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Property Assets Fair Value Accounting Under Uncertainty

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Abstract:

Accounting fairness refers mostly to the fair presentation, and therefore, measurement or valuation of an element recognized in the entity's financial statements. In accounting and finance, fair value is a rational and unbiased estimate of the potential market price of a good, service, or asset. Applying different accounting and valuation methods across firms or countries makes financial statements incomparable to each other. The research objects of the paper are: a literature view of IFRS[2] and US GAAP[3] principles and accounting standards for fixed assets; a critical perspective of the used accounting frameworks, providing comparison for each framework and each portfolio; the incorporation of uncertainty into the WLC[4] methodology for the valuation and management of real property assets. The methodology of WLC with the NPV[5] technique of a property asset, are used. These methods are incorporated into a decision-making mathematical model using the PERT [6] probability distribution function for the input variables. The model is applied to a typical property asset (an office building as a part of a company's fixed assets portfolio) in order to explore the significance of impacts from changes in structured variables by using the Monte Carlo Simulation. After the above procedure a unique fair value accounting model is founded on the dynamic integration of WLC fundamental concepts and the widely used appraisal measures for property assets with quantitative risk analysis to address the endemic in the property assets uncertainty.

Key Words: *Fair Value Accounting, Valuation, WLC, PERT, Monte Carlo Simulation, Real Property*

JEL Classification *: M41, C15, C63, R33*

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1. Introduction

According to microeconomics, property is defined as a good able to provide a constant flow of services, such as housing services or a source of cash inflow. Assets are consumer durable goods held either by households for housing needs, or by firms in order to install their business activities necessary to operate. As goods traded in the market, asset prices are defined through the law of demand and supply. In markets under equilibrium current values must reflect the assets' present values taking into account the time value of money. Any variation from the valuation under present values leaves space for moving from the equilibrium spot and the movement will continue till all current values reflect present values. Economics recognize the financial return of the asset by consumption or sale as a capital gain arising from the increase of the value of the asset. By establishing variable accounting treatments for assets, assets have developed into a prosperous investment tool for companies in order to obtain economic benefits, not only through consumption (own use) or sale, but also through investing.

In accounting and finance, fair value is a rational and unbiased estimate of the potential market price of a good, service, or asset. It takes into account such objective factors as: acquisition/production/distribution costs, replacement costs, or costs of close substitutes; actual utility at a given level of development of social productive capability; supply vs. demand; and subjective factors such as risk characteristics; cost of and return on capital; individually perceived utility. In accounting, fair value is used as a certainty of the market value of an asset (or liability) for which a market price cannot be determined (usually because there is no established market for the asset). Under US GAAP (FAS 157), fair value is the amount at which the asset could be bought or sold in a current transaction between willing parties, or transferred to an equivalent party, other than in a liquidation sale.

The latest edition of International Valuation Standards (IVS 2007), clearly distinguishes between fair value, as defined in the IFRS, and market value, as defined in the IVS: So as the term is generally used, Fair Value can be clearly distinguished from Market Value. It requires the assessment of the price that is fair between two specific parties taking into account the respective advantages or disadvantages that each will gain from the transaction. Although Market Value may meet these criteria, this is not necessarily always the case. Fair Value is frequently used when undertaking due diligence in corporate transactions, where particular synergies between the two parties may mean that the price that is fair between them is higher than the price that might be obtainable on the wider market. On other words Special Value may be generated. Market Value requires this element of Special Value to be disregarded, but it forms part of the assessment of Fair Value.

Accounting fairness refers mostly to the fair presentation – and therefore, measurement or valuation – of an element recognized in the entity's financial statements. According to the Generally Accepted Accounting Principles across the countries, two basic asset valuation methods exist: the accounting of fair value and the accounting of historical cost. *Fair value* is used as a certainty of the market value of an asset for which a market price cannot be determined usually because there is no established market for the asset. Under US GAAP (FAS 157), fair value is the amount at which the asset could be bought or sold in a current transaction between willing parties, or transferred to an equivalent party, other than in a liquidation sale.

Historical cost states that each financial effect of a realized transaction stated in the firm's financial position shall be recorded at acquisition cost. Applying different accounting methods across firms or countries makes financial statements incomparable to each other. Even within the IFRS framework the choice between the two valuation models for certain asset portfolios is a given option. US GAAP, also seem to have a different approach in property valuation. Whichever of the above methods used, no account is taken for the WLC of the asset and, despite the fact that WLC is a field of continuous growing interest in the real estate sector and substantial amounts of research into the field can be found in the literature, there is no formal framework that imposes WLC calculations in real property valuation.

