing the use of relevant observable inputs and minimizing the use of unobservable inputs. All investment properties are categorized within the fair value hierarchy, described below. Categorization is based on the lowest level input that is significant to the fair value measurement as a whole:

- Level 1 - Quoted (unadjusted) market prices in active markets for identical assets

- Level 2 - Valuation techniques for which the lowest level input that is significant to the fair value measurement is directly or indirectly observable

- Level 3 - Valuation techniques for which the lowest level input that is significant to the fair value measurement is unobservable

Transfers between levels in the hierarchy are presented at the end of each reporting period (Citycon Oyj, 2014).

5.3 Real Estate Investment Analysis Process in Citycon

Citycon's standard real estate investment analysis is similar to the theory already presented in the literature study. As assets in the size category of Shopping Centre Arabia acquired are usually financed using existing credits (as also in the case of Shopping Centre Arabia), the task of analyzing the finance structure is not included in the responsibilities of the investment team. Citycon also aims to hold the targets with a very long investment horizon and therefore the holding period is of low importance to the investment team when analyzing potential investment targets. Main task of the investment team is to answer to the questions (Oprea, 2010) (Halsti, 2014):

- Should the property be acquired?
- How risky is the investment?
- Will it work?

In the process of analyzing the potential acquisition target the following factors are taken into account (Bailey, 1984) (Halsti, 2014):

1. Physical attributes: the location, the functional fitness for the planned use, the age and physical condition of the property, need for capital expenditure and competitive position in the current marketplace.

2. External economic factors: economic base and demographic characteristics of the community the property is located in, inflation, present and future market competition, and trends of the local real estate market.

3. Internal economic factors: possibility and probability of increased revenue due to built-in lease terms, turnover of tenants, availability of and finance in place.

Additionally to the factors listed in the literature study, things that should be investigated in the analysis also include (Citycon Oyj, 2011):

- Development potential of the property, including unused building rights and suitability of the current structure for an extension or refurbishment.
- Value upside potential through asset management initiatives such as changing tenant or other issues discovered in an initial analysis or site visits.

The investment team preferably conducts the analysis of the investment target using internal resources. If required it can engage an external resource to assist with some part of the analysis (Halsti, 2014).

An important phase of the analysis is developing cash-flow schedules to find out the net present value of the property through discounted cash flow analysis or building a net operating income calculation to find out an estimate of the property worth through direct capitalization method (Halsti, 2014).

Discounted cash flow used in Citycon's property valuation is defined chapter 5.1 and direct capitalization is used as described in chapter 2.1.4.

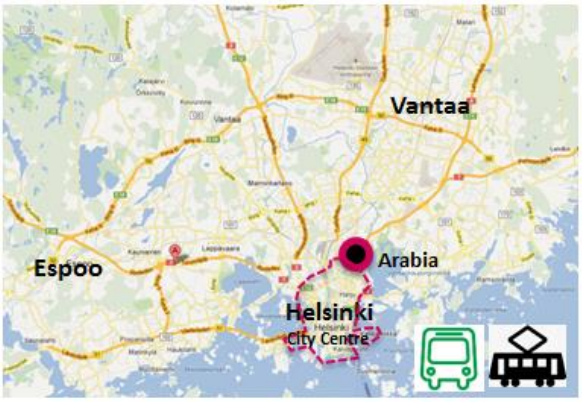
6 Case Study: Acquisition of Shopping Centre Arabia

6.1 Introduction of the Investment Target: Shopping Centre Arabia

In 2011 shopping centre Arabia could be introduced as follows: “Shopping Centre Arabia is a mid-sized local necessity shopping anchored shopping centre located approx. 4km North-East from Helsinki CBD” (Citycon Oyj, 2011).

Arabianranta is an urban residential and campus area, employing more than 6,000 people and offering educational facilities for nearly 13,000 students. In 2011 anchor tenants were two leading grocery store chains (K-Supermarket, Ruokakesko and S-Market, S-Group) and the national alcoholic beverage retailing monopoly (Alko). Arabia already had very good connections via public transport (bus & tram) and also by private car (highly visible intersection of two main artery roads and approx. 300 parking garage places). In 2011 there was also major residential construction underway in the area (Citycon Oyj, 2011).

Map of Helsinki



Aerial View of the centre

Property Information	
Location	Helsinki
Catchment area 5 min	20 000
Catchment area 10 min	102 000
Growth in catchment area (2011-2020)	13,1 %
Average disposable income (Helsinki)	€ 25 800 (€ 25 500)
Built/last renovated	1960s/2002
Unused building rights	2 382 sqm
Tenure	Leasehold
No of parking spaces	340

Key Figures	
GLA (Retail GLA)	14 000 (12 900)
NOI (2010)	€ 1,36 million
Potential NOI	€ 1,83 million
Retail sales (2010)	€ 50,9 million
Footfall p.a. (2010)	2,65 million
Occupancy rate (rents)	97%
Occupancy rate (area)	97%

Figure 12 Executive Summary of Shopping Centre Arabia

6.2 Investment Process: Shopping Centre Arabia

Shopping Centre Arabia was brought to the market in March 2011 as an advisor hired by the seller published an investment teaser of the property. The investment teaser was followed by an investment memorandum two weeks later. The bidding was to be carried out as a targeted closed auction. The acquisition possibility was offered in the form of the investment memorandum to a selected group of investors that had shown interest towards the acquisition after the investment teaser (Citycon Oyj, 2011).

The object of sale was mutual real estate company (MREC) KOy Helsingin Hämeentie 109-111 ('Asset'), which owns Shopping Centre Arabia ('Arabia'). Tapiola Group had owned the asset since the redevelopment in 2002 (Citycon Oyj, 2011).

Citycon entered the sales process with an initial bid in 20th April 2011 according to the time schedule of the sales process (Citycon Oyj, 2011).

After the first initial bid the divestment process was put on hold by the seller due to high vacancy and lease negotiations with an anchor tenant playing an important role in lease maturity and gross rental income of the asset (Halsti, 2014).

During the delay calculations were reviewed and a revised bid was offered to the seller 17th February 2012. The revised bid was approved by the seller and Citycon was granted with exclusivity to continue to a due diligence phase ('DD'). DD process was carried out during February-March 2012 and the sales and purchase agreement was signed 4th April 2012. (Halsti, 2014).

Although there was a great amount of analysis conducted during the acquisition process it is reasonable in this case study to concentrate in reviewing the calculations made to during the revisions of the indicative bids and the final DCP analysis during the DD phase and SPA negotiations.

6.2.1 Initial Analysis, Indicative Bid and Reviewed Indicative Bids

To enter the bidding process, Citycon ordered a simple study of the property from an advisor to be able to deliver an indicative bid to the seller. The study was by way of exception ordered as an external resource, as Citycon's investment team was undergoing a change and internal resources were insufficient to fulfill this task (The acquisition project team consisted of only an analyst and a lawyer) (Halsti, 2014).

This simple study covered the following features of the property (Citycon Oyj, 2011);

- Property: Overview of the property including information on gross leasable area, owner of the property, construction year, anchor tenants, number of shops etc.
- Floor Plan: Showing sizes of the shops and how the shops are located in the shopping centre.
- Location Analysis: Analysis of the surrounding area, accessibility to the centre (with private cars and by public transport) and analysis of competition in retail business in the respective area.

- Demographic Analysis of the Catchment Area: Population, number of jobs in the catchment area, household size, distribution of age groups in the area, education level of residents, purchasing power, percentage of sales focusing in the catchment area, distribution of use of building mass in the area.
- Consumer Behavior Analysis: type of transport used to visit the centre, type of services and products demanded by the customers in the area.
- SWOT Analysis: Listing strengths, weaknesses, opportunities and threats related to the investment target.
- Underlying Potential Analysis: List of things that might have potential by developing (e.g. extending lease agreements with experienced negotiation or improving the tenant mix by finding new better suitable tenants to fit the customer demand).
- Cash Flow Analysis: Cash flow calculations with three different scenarios and a view of possible bids made by competitors assumed to enter the bidding.

According to this study Citycon's investment team decided to start further analyze the asset to be able to submit an indicative bid. The project was introduced to Citycon in spring 2011, but the process was lengthened due to reasons relating to the owner. Final revised bid was accepted 17th February 2012 (Halsti, 2014).