Hence, although funding and insurance organisations are strongly interested in WLC as part of their *due diligence* enquiries into how robustly cost estimates are prepared and how successfully the risks of designing and delivering fixed assets have been tackled (Constructing Excellence, 2003), WLC application has not been implemented into standard practice (Davis Langdon, 2007). The lack of historical data and databases on building operation and maintenance and the complexity of calculating the factors involved in WLC have been determined as reasons for this (Kehily and Hore, 2012). National Audit Office Report on 'Improving Public Services through better construction' (NAO, 2005) identified as key barriers to WLC wider application, the confusion over scoping and terminology and the lack of a common methodology, tangible evidence and 'know-how' skills. Furthermore, the conventional modelling approach to valuing real estate projects – like the discounted cash-flow (DCF) analysis – is based on deterministic estimates (single 'best guesses') of the variables involved without formally addressing the endemic in the real property environment dynamic problem of uncertainty in future events and performance (French and Gabrielli, 2004). Hence, two important procedures must take place: to identify the sources of uncertainty in the various stages of the valuation process and to determine their probability distribution parameters.

Therefore, the inherent risk can be estimated and real property developers can make a calculated decision concerning whether or not to undertake the project based on

their acceptability of risk (Loizou and French, 2012). Quantitative risk analysis technique of Monte Carlo simulation is incorporated in the unique integrated WLC mathematical model for real property valuation, as introduced in Liapis *et al.* (2014 – accepted for publishing), through the use of the PERT probability distribution function assigned to each input variable.

The main objective of the paper is to introduce the method of whole-life fixed assets valuation under uncertainty considering different GAAPs. An integrated WLC mathematical model for fixed assets valuation under uncertainty is proposed and analysed and its application to a typical property asset following different accounting portfolios of fixed assets is carried out in order to illustrate its use and to explore the significance of impacts from changes in the input variables.

2. The Accounting Framework of Fixed Assets

As accounting elements, assets are ruled by a set of basic aspects, such as: the cost (cost of land, construction cost), the residual value, the useful life estimation and the depreciation impact. The above elements are correlated with type and the use form of the asset. Asset accounting is subject to the accounting framework instituted by the Accounting Board of each country. The most famous Accounting Boards are the: International Accounting Standards Board (IASB - IFRS, IASs) and the Financial Standards Board (FASB - US GAAP). Both the IASB and FASB aim to develop a set of high quality global accounting standards that require transparent and comparable information in general purpose financial statements. In pursuit of this objective FASB and IASB co-operate with national accounting standard-setters to achieve convergence in accounting standards around the world. The accounting framework provides a general set of accounting principles. Some of the principles that apply to our study are: Prudence; Historical Cost; Substance over Form; Going Concern; and True and Fair View. Other principles and qualitative characteristics of the financial statements are: Matching Principle, Accrual basis, understands ability, relevance, materiality, reliability, faithful representation, comparability, neutrality, completeness, timeliness, materiality, cost and benefit balance and consistency.

Prudence or conservatism is a principle which is adopted by IFRS and US-GAAP and refers to the inclusion of a degree of caution in the exercise of the judgments needed in making the estimates required under uncertainty conditions (e.g. useful life of plant and equipment), so that assets or income are not overstated and liabilities or expenses are not understated. Conservatism is the asymmetry in the verification requirements for gains and losses. This interpretation allows for degrees of conservatism: the greater the difference in degree of verification required for gains versus losses, the greater the conservatism. According to Watts (2003) conservatism has benefits to parties associated with the firm. Specifically,

conservative accounting is a means of addressing problems due to parties to the firm having asymmetric information, asymmetric payoffs and limited liability. For instance, shareholder litigation produces asymmetric payoffs: overstating net assets is more likely to generate litigation costs than understating net assets. Therefore conservatism, by understating net assets, reduces the firm's expected litigation costs.

Historical cost is a basic accounting principle states that each financial effect of a realized transaction stated in the firm's financial position shall be recorded at acquisition cost, which is the amount of cash received or paid at the time of the transaction (e.g. market price of a building at purchase time).

Substance over form is a US GAAP and IFRS principle. However, US GAAP and IFRS embrace the fact that faithful representation of accounting events permits that these events shall be accounted and presented with their substance and economic reality, which is not always consistent with their legal form.

Going Concern is a basic accounting principle accepted by the US GAAP, IRFSs. Under this principle it is assumed that the entity will continue to operate for the foreseeable future.