During the process Citycon's investment team further analysed the information provided by the seller at intervals. These updates covered changes in the leasing situation (negotiation for new tenants or extensions with current tenants, terminated lease agreements etc.), verification of the OPEX figures and any other things discovered along the way (Halsti, 2014).

Assumptions	
Vacancy	1 %
Achor tenant rent ren	26,2
Cap rate	6,50 %

	Case 1	Case 2
	Anchor tenant rents renewed on current level	Anchor tenant renewed on higher level
Potential gross rents (rent roll)	2 930 000	2 930 000
Vacancy deduction	-30 000	-30 000
Kesko		*-10 000*
Effective gross rents	2 900 000	2 890 000
OPEX	-1 510 000	-1 510 000
Non-recoverables	-120 000	-120 000
NOI	1 270 000	1 260 000
Value	**19 540 000**	**19 380 000**

Figure 13 Direct Capitalization for the Indicative Bid

This further analysis included a direct capitalization calculation to come up with an indicative pricing proposal. The simple direct capitalization model is presented in Figure 13 (Halsti, 2014).

The model represents Citycon's investment team's view of the asset's pricing. Case 1 is Citycon's estimation of the price, which assumes a potential GRI of MEUR 2.93. The potential GRI is further deducted with the vacancy discovered when analyzing the rent roll (MEUR 0.03) to end up with effective GRI of MEUR 2.9. OPEX are estimated to be MEUR 1.5 and also that not all of the OPEX are assumed to be recoverable through maintenance rents paid by the tenants. This adds up to NOI of MEUR 1.28. The NOI is again capitalized with the expected rate of return 6.5% to reach the valuation of MEUR 19.7 (Halsti, 2014).

Case 2 is identical to Case 1 with the exception of the situation of the anchor tenant whose lease is assumed to be extended with amended gross rent (€ 26.2 / sqm when the original level was € 26.6€ / sqm), based on Citycon's long experience in operating as lessor for the company, leading to a deduction of gross rental income by MEUR 0.01. The effect of this deduction is reduction of the valuation of approx. MEUR 0.15 (Halsti, 2014).

The official indicative bid was composed according to this calculation leading to a proposed (non-binding) sales price of MEUR 19.5 conditional on renewal to the agreement of the fore-mentioned and exclusivity in the sales process and 6 weeks of time to conduct due diligence process. This bid was accepted by the seller and was followed by a due diligence phase that lasted approx. six weeks (Halsti, 2014).

6.2.2 Due Diligence, Revised Purchase Price and Sales & Purchase Agreement

During the due diligence process all physical, environmental and legal matters were investigated by the transaction team with the help of an external consultant. In addition to the physical and legal matters, the main focus of the investment team was in all the things that could affect the NOI figure and further the valuation of the asset (Halsti, 2014).

The things that were inspected in this respect were (Citycon Oyj, 2011):

- The land lease agreement with the City of Helsinki: The lease agreement will expire date and the form of the agreement.
- Acquisition of the land plot from City of Helsinki: It was stated that it is not financially feasible to acquire the land lot without developing more GLA.
- Contamination of the soil: According to the environmental DD report provided by the seller the land is contaminated. According to an expert opinion ordered by Citycon the cost of cleaning the contaminated soil would be approx. EUR 240 000 and would materialize when developing the plot.
- According to the lease agreement of another anchor tenant it has the right to determinate the agreement at any time during the lease period. This forms a risk for decreasing rental income or creating a vacant space in the asset.
- Leasing potential to be mobilized: income could be received from developing specialty leasing the shopping centre (e.g. virtual ads/promotion places, temporary sales booths in common areas, pop-up stores), free parking spaces could be converted into fee-based spaces and two potential new tenants could be drawn into the shopping centre through Citycon's strong leasing managers.

- Lease agreement structure: At the time most lease agreements obligated the landlord to pay for major repairs, real estate tax, administration and real estate insurance. These kinds of costs could be transferred as tenant's responsibility after the end of lease period.
- Unused building right: An extension would be costly to implement due to land contamination, but according to the seller's expert report more GLA could be created inside the shopping centre by building on the cargo platform.
- Tenant mix: Analyzed by measuring percentage of total leasable area covered, percentage of total gross leasable income produced, and occupancy cost ratio (the percentage of annual gross rent paid by a tenant compared to tenant's annual sales excluding valued added tax (expresses tenant's ability to pay rent)).
- OPEX: Arabia's historic figures were projected against comparable shopping centres owned by Citycon to find out whether there is saving potential or deficit in the operational cost components. OPEX levels were accepted.

According these DD findings the investment team composed a DCF model to verify the estimation of the purchase price earlier produced by the direct capitalization calculation for the indicative bid. DCF model provided the required comfort of the property value and eventually EUR 19 500 00 was agreed as the sales price of the property in the sales and purchase agreement (Halsti, 2014).

6.2.3 Discounted Cash Flow Used in the Analysis

Discounted cash flow model used in the transaction is based on the model used in Citycon's property valuation already described in chapter 5.1.

Rental income used in the DCF model is based on actual rents obtained from the lease agreements provided by the seller. After lease expiry the model assumes a void of three months for all spaces located in the 1st floor and a void of six months for the premises located in the 2nd floor. Also after lease expiry the model uses market rents determined by a workshop which the investment team organized together with Citycon's leasing managers. Leasing point of view was used to find out sustainable rental levels for the spaces (Halsti, 2014).

Arabia's historic OPEX figures were projected against comparable shopping centres owned by Citycon to verify that there are no abnormal figures among the component. This comparison is demonstrated in Figure 14. Major findings in this comparison: 1. Comparable insurance payment considerably lower in accordance with Citycon's comparable centres. 2. Based on Tax authorities' decision to revise the real estate tax, € 35 000 is the estimation for 2012 and € 40 000 is adjusted to tax correction in 2011. 3. The amount of commercial management has been estimated internally in accordance with comparable shopping centres. Additionally an extra € 30 000 was added to the cash flow calculation (this is not visible in the demonstration) (Citycon Oyj, 2011).

Expense item		2011 Act. (€)	CTY View (€)
Administration		33 000	30 000
Maintenance		309 415	315 000
Yard work		47 687	30 000
Cleaning		96 653	99 000
Heating		163 757	152 000
Water and waste water		25 143	25 000
Electricity		205 353	210 000
Waste maintenance		68 789	72 000
Insurance	1	40 516	15 000
Leasehold fee		411 060	415 000
Property tax	2	40 349	35 000
Repairs		74 820	115 000
Total Opex		**1 516 542**	**1 513 000**
Commercial mgmt	3		170 000

Figure 14 Operational Expenses Used in the DCF Model

Annual capital expenditure was estimated by an external specialist in a second opinion report about the technical condition of the building during the DD phase. Those annual figures were further compounded to correspond to the cash outflow of the respective year using the inflation assumption of 2%. In addition the model takes into account an extra € 300 000 of capital expenditure for a facelift estimated by Citycon to be used during the first year. The model also calculates implied yield on total investment. The implication of this figure is that it takes into account an estimated EUR 240 000 cleaning reservation due to the finding about contaminated soil (Citycon Oyj, 2011; Halsti, 2014).

	1	2	3	4	5	6	7	8	9	10
Annual CAPEX	10 000	140 000	128 000	63 000	149 000	240 000	85 000	170 000	250 000	550 000
Compunded CAPEX	10 000	153 000	141 000	92 000	201 000	322 000	116 000	245 000	340 000	745 000

Figure 15 Capital Expenditure Estimation Used in the DCF Model

To determine the yield requirement for this project, the view from the external consultant was reflected to Citycon's comparable centres and asset specific potential and risks were evaluated to arrive at 6.25%. In the initial direct capitalization analysis, the figure used for required rate of return was 6.5%, but this figure was amended as after analysing the DD findings there was a strong sentiment for increasing and securing the cash inflows by active asset management (leasing, specialty leasing, facelift etc.). Also direct capitalization does not take into account void periods etc. (Citycon Oyj, 2011).

Inflation expectation of 2% used in the calculation is based on 10 year historic average of customer price index (CPI). This figure is also used in the rental growth expectation as most of the lease agreements are annual indexed using the CPI. This is presented in Figure 16 (Trading Economics, 2014; Citycon Oyj, 2011).

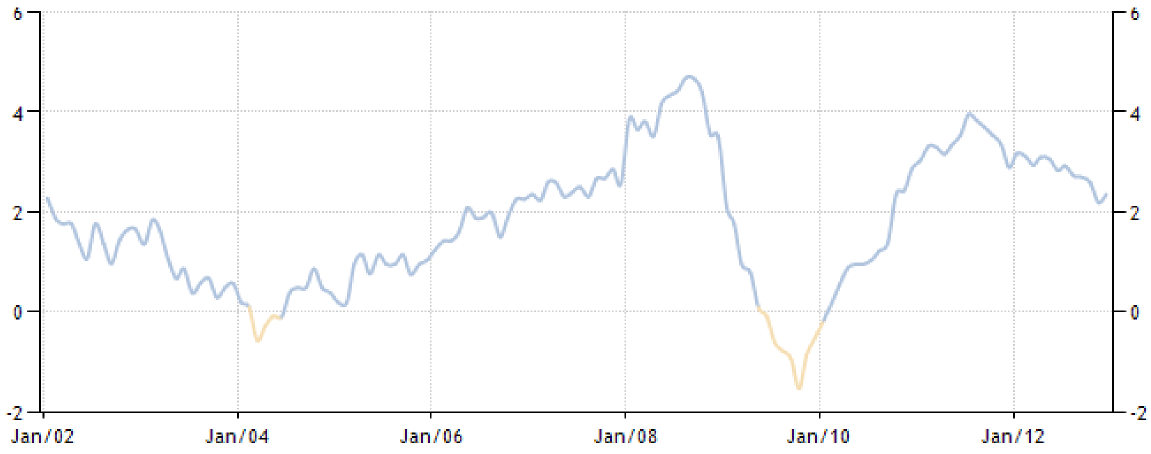


Figure 16 Historic Change of Customer Price Index in Finland

Vacancy rate is assumed to be 3% at the end of the holding period. This is an average technical vacancy of Citycon's shopping centres (Citycon Oyj, 2011).

The DCF calculates the free cash flows for each year then discounting the cash flows with the real discount rate (required rate of return + inflation). Residual value is calculated estimating the net operating income for year 11. This net operating income is capitalized using the required rate of return. This residual value is again discounted using the real discount rate to arrive at present value of the residual value. Market value of the asset is the sum discounted residual value and the present value of the cash flows. The calculation leads to a result that is above the estimated value of MEUR 19.5 and therefore the DCF calculation ratifies the initial analysis and the process was continued with the indicated pricing of EUR 19 500 000. Unused building right was not taken into account in the valuation. The DCF cash flow sheet is presented in Appendix 2 Discounted Cash Flow Used in the DD Phase (Citycon Oyj, 2011).

6.3 Revision of the Process Using MCS

After studying the acquisition process, the Monte Carlo simulation model is constructed using the information reviewed in the previous chapter. Using the support of reviewed literature the model is constructed as instructed by academics.

6.3.1 Sensitivity Analysis of the DCF Used in the Transaction Process

According to literature on the topic MCS modelling starts with a careful sensitivity analysis of the variables affecting the property value. All used inputs were tested using Microsoft Excel's integrated data table function with the exception to the variables not applicable to the function. Those non-applicable variables were tested manually in an exercise where input variables were manually changed and resultant net present values were stored to gather a sensitivity table similar to the ones created using the data table function. The findings of the sensitivity analyses are presented in Figure 17, Figure 18 and Figure 19.

The following variables were tested using the data table function:

- Yield requirement
- Inflation
- Residual vacancy
- Other income (including specialty leasing and parking income)

Variables analyzed manually:

- OPEX
- CAPEX
- Market Rents

Yield requirement was sensitized simply by testing how the calculated market value changes when given a lesser or greater input figure within 0.25% intervals. Change in yield requirement has a very significant change in the market value. When implying a probability distribution for the yield requirement, the changes should not be drastic and should be closely linked to the value used in the discount cash flow analysis although values between 6.0% and 6.5% should also be accepted as process was long considered feasible with 6.5%.

Residual vacancy rate has a linear effect on the market value, each halve percent consumes EUR 135 000 of the market value. Residual vacancy rate should be assumed to be at a stabile level of 3% (which is the average vacancy rate of Citycon's shopping (Citycon Oyj, 2011)), but an adjusted beta function could be used to fix the vacancy rate close to 3%, but allowing close to zero values or higher vacancies with very low probabilities.

Yield Requirement	Market Value
	19 769
5,00 %	24 893
5,25 %	23 670
5,50 %	22 559
5,75 %	21 547
6,00 %	20 620
6,25 %	**19 769**
6,50 %	18 985
6,75 %	18 260
7,00 %	17 588
7,25 %	16 963
7,50 %	16 381
7,75 %	15 837
8,00 %	15 328
8,25 %	14 851
8,50 %	14 402
8,75 %	13 980
9,00 %	13 582
9,25 %	13 206
9,50 %	12 850
9,75 %	12 513

Residual Vacancy	Market Value
	19 769
0,00 %	20 581
0,50 %	20 445
1,00 %	20 310
1,50 %	20 175
2,00 %	20 040
2,50 %	19 904
3,00 %	**19 769**
3,50 %	19 634
4,00 %	19 499
4,50 %	19 364
5,00 %	19 228
5,50 %	19 093
6,00 %	18 958
6,50 %	18 823
7,00 %	18 688
7,50 %	18 552
8,00 %	18 417
8,50 %	18 282
9,00 %	18 147
9,50 %	18 012

Figure 17 Sensitivity Analysis Results 1/3

According to the sensitivity analysis, rising inflation has a negative effect on the market value. Rental agreements and are also indexed using the CPI, although a negative inflation will decrease the rental income (Citycon Oyj, 2011). In the DCF model the growth expectation of operational expenses is also linked to inflation expectation.

10 year historic inflation has been very close to 2%. This is mainly due to the price stability policy dictated by the European Union (EU). Target level for inflation has been 2% since the beginning of EU, but during 2014 inflation has been below 1% in some parts of the Eurozone (Bank of Finland, 2014). Although there is some instability in the annual inflation figure, it should be assumed that inflation stays close to 2%, but some fluctuation should be allowed, as EU will require overall inflation to remain close to the target.

Other income also has a linear effect on the market value. Each 5% increase in other income increases the market value by EUR 27 000.

Inflation	Market Value
	19 769
1,55 %	20 419
1,60 %	20 345
1,65 %	20 272
1,70 %	20 199
1,75 %	20 127
1,80 %	20 055
1,85 %	19 983
1,90 %	19 911
1,95 %	19 840
2,00 %	**19 769**
2,05 %	19 699
2,10 %	19 629
2,15 %	19 559
2,20 %	19 489
2,25 %	19 420
2,30 %	19 351
2,35 %	19 282
2,40 %	19 214
2,45 %	19 146
2,50 %	19 079

Other Income	Market Value
	19 769
-25 %	19 743
-20 %	19 748
-15 %	19 753
-10 %	19 759
-5 %	19 764
+-0	19 769
5 %	19 775
10 %	19 780
15 %	19 785
20 %	19 791
25 %	19 796

Figure 18 Sensitivity Analysis Results 2/3

Market rents were tested by changing each market rent input value simultaneously at EUR 0.5 intervals. This exercise had a very significant impact on the market value, as each EUR 0.5 change in all market rents affect the market value by EUR 765 000. This is due to the large of amount of lease agreements with short lease maturity, which leads to market rents dictating majority of the rental income after expiry. When assigning the probability distribution all market rents should be allowed to moderately fluctuate around the estimated values. This is justified as estimating market rents is rarely very accurate given that future demand for certain spaces is not possible.

CAPEX was tested by changing the annual CAPEX estimated by the external specialist in 5% intervals, whereas OPEX was sensitized by changing the all the OPEX components of the first year simultaneously in 5% intervals. These alterations have a linear effect on both variables. 5% increase in annual CAPEX decreases the market value by EUR 61 000 and OPEX respectively by EUR 1 379 000. Market value changes caused by OPEX are very significant and should be carefully addressed in the MCS to reach plausible results with the simulation. Components should also be separately regarded, as there are major differences in probable outcomes for the components (e.g. annual insurance payments are fairly stable but yard work and heating can vary according to weather).