True and fair view principle, applied mainly in US GAAP and IFRS, relates to the 'fair' presentation of the financial position, performance and changes in financial position of an entity. As we will demonstrate on this study, 'fair' is a hard-to-define accounting principle, as the specification of 'fair' is highly subjective and differs across economic circumstances. Therefore a specific definition is a difficult case. However, US GAAP and IFRS provide a general definition, not much different between each other. According to IFRS Fair Value is the price at which the property could be exchanged between knowledgeable, willing parties in an arm's length transaction (IAS 40). According to US GAAP Fair Value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date (FAS 157).

2.1 Cost Accounting versus Fair Value Accounting Principles

Accounting fairness refers mostly to the fair presentation, and therefore, measurement or valuation of an element recognized in the entity's financial statements. According to the GAAP across the countries, two basic valuation methods exist under the estimate that the firm is under going concern: The accounting of fair value and the accounting of historical cost (Freshfields Bruckhaus Deringer LLP, (2009), Missonier-Piera, F., (2007)). Applying different accounting methods across firms or countries makes financial statements incomparable to each other. Even within the IFRS framework the choice between the two valuation

models for certain asset portfolios is a given option. US GAAP, also seem to have a different approach in measuring property. The measurement method choice is of great importance because it affects the comprehensive income of the firm (income and shareholder's equity). Valuation of property results, therefore, to a change in financial statements. This result can directly affect contracts linked to accounting numbers, e.g. it can loosen the stranglehold of debt covenants and reduce the informational asymmetry. Lin and Peasnell (2000) point out benefits and disadvantages associated with asset revaluation.

The potential benefits include: The reduction of the risk of violating accounting-based covenants as a result of a strengthened balance sheet, the provision of a credible signal of better prospects to come and the reduction of the firm's reported accounting rate of return, improving its bargaining position. Among the potential disadvantages are the additional out-of-pocket costs (mainly the valuation fees paid to independent valuers) involved. According to the studied frameworks that refer to fair value revaluation of assets, IFRS give a more free and less specific definition about fair value, US GAAP (SFAS 157) provide a hierarchy of three levels of inputs in applying various valuation techniques.

The fair-value hierarchy gives the highest priority to quoted prices in active markets for identical assets or liabilities (level 1) and the lowest priority to unobservable inputs (level 3). Level 1 is designated to quoted prices for identical items in active, liquid and visible markets such as stock exchanges. Level 2 indicates observable information for similar items in active or inactive markets, such as prices for two similarly situated buildings in the same downtown real estate market. Level 3 marks unobservable inputs to be used in situations where markets do not exist or are illiquid. For an asset, a fair value measurement assumes the highest and best use of the asset by market participants. According to FSP FAS 157-3 fair value is a current exit value and may differ from a transaction price (entry price) due to different markets of purchase and sell, or bargain purchase options, or due to transaction prices including acquisition costs.

Moreover, measurement must include assumptions about risk and uncertainty when pricing the asset. FSP 157-3 also highlights the need to consider the relevance of market data and environment, especially in the present credit squeeze, where fair value becomes highly subjective. Supporters of fair value assert that the revaluation of property, plant, and equipment improves forecasts of future earnings and provides greater feedback value and more timely information than historical cost measures (Herrmann, Saudaragan & Thomas, 2005). In addition, the predictive value of fair values over historical cost extends in situations as: the asset valuation of an entity which is no longer a going concern, the estimation of an acquisition price, the liquidation of the firm's assets. The number of fair value exceptions (instead of

historical cost) already existing under U.S. GAAP provides many examples whereby fair value measures are currently used in place of historical cost measures in the valuation of property, plant and equipment, such as: Assets subject to impairment are written down to fair value, donated property, plant, and equipment are measured at fair value as there is no historical cost alternative. Although fair values are assessed by professional experienced valuers, they include judgment and acceptances when estimating the fair value of property, so the estimates, at least to some degree, are subjective (J.R. Dietrich et al, 2001). Therefore the level of subjectivity and uncertainty is greater of that in the case of historical cost. Some academics have also expressed reservations over fair value accounting following the perceived misuse of fair value accounting in some recent American accounting scandals (Watts, 2003). Also, fair value estimates are more likely to be relevant but less likely to be reliable in compare to historical cost (J.R. Dietrich et al, 2001).