Market Rents	Market Value
-2€ / sqm	15 922
-1,5€ / sqm	16 687
-1€ / sqm	17 715
-0,5€ / sqm	18 742
+-0	**19 769**
+0,5€ / sqm	20 797
+1€ / sqm	21 824
+1,5€ / sqm	22 851
+2€ / sqm	23 879

CAPEX	Market Value
	19 769
-25,00 %	20 076
-20,00 %	20 015
-15,00 %	19 954
-10,00 %	19 892
-5,00 %	19 831
0,00 %	**19 769**
5,00 %	19 708
10,00 %	19 646
15,00 %	19 585
20,00 %	19 524
25,00 %	19 462

OPEX	Market Value
	19 769
-25,00 %	26 666
-20,00 %	25 287
-15,00 %	23 908
-10,00 %	22 528
-5,00 %	21 149
0,00 %	**19 769**
5,00 %	18 390
10,00 %	17 010
15,00 %	15 631
20,00 %	14 252
25,00 %	12 872

Figure 19 Sensitivity Analysis Results 3/3

6.3.2 Defining the Input Variables and Interrelations

As described by the literature study, defining input variables is the most demanding and time consuming part of building a MCS model. To define probability distributions for the input variables, original assumptions made in the initial DCF model and sensitivities must be analyzed to be able to understand how probable the inputs are and what should be their lower and upper limits. This process results in an estimation of probability distribution for each of the input variables.

As a basic probability distribution, normal distribution is chosen as it best describes the nature of the variables being located around a proposed mean and being uncertain according to some expected range (French & Gabrielli, 2004).

To begin with, it must first be explained which input figures must be examined and defined as state variables (defined as probability distributions) and which variables can be left as control variables (single input) as they are not subject to probability or defined by legislation or made stable otherwise.

As the current rental income used in the DCF model was bound by in-place rental agreement there is no uncertainty affecting gross rental income and therefore capital rents & maintenance rents can be held as control variables. Also the following OPEX components are regarded as control variables as they are bound by in-place agreements: administration, insurance, leasehold fee (agreement with City of Helsinki) and property tax (tax authorities' decision).

Other variables used in the calculation are state variables which will be assigned to generate a value according to a respective probability distribution as they are exposed to uncertainty.

Exit vacancy rate is defined to according to Citycon's comparable shopping centre's historic vacancy rates. The average historic vacancy is 2.41% and standard deviation 1.99%. Exit vacancy is therefore defined as a normal probability distribution according to these figures with the exception of negative values provided by the probability distribution which will not be accepted as inputs (in those occurrences exit vacancy is 0). The comparable shopping centre (urban local, grocery anchored shopping centres with good transport connections) vacancy rates are presented in Figure 20. Frequency distribution of 10 000 tests with these assumptions is presented in Figure 21.

	2009	2010	2011	2012	2013	2014
Iso Omena	1,40 %	0,70 %	0,20 %	0,20 %	0,50 %	0,50 %
Lippulaiva	0,20 %	0,30 %	2,80 %	1,00 %	3,40 %	0,40 %
Koskikeskus	3,60 %	3,20 %	0,00 %	0,00 %	5,10 %	5,40 %
Duo	5,80 %	5,70 %	2,10 %	0,90 %	3,40 %	2,30 %
IsoKarhu	5,80 %	1,10 %	1,80 %	0,60 %	0,50 %	1,10 %
Martinlaakso	1,45 %	1,45 %	1,50 %	3,20 %	0,00 %	1,10 %
Tikkuri	5,50 %	5,40 %	4,30 %	2,30 %	2,30 %	6,60 %
Myyrmanni	3,00 %	6,50 %	5,30 %	3,60 %	4,10 %	4,20 %
Columbus	0,40 %	0,40 %	0,40 %	2,50 %	0,90 %	3,60 %

Figure 20 Historic Vacancy Rate in Citycon's Comparable Centres

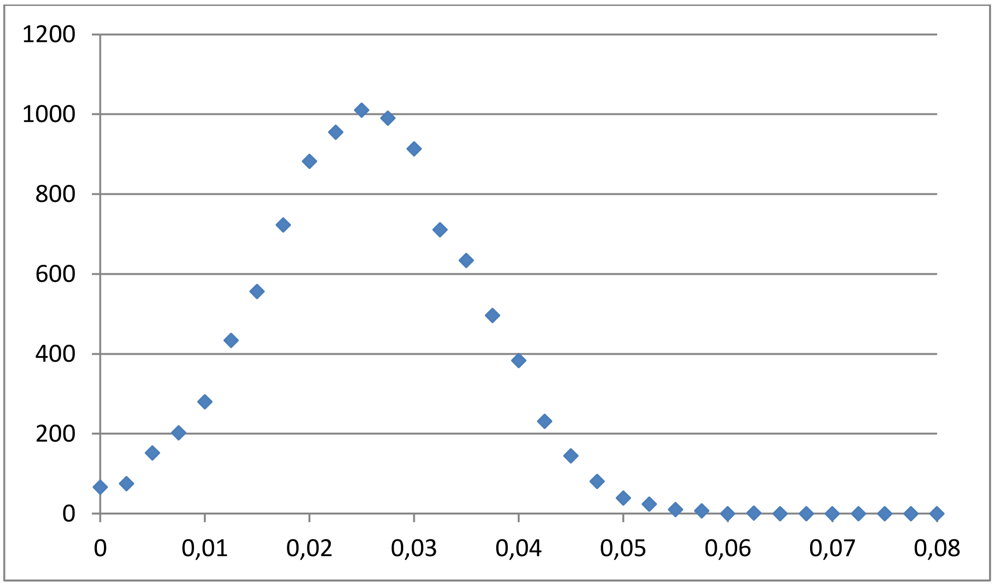


Figure 21 Exit Vacancy Probability Distribution

For OPEX items different probability distributions have been utilized to reflect the various degrees of uncertainty associated with different components. OPEX components are defined as presented next:

- Cleaning, Water and waste water, electricity and gas, waste management and commercial management are defined as a normal distribution with the mean of the estimated cost of the cost component and a standard deviation of 5% of the cost divided by 3 (3 standard deviations account for 99.7% of the total frequency of all events in a normal probably distribution (French & Gabrielli, 2004)).
- Maintenance, repairs, heating are respectively estimated to being subject to more uncertainty and are defined to have a normal probability distribution with the mean of the estimated cost and a standard deviation of 10% of the cost divided by 3. Maintenance and repairs are hard to anticipate and heating costs can be fluctuated

according to the weather which is not a constant in Finland. An example of the frequency distribution of a normal distribution with the mean of the estimated costs of EUR 115 000 for repairs and standard deviation of 10% divided by 3 is presented in Figure 22.

- Yard work again has a normal distribution with the estimated cost as a mean and 25% of the estimated costs divided by 3 as standard deviation as Finland's winters can really affect yard work costs.

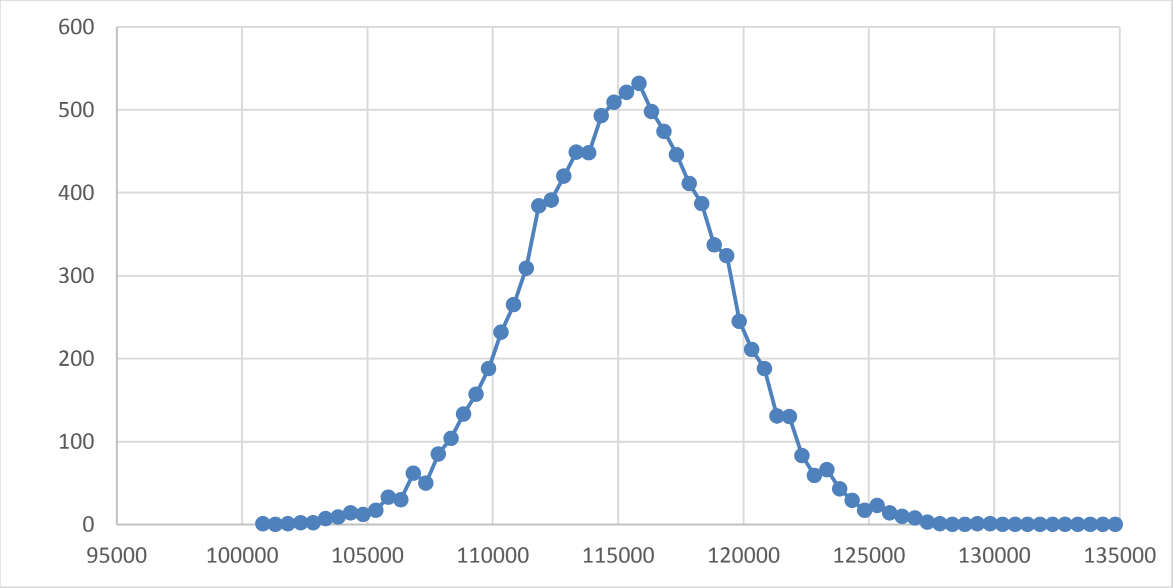


Figure 22 Mean of Estimated Costs (EUR 115 000) and 10 % Standard Deviation of the Estimated Costs

Similarly the estimated annual CAPEX figures are given normal probability distributions with the estimated annual costs as means and 10% of the costs divided by 3 as standard deviations to fluctuate the values +-10% from the estimated costs. The frequency distribution of the values looks identical to the example of the repairs costs presented in Figure 22.

Also other income is similarly defined to have a normal distribution with the mean of the estimated value and standard deviation of 10% divided by 3.

Input for yield requirement is defined as a probability distribution with a mean of 6.25% and a standard deviation of 0.5% divided by 3. This results in yield requirement figures varying from 6% to 6.5% with a 99.7% probability with 6.25% being the likeliest input figure. These numbers are supported by the results of the initial analysis, DD phase analysis and the sensitivity analysis. The frequency chart of this probability distribution is presented in Figure 23.

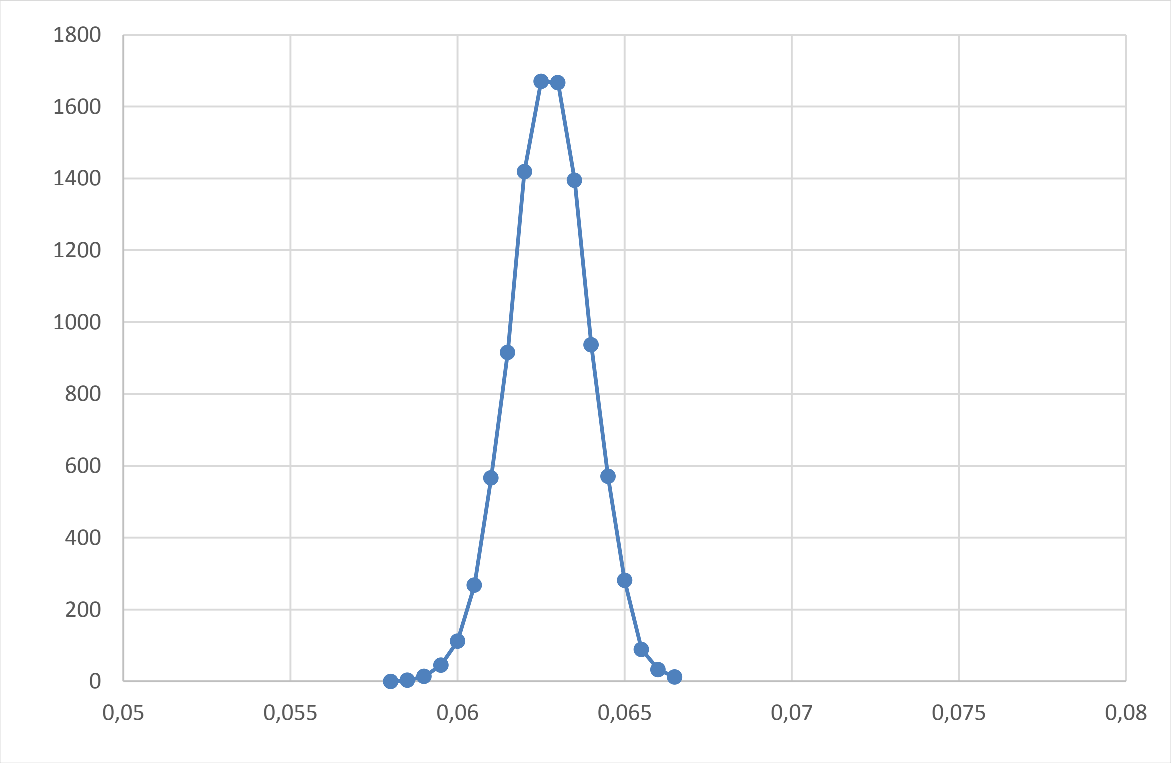


Figure 23 Frequency Distribution of Inputs for Yield Requirement

According to the sensitivity analysis, market rents had the strongest impact on the market values. This is due to short average lease maturity meaning that there will many leases expiring in the beginning of the assumed holding period thus potential rental income being a function of the market rents. Therefore a lot of emphasis in the analysis has been given to define the input probability distribution for the market rents. The problem with the current markets rents is that they have estimated according to the current demand for spaces in shopping centre Arabia or comparable shopping centres, although the values required for a proper analysis should be reflected to the future demand for such spaces. This is of course difficult but it could be assumed that with active management (leasing, specialty leasing, facelift etc.) the centre should start to function more efficiently, yield stronger footfall and thus be strengthened as market place resulting in increased demand for space and higher market rents. This theory is also supported by the development of the area providing more population and disposable income in the primary catchment area. In the future market rents can of course decrease if retailing faces difficulties e.g. due to general economic conditions.

To take the issues discussed in the last paragraph into account, market rents are defined to have a mean of the estimated market rent and standard deviation of EUR 2 divided by 3 to yield in input figures between +- EUR 2 of the estimated input market rents. A frequency chart presenting an example of a market rent of Alko (Finnish alcohol retail monopoly) space with market rent of EUR 23.28 is presented in Figure 24.

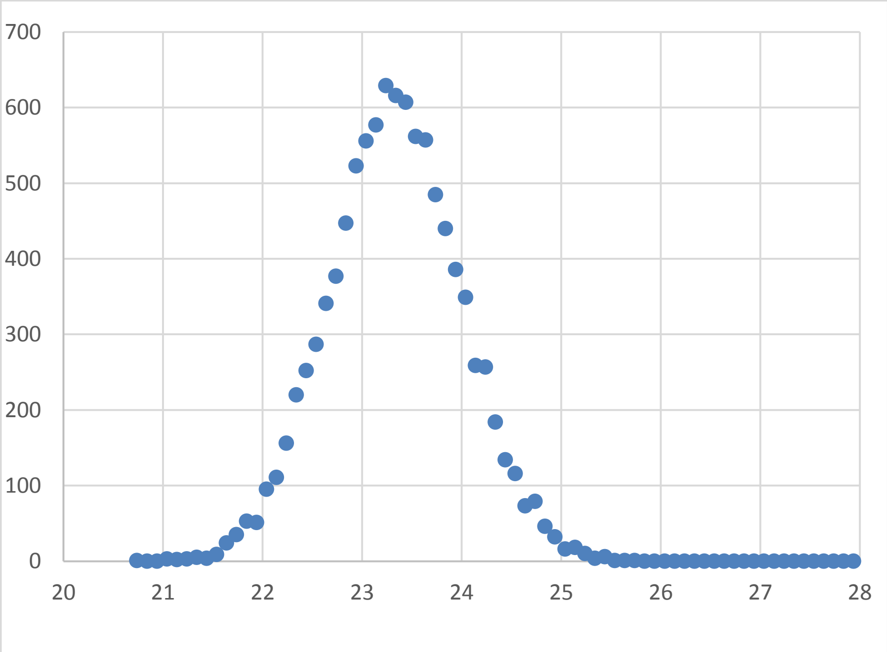


Figure 24 Frequency Distribution of Market Rent Input for Alko Space (EUR 23.28)

An important factor also affecting the rental income is the assumed void period after lease expiry. To simulate uncertainty pertaining to the time a space is left vacant after lease expiry the void periods follow normal distribution with the mean of the estimated void period, standard deviation of 4 divided by 3 for the spaces in the 1st floor (to yield with input figures from 1 to 5) and standard deviation of 6 divided by 3 for other spaces. These inputs are also corrected by subtracting one month from the resulting figures to take increasing demand for space into account.