However, historical cost may under certain circumstances be also a defective measure of valuating assets, e.g. in cases where prices are not specified objectively (during inflation periods), and does not always comply with the principal of the timeliness of information. Both cost and fair value accounting incorporate advantages and disadvantages, under different situations and therefore both FASB and IASB provide alternative choices about the asset valuation adoption method. The gap between the market prices and the 'fair' values of the assets is today an important issue caused by the world financial crisis, the credit squeeze and the exceeding supply of assets. The adaptation debility of the market to the present economic environment which does not permit an equilibrium point of demand and supply has caused price warps and declination from 'fair' values.

Accounting treatment for funding fixed assets, asset can be acquired through various ways. The simpler acquisition method is the purchase with cash. When cash or cash equivalent is not available, the funding of fixed assets can be obtained through asset exchange transactions (IAS16 BC- Property, Plant and Equipment), through borrowing (IAS 23- Borrowing Costs), through grants (IAS 20- Government Grants). Fixed assets can be also funded through stock issue when establishing a firm or with new capital stock issue or through acquirement or merger of other companies. It can also be funded by issuing corporate bonds. Finance or operating leasing is also a way of funding assets. Leasing is a famous asset acquiring method when cash acquisition is not possible. Another case of funding a fixed asset acquisition refers to sale and leaseback. Under IFRS Leasing is dealt by IAS 17.

The uses of fixed assets and accounting portfolio composition, fixed assets are elements of the financial position of the entity. According to IFRS, an asset is recognized only if it is probable that future economic benefits associated with the item will flow to the entity and the cost of the item can be reliably measured (IAS

16). Fixed assets can be used in many different ways in order to create future economic benefits for the entity, such as: *The continuing use of fixed assets* by the firm in order to operate; *The construction and sale of fixed assets* in the normal course of business; *The lease of fixed assets* in order to benefit from rentals; *The investment in fixed assets* made for capital appreciation; *The purchase, manufacturing and subsequent sale* made with bargain options, as trading transaction. Each portfolio has different features and accounting treatments for each kind of financial transaction and under different GAAPs (Herrmann, D., Saudaragan, S.M. and Thomas, W.B., (2006)). Following IFRS the portfolios for fixed assets are: Own Used Portfolio, Current Asset Portfolio, Held for Sale Portfolio, Investment Portfolio and a special treatment for fixed assets under Long Term Leasing. A comparative analysis of each portfolio among different GAAPs is provided in Appendix A.

The decision of the use intention, from the other hand, of a fixed asset at initial recognition is dependent of the key profitability metrics detection and measurement. The key profitability metrics of tangible assets are: (i) rent, (ii) the opportunity cost of not using the asset and (iii) any expected gain that will result from the valuation of property at 'fair' value. The measurement of profitability metrics is the basis for creating asset valuation models (discounted rentals, value in use, 'fair' observed market values). At initial recognition management should establish a purchase price allocation method, such as the one used when acquiring a company. According to the studied accounting frameworks, the cost of the asset recognized initially is the cash equivalent paid to acquire the asset. However, purchase price usually contains a bargain when acquiring commercial real estates. Also, it may contain a revaluation gain arising from the past use of the asset. So, the 'bare' value must be abstracted from any surplus value attached to the purchase price. The purchase price allocation should recognize the bare value in assets, while any surplus value should be transferred to equity reserve as gain from acquired assets. As an important investment and accounting tool, property requires both financial and accounting knowledge in order to be managed. Financial knowledge is necessary for the management to locate investments in property that will result to surplus values for the firm and accounting knowledge is the background of the appropriate classification and measurement of property, according to their use purpose.

The accounting frameworks of US GAAP, IFRS and Greek GAAP differ between each other. The US and Greek GAAP are more prudent in compare to IFRS. Also, the US and Greek GAAP are rule-based, while IFRS are principle-based. Therefore, IFRS leave decision choices to the management of the firm, while US GAAP set also numbered boundaries above or under which the accounting treatment methods change. IFRS comprise the most 'fair' approach, because they provide the choice of the presentation of financial statements at fair value, although calculation of fair

value of fixed assets is a difficult issue which requires professional skills. The full convergence of the three studied accounting frameworks in a common-global framework is a challenge. The framework that is proposed shall use fair values, meaning values that will resemble economic reality at measurement dates, as much as possible, as the accounting valuation principle used to value fixed assets irrespectively of their use and their portfolio categorization. Revaluations shall affect the firm's equity special reserve by passing P/L, as unrealized gain or loss and shall be recycled to the firms' profit and loss only by realization, e.g. sale, disposal, destruction. Such a framework eliminates any motivations of the management to classify property in certain portfolios and prohibits the choice between avoiding and undertaking the risk of affecting the profit and loss account when revaluating assets. Therefore, profit becomes more prudent and balance sheet becomes more timely and relevant, resulting to uniformity of financial accounting and representation of fixed assets and succeeding comparability between firms and countries.