To define inflation, unlike other variables, beta probability distribution is used. This is because inflation should be close to 2 percent in most cases, but should also be allowed to increase up to six percent (which was the maximum of the 1990’s (Statistics Finland, 2014)) and decrease down to 0.5% (all time low since 1971 (Statistics Finland, 2014)) with a very low probability. Therefore a beta function with an alpha of 2, beta of 5, lower limit of 0.05 and upper limit of 0.8 is used. The resulting figures are further divided by 10 to reach the right order of magnitude. The resulting frequency distribution is showed in Figure 25.

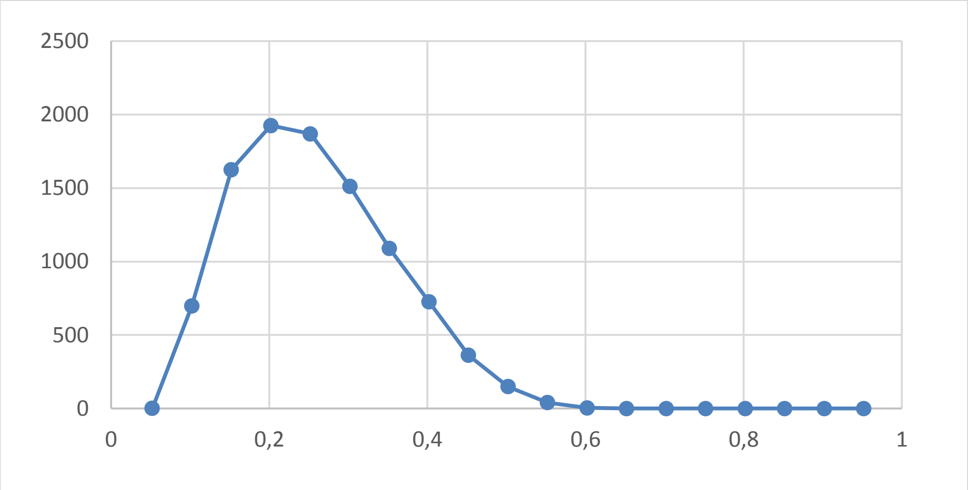


Figure 25 Frequency Distribution of Inflation Assumption Input

6.3.3 Simulation of the Outputs Using MCS

The MCS model used in this thesis is built into the original DCF model in Microsoft Excel. Single point input figures are replaced with a combination of Microsoft Excel's integrated inverse probability functions with the predetermined means and standard deviations and random probability. The Excel model has four worksheets where input data is defined:

- Assumption input: In the work sheet exit vacancy and inflation are defined as described in the previous chapter. The single value input for exit vacancy is replaced with the inverse probability function. Inflation, growth of rental income and OPEX all have an input slot for each year. The inverse probability function is inserted for inflation for each year. The growth expectations are then ordered to follow this randomly created inflation expectation for the respective year. This way the obvious connection between rental income growth and inflation (rental agreements are annually indexed with the CPI) is taken into account in the model. The cash flow calculation providing results then uses the average of the randomly generated inflation figures in the residual value calculation and discounting.
- Rent roll: In rent roll worksheet market rent and void inputs replace the single input figures with the inverse probability functions as described in chapter 6.3.2.
- OPEX + CAPEX: Single value input figures are replaced for the OPEX components. After the first year the OPEX components start to follow the value randomized for the first year. Single input figures for annul CAPEX are replaced with the inverse probability functions.
- Other Income: Other income components are defined as inverse probability functions.

The cash flow calculation sheet provides the net present value or the market value. Simulation worksheet has a data table which collects the results of the 10 000 calculations. It also has a frequency data table which calculates the occurrences between EUR 100 000 intervals. With this information the results can be analyzed to calculate probabilities for certain market value intervals, measure skewness and kurtosis etc. The worksheet also provides a frequency chart of the occurrences. This chart if presented in

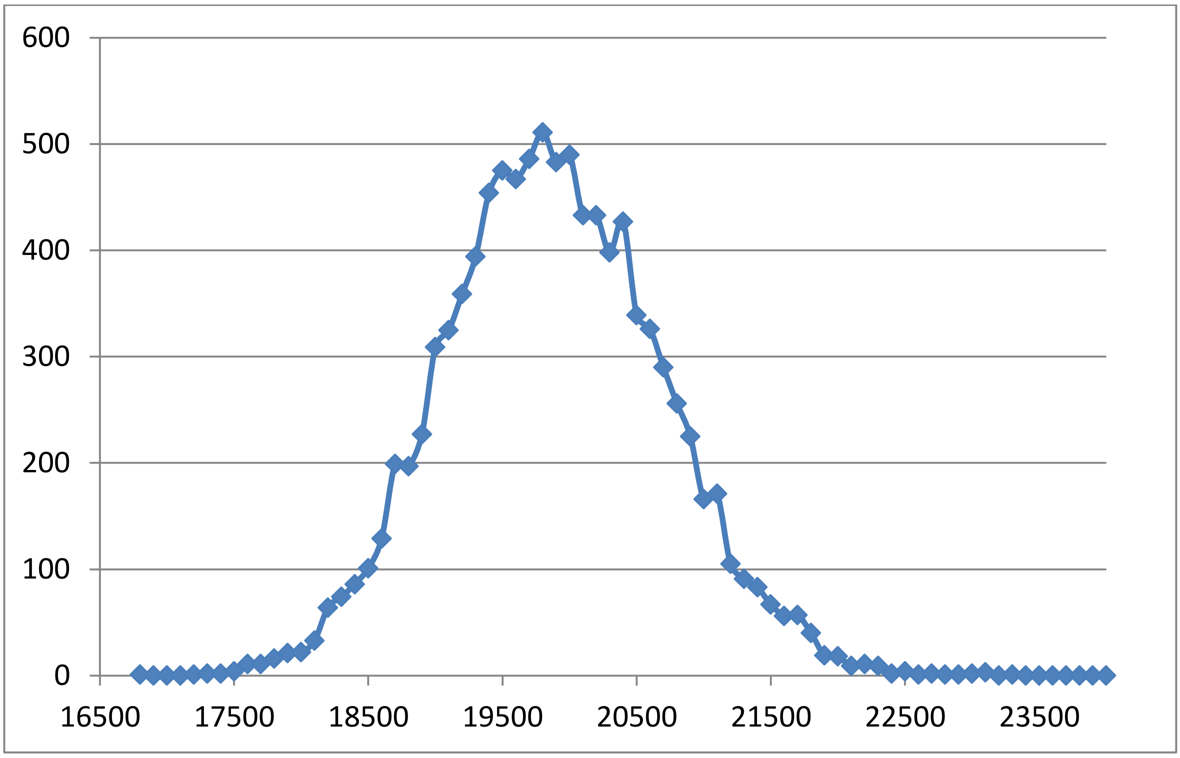


Figure 26 Frequency Distribution of the Resulting Market Values

Previously in this thesis historic time requirements for MCS were listed to describe the technological progress that has made MCS more easily conducted. Although computers have advanced, use of hardware that is not designed for making simulations or wrong design of the simulation model may cause the simulation to last very long time. For example the model used in this simulation would require some two hours to complete the 10 000 repetitions of the calculation when performed on a laptop computer before a clean-up of the model. The clean-up included the removal of all unnecessary work sheets of the excel file and simplification of the calculation formulas. After the clean-up, the simulation required approx. 30 seconds with an Intel Xeon 3.30GHz processor with 16GB of RAM memory. Therefore it must be emphasized that the simulations should not be done with any computer in the office but to select the strongest device to handle the multitude of required calculations.

6.3.4 Analyzing the Results

The simulation provides market values between MEUR 17.0 – 23.3. The average for the market values is MEUR 19.824, median MEUR 19.808 and standard deviation MEUR 0.808. The results have skewness of 0.14 and kurtosis of 0.06. The positive skewness means that the mass of the property values are mildly concentrated on the left side of the mean and the values have a tail on the right side of the mean. Positive kurtosis of the market values means that the frequency distribution is a bit peaked compared to a normal distribution. The frequency chart of all the market values is presented in Appendix 3 Results of the MCS Simulation

According to the frequency calculations the market values will be between MEUR 18.3 – 21.4 with 95% probability. Probability for loss (market value being below discussed pricing) is 30.5%. Probability for a loss over EUR 500 000 is 22.5 % and probability for a loss over MEUR 1 is 7.6%.

Respectively the probability of profit is 50.4%, probability for a profit over EUR 500 000 is 27.5% and probability of a profit over MEUR 1 is 11.5%.

When assuming that the most probable market value for the asset is MEUR 19.8, the probability for the market value to be found in interval of MEUR 19.7 to 19.9 is 15%, whereas the value being under MEUR 19.7 is 39.8% and above 19.9 is 50.4%. Therefore it can be said that the property has more upside than downside potential, although the market values have a positive skew.

Statistical Summary	
TRIALS	10 000
MIN	17 084
MAX	23 312
AVERAGE	19 824
MEDIAN	19 808
STD DEV	806
SKEWNESS	0,14
KURTOSIS	0,06

Figure 27 Statistical Summary of the Results

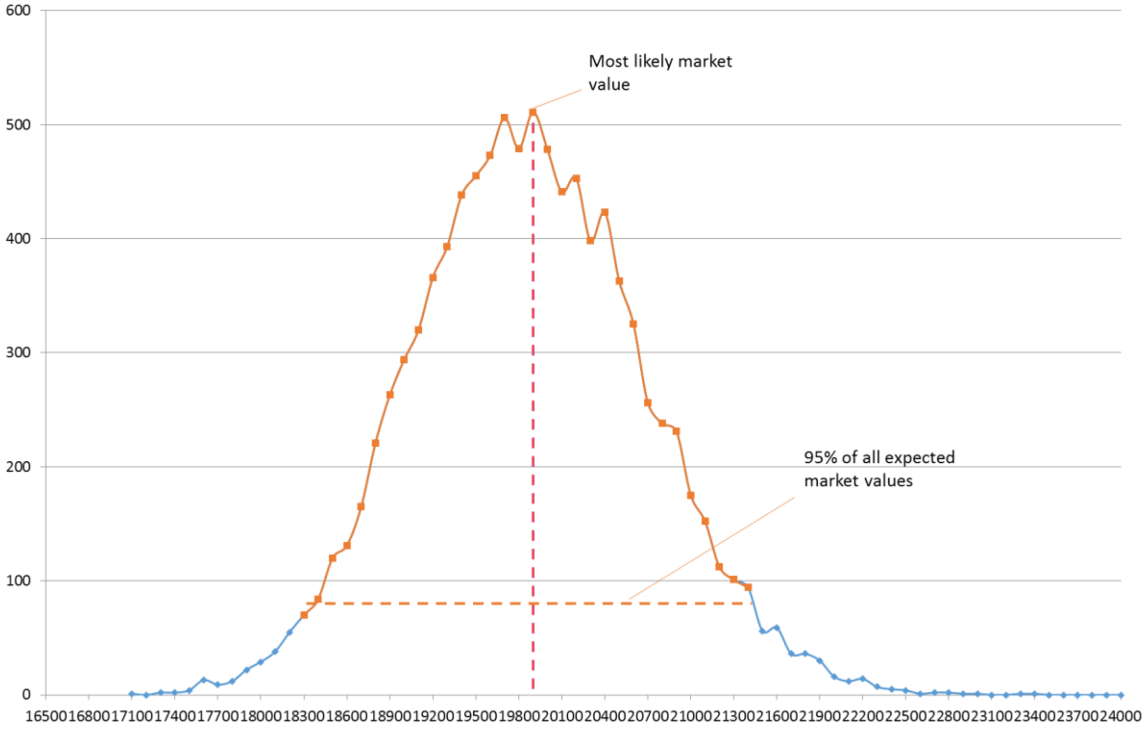


Figure 28 Analysing Results of the MCS Simulation

6.3.5 Comparison of Results: Original Investment Process and MCS

The results of the MCS support the findings of the DCF analysis made during the process of the acquisition. If the process would have been stalled due to price negotiations the MCS simulation suggests that the bid could have been raised up to MEUR 19.8.

When taken into account the probable transaction price of MEUR 19.5, the possibility for a potential profit increases according to the frequency calculations as follows:

The probability of profit is 64.5%, probability for a profit over EUR 500 000 is 40.5% and probability of a profit over MEUR 1 is 19.7%.

6.4 Proposed Actions According to the Results

MCS should be modelled as an addition to the current models used in Citycon’s investment analysis. The Analysis process requires a precise execution of the sensitivity analysis which usually exposes the main risk related to an investment process. For example the sensitivity analysis conducted for this simulation exposed the importance of the estimations for market rents for the market value of the asset. With a further analysis the reason for this was found out as well.

During the research it was noticed that it is fairly easy to convert any DCF calculation into a MCS model by using Microsoft Excel’s (which is widely used in the industry) inverse normal distribution & data table functions, whereas in the academia most of the practitioners have promoted the usage of some statistics package. Due to the ease of usage MCS analysis is recommended to be conducted related to investment analysis processes which are without exception subject to uncertainty.

MCS simulation can bring forward issues related to the investment target that could pass unnoticed in a traditional real estate investment analysis.

During the MCS process the analyst making assumptions should bring together a team including operational management, leasing management, technical management and legal specialist in order to utilize all the potential within an organization to reach the most suitable assumptions for the input figures used in a simulation.

PART IV: Summary of the research

7 Research Results and Conclusions

First this chapter presents the findings and conclusions of the study. After this the chapter explains reliability, validity and limitations of the study and suggests potential for further research.

7.1 Research Results

"Discounted cash flow is an income valuation approach where a discount rate is applied to a series of cash flows for future periods to discount them to a present value" (IVSC, 2011). It solves problems related to the simplistic nature of a direct capitalization calculation taking into account more items relating to the property value (French & Gabrielli, 2004; Kishore, 1996).

The main disadvantage of using only DCF calculation to assess a real estate investment target is that DCF does not take into account the uncertainty that the input variables are subject to (Hoesli;Jani;& Bender, 2006; French & Gabrielli, 2004; Kelliher & Mahoney, 2000; Martin, 1991).

In the empiric study it was recognized that a MCS model can support an initial analysis based on direct capitalization calculation and DCF calculation. MCS model provides numerical data about the uncertainty of the market value calculation results of a standard DCF calculation and therefore measures the level of comfort that the analyst has towards the DCF calculation.

In the research any observations about MCS supporting especially retail real estate investments were not possible to make because there were no comparable asset types included in the study.

Due to the ease of usage MCS analysis is recommended to be conducted related to investment analysis processes which are subject to uncertainty.

The strength of the probabilistic simulation model is that it requires the decision maker to bring together experts (engineers, economists, lawyers etc.) of different fields to provide information on essential issues affecting the investment process to reach the most accurate estimation of the property value (Pyhrr, 1973).

7.2 Validity, Reliability and Limitations of the Research

7.2.1 Validity

The empirical study consists of two interviews conducted during fall 2014 and a careful analysis of the material used by Citycon in 2011-2012 when acquiring Shopping Centre Arabia.

The validity of the model built for the empirical study is based on accurately following the theoretical guidelines set by the literature study and basing assumptions in the simulation on actual findings in the analysis of the material used in 2011-2012.

7.2.2 Reliability

The main limitation of the research is the fact that the research is based on only one asset. Therefore it is uncertain whether the findings of this thesis are relevant if projected to another project in the future (one objective being to find out whether Monte Carlo analysis can be used in the future to enhance decision making when analyzing a potential retail real estate investment target).

Also correlations between the input variables were not used in the simulation as relevant data was not available to be used in the research.

7.3 Future Research Possibilities

Citycon could assign its analysts to internally research its database to calculate correlations between cash flow calculation inputs to be used in MCS in the future to enhance the simulation process and to receive more reliable results.

The potential underlying within unused building rights should be assessed in real estate investment analysis processes. This could be done by utilizing real option thinking in addition to the traditional DCF calculation and MCS analysis.