3. WLC Definition, Key Variables and Basic Steps

The first International Standard for property life-cycle costing (LCC), BS ISO 15686-5:2008 'Buildings and constructed assets – Service life planning – Part 5: Life cycle costing' (BSI, 2008) defines LCC as the: *'methodology for the systematic economic evaluation of life cycle costs over a period of analysis, as defined in the agreed scope'*. Life-cycle cost, in turn, is defined as the *'cost of an asset, or its parts throughout its life cycle, while fulfilling the performance requirements'*. Accordingly, BS ISO 15686-5:2008 defines whole-life costing (WLC) as the *'methodology for the systematic economic consideration of all whole life costs and benefits over a period of analysis, as defined in the agreed scope'*. Hence, WLC is considered to have a broader scope than LCC emphasising not only on economic life-span but on the entire span of real property existence including non-construction costs such as finance, business costs, incomes from sales/disposals etc. and also external social/ environmental costs and benefits.

In order to achieve WLC objectives, the following critical variables have been identified in numerous papers and textbooks on the subject (Flanagan and Norman, 1983; Ferry and Flanagan, 1991; Hoar, 1993; Bull, 1993; Norman, 1993; Kirk and Dell'Isola, 1995; Woodward, 1997; Kishk et al., 2003; Olubodun, F., Kangwa, J., Oladapo, A. and Thompson, J. (2010), among others): project life-time (the analysis period); the discount rate (to address the 'time value of money'); inflation and taxation; construction cost; operating cost; repair and maintenance cost; occupancy cost; end of life/disposal cost; non-construction costs; incomes; externalities (social/environmental costs/benefits); Uncertainty (risk assessment/sensitivity analysis).

WLC analysis requires the following steps (Constructing Excellence, 2003): to identify/estimate all property costs and incomes in its entire life-cycle; to employ an effective Cost Breakdown Structure (CBS) (see BCIS, 2012); to decide when these costs and incomes are likely to occur; to use 'discounted cash-flow' techniques to bring costs and incomes back to a common basis – items should normally be entered into the analysis at the current cost / income and a discount rate applied; to address uncertainty issues by undertaking risk assessment and/or sensitivity analysis of the variables such as the discount rate, the study period, the predicted design lives of various components, assumptions about running costs, etc.

4. Property Valuation Under Uncertainty

The basic equation of Net Present Value (NPV) as found in Kishk *et al.* (2003) is:

$$NPV = C_0 + \sum_{t=1}^{T} O_t + \sum_{t=1}^{T} M_t - SAV \quad (1)$$

C	: the initial construction costs (at time zero)
$\sum_{t=1}^{T} O_t$	: the sum of discounted operation costs at time t
$\sum_{t=1}^{T} M_t$	: the sum of discounted maintenance costs at time t
SAV	: the discounted salvage value = $RV_T - DC_T$
RV_T	: the discounted resale value (at the end of the analysis period)
DC_T	: the discounted disposal costs (at the end of the analysis period)
T	: the analysis period in years (project life-cycle)

In Liapis *et al.* (2014) this traditional NPV equation was transformed by introducing a number of variables that affect the valuation of real property projects, after analysing a number of components like: operating and net cash flows (OCF and NCF); the relationship between Price and Revenue of real property; the discount factor or Weighted Average Cost of Capital (WACC); tax rates; inflation and risk-free rates; risk premium; and expected capital gains. The analysis resulted in the development of a prototype integrated WLC methodology based on the following mathematical expressions:

$$NCF_t = [(R_{ot} + RV_T) - (O_{ot} + M_{ot} + OC_{ot})].(1 + \varphi_t^{ind}).(1 - \varphi_t^{y}) + \varphi_t^{y}.a.(C_{ct} + NCC_{pct} + DC_{T,ct} - RV_{T,ct}) - \varphi_t^{p}.(C_{ct} + NCC_{pct}) - (C_{ct} + NCC_{pct} + DC_T).(1 + \varphi_t^{ind}) \quad (2)$$

$$AC_t = [(i_{FR} - \varphi_t^{p})(1 - \varphi_t^{y} + a.\varphi_t^{y}) + \delta_t] \quad (3)$$

$$i_S = \exp\left(\frac{\ln 2 * \ln(1+g)}{\ln\left(\frac{AC_t + \Lambda_t}{AC_t + \Lambda_t - g}\right)}\right) - 1 \quad \text{Liapis } \textit{et al.} \text{ (2011)} \tag{4}$$

$$WACC = i_D.\left(1 - \varphi_t^y\right).\left(\frac{D}{D+S}\right) + i_S.\left(\frac{S}{D+S}\right) \tag{5}$$