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Table of Figures

Appendix 1 Material Used When Analysing Shopping Centre Arabia

- Investment Memorandum April 2011
- Indicative offers 15.4.2011-17.2.2012
- Sales & Purchase Agreement (including attachments) 4.4.2012
- Presentations:
    - Findings of the Initial Analysis April 2011
    - Overview February 2012
    - Overview March 2012
    - Due Diligence Findings March 2012
    - Investment Proposal March 2012
- Calculations:
    - OPEX March 2012
    - Direct Capitalization December 2011
    - Cash Flow March 2013
- Rent Roll

Appendix 2 Discounted Cash Flow Used in the DD Phase

Shopping Centre Arabia DCF, kEUR	Current agreements	1. year	2. year	3. year	4. year	5. year	6. year	7. year	8. year	9. year	10. year	Next 12 months
Rental growth assumption	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %
POTENTIAL GROSS RENTAL INCOME	2 778	3 047	3 101	3 154	3 217	3 280	3 346	3 420	3 496	3 566	3 640	3 734
Vacancy rate %		10,4 %	3,3 %	3,2 %	0,6 %	1,8 %	0,2 %	1,6 %	1,0 %	0,1 %	5,1 %	3,0 %
EFFECTIVE GROSS RENTAL INCOME	2 778	2 728	2 996	3 052	3 197	3 220	3 338	3 367	3 460	3 561	3 452	3 622
Specialty leasing income		50	51	52	53	54	55	56	57	59	60	61
Parking income		54	55	56	57	58	60	61	62	63	65	66
Utility charge income		7	7	7	7	8	8	8	8	8	8	9
Other income		**111**	**113**	**115**	**118**	**120**	**123**	**125**	**128**	**130**	**133**	**135**
Estimated gross rental growth %	2,0 %	-1,8 %	9,8 %	1,9 %	4,8 %	0,7 %	3,7 %	0,8 %	2,8 %	2,9 %	-3,1 %	4,9 %
Operating Costs	1 683	1 713	1 717	1 751	1 786	1 822	1 858	1 895	1 933	1 972	2 011	2 075
Estimated expense growth %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	2,0 %	3,2 %
NET OPERATING INCOME	1 095	1 126	1 393	1 416	1 529	1 518	1 603	1 596	1 655	1 719	1 574	1 682
Implied yield (on total investment)		5,7 %	7,1 %	7,2 %	7,7 %	7,7 %	8,1 %	8,1 %	8,4 %	8,7 %	8,0 %	
TI's	0	68	70	71	73	74	75	77	79	80	82	84
Investments	0	310	146	136	68	165	270	98	199	299	670	0
CASH FLOW	1 095	748	1 178	1 209	1 388	1 280	1 257	1 422	1 377	1 341	822	1 598
CASH FLOW, PRESENT VALUE		**719**	**1 046**	**992**	**1 052**	**896**	**813**	**849**	**760**	**683**	**387**	

RESIDUAL VALUE CALCULATION	
Net operation income in the end of period (yr 11)	1 598
Capitalization rate for the residual value	6,25 %
Present value of the residual value	**11 573**

MARKET VALUE	
Present value of the cash flow	**8 196**
Present value of the residual value	**11 573**
VALUATION	**19 769**

Appendix 3 Results of the MCS Simulation

BINS	Market Value	Frequency	Prob. of Frequency
17083,6	17100	1	0,0 %
17183,6	17200	0	0,0 %
17283,6	17300	2	0,0 %
17383,6	17400	2	0,0 %
17483,6	17500	4	0,0 %
17583,6	17600	13	0,1 %
17683,6	17700	9	0,1 %
17783,6	17800	12	0,1 %
17883,6	17900	22	0,2 %
17983,6	18000	29	0,3 %
18083,6	18100	38	0,4 %
18183,6	18200	55	0,6 %
18283,6	18300	70	0,7 %
18383,6	18400	84	0,8 %
18483,6	18500	120	1,2 %
18583,6	18600	131	1,3 %
18683,6	18700	165	1,7 %
18783,6	18800	221	2,2 %
18883,6	18900	263	2,6 %
18983,6	19000	294	2,9 %
19083,6	19100	320	3,2 %
19183,6	19200	366	3,7 %
19283,6	19300	393	3,9 %
19383,6	19400	438	4,4 %
19483,6	19500	455	4,6 %
19583,6	19600	473	4,7 %
19683,6	19700	506	5,1 %
19783,6	**19800**	**479**	**4,8 %**
19883,6	19900	511	5,1 %
19983,6	20000	478	4,8 %
20083,6	20100	441	4,4 %
20183,6	20200	453	4,5 %
20283,6	20300	398	4,0 %
20383,6	20400	423	4,2 %
20483,6	20500	363	3,6 %
20583,6	20600	325	3,3 %
20683,6	20700	256	2,6 %
20783,6	20800	238	2,4 %
20883,6	20900	231	2,3 %
20983,6	21000	175	1,8 %
21083,6	21100	152	1,5 %
21183,6	21200	112	1,1 %
21283,6	21300	101	1,0 %
21383,6	21400	94	0,9 %
21483,6	21500	56	0,6 %
21583,6	21600	59	0,6 %
21683,6	21700	36	0,4 %
21783,6	21800	36	0,4 %
21883,6	21900	30	0,3 %
21983,6	22000	16	0,2 %
22083,6	22100	12	0,1 %
22183,6	22200	14	0,1 %
22283,6	22300	7	0,1 %
22383,6	22400	5	0,1 %
22483,6	22500	4	0,0 %
22583,6	22600	1	0,0 %
22683,6	22700	2	0,0 %
22783,6	22800	2	0,0 %
22883,6	22900	1	0,0 %
22983,6	23000	1	0,0 %
23083,6	23100	0	0,0 %
23183,6	23200	0	0,0 %
23283,6	23300	1	0,0 %
23383,6	23400	1	0,0 %

Appendix 4 Press Release: Citycon Acquired Shopping Centre Arabia in Helsinki

CITYCON OYJ Stock Exchange Release 4 April 2012 at 13:25 hrs

Citycon has today acquired the shopping centre Arabia in Helsinki, Finland, for EUR 19.5 million from Tapiola Group. Shopping centre Arabia is located in the fringe of Helsinki's city centre, some four kilometres North-East on a lot owned by the City of Helsinki. The shopping centre has a gross leasable area of approximately 14,000 square metres, with 11,400 square metres of retail premises. The net initial yield on the acquisition price is around 6 per cent but it is expected to grow rapidly to 7 per cent after planned commercial development actions.

Arabianranta is former industrial area that has been converted into an urban residential and campus area during past decades. Round 13,000 inhabitants live in the Arabianranta area and thousands of homes have been built there during the last 10 years and further homes are under construction. Rich in cultural history and modern community living the Arabianranta area at the moment employs 6,000 people and offers 13,000 students a place to study. It is a part of Helsinki's tram and bus network.

"The excellent location of the centre with good public transportation connections and its situation among a demographically strong, urban living, working and studying environment brings growth potential in daily footfall. Our aim is to reach this potential with active development: we will both increase and diversify the offering of the centre. The centre fits Citycon's strategy like a glove: we invest in shopping centres located in growing city centres," says Michael Schönach, Head of Citycon's Finnish Operations.

Arabia Shopping Centre in Figures

Gross leasable area, sq.m.	approx. 14,000	
Retail premises, sq.m.	approx. 11,400	
Other, sq.m.	approx. 2,600	
Number of shops		31
Built/redeveloped in	Built 1960 Redeveloped 2002	
Sales, EUR million, 2011		48.2
No. of parking spaces	326 heated spaces	
Anchor tenants	K-Supermarket, S-Market, Tarjoustalo, Alko, Chico's, pharmacy	
Economic occupancy rate, %		93

Citycon financed the acquisition from its existing credit facilities. The acquisition will increase rental income and improve the profitability of Citycon's Finnish operations. It is also expected to be earnings per share accretive.

Following the acquisition, Citycon owns 36 shopping centres and 41 other retail properties in Finland, Sweden, Estonia and Lithuania. In addition, the company manages and leases two shopping centres without owning them. In Finland, Citycon owns a total of 23 shopping centres after the acquisition.

Helsinki, 4 April 2012