For any year 'y' of property life-cycle, the remaining Value of the project is the sum of the (discounted) values of the NCFs from year 'y' until the end year 'T' of the project:

$$Value_y = \sum_{t=y}^{T} \frac{NCF_t}{(1+WACC)^t} \tag{6}$$

Where:

NCF_t : Net cash-flow of the project at year t
t : 1, …, T and T = total years of property life-cycle (the analysis period)
y : 1, ... y ..., T any year of the project
WACC : The discount rate or the Weighted Average Cost of Capital
OCF_t : Operating cash-flow at year t
R_t : Revenue (income) at year t, where: $R_t = (R_{ot} + RV_T)$
ot : Operating period
T : End year of property life-cycle
R_{ot} : Revenue (income) at operating year t
RV_T : Resale value at the end year of property life-cycle
TC_{ot} : Fixed and variable (total) costs at operating year t: $TC_{ot} = (O_{ot} + M_{ot} + OC_{ot})$
O_{ot} : Operating costs at operating year t
M_{ot} : Maintenance costs at operating year t
OC_{ot} : Occupancy costs at operating year t
φ_t^y : Corporate tax rate, Income tax on property yield (annual rent)
D_t : Annual depreciation
$P_{ct,T}$: Initial construction and non-construction costs plus disposal cost at the end year of property life-cycle: $P_{ct,T} = (C_{ct} + NCC_{pct} + DC_T)$
ct : Construction period
pct : Pre-construction period
C_{ct} : Construction cost at construction period
NCC_{pct} : Non-construction cost at pre-construction period
DC_T : Disposal cost at the end year of property life-cycle
$SAV_{T,ct}$: Salvage Value of fixed asset at the end of construction period: $SAV_{T,ct} = (RV_{T,ct} - DC_{T,ct})$
φ_t^p : Property tax rate

φ_t^{ind} : Indirect tax rate.
i_{FR} : Risk-free rate of interest, where: $i_{FR} = i_* + i_{inf}$
i_* : Risk-free rate of interest in an economy without inflation
i_{inf} : Inflation rate
a : Depreciation rate on tax deductible amount of price of property. Rate of constant depreciation of fixed asset (1/useful life)
δ_t : Rate of operating, maintenance and occupancy cost, where: $\delta_t = \frac{(O_{ot}+M_{ot}+OC_{ot})}{(C_{ct}+NCC_{pct})}$
Λ_t : Risk premium, for commercial property investments
EG_{t+1} : Expected capital gains (profits) at year t+1, but in terms of WLC is closely to 0
AC_t : Direct cost of property asset which is equal to cost ratio exempt risk premium and capital gains, thus: $AC_t = \left[\left(i_{FR} - \varphi_t^p\right)\left(1 - \varphi_t^y + a.\varphi_t^y\right) + \delta_t\right]$

4.1 Monte Carlo Simulation

Fifty years ago, Hertz (1964) proposed a method which applied Monte Carlo (due to the gambling aspect of the process) simulation to business decisions under uncertainty. Since then, this method has been popularized by the rapid development in information technology. Nowadays, many practical and theoretical problems involving risk and uncertainty in the area of economics and management are solved using approaches which follow the same principles originating from his work. According to Bennett and Ormerod (1984), Monte Carlo technique or *stochastic* simulation (due to the presence of random processes) typically generates estimates by randomly calculating a feasible value for each variable from a statistical probability distribution function which represents the range and pattern of possible outcomes. To ensure that the chosen values are representative of the pattern of possible outcomes, a quite large number of repetitive deterministic calculations (known as iterations) are made.

Lorance and Robert (1999), as cited in Loizou and French (2012), list the various steps of carrying out a Monte Carlo simulation: the first step is to define the capital resources by developing the deterministic model of the estimate. The second step is to identify the uncertainty in the estimate by specifying the possible values of the variables in the estimate with probability ranges (distributions). The third step is to analyse the estimate with simulation – the model is run (iterated) repeatedly to determine the range and probabilities of all possible outcomes of the model. Prior to running the simulation, the model produces a single-point value (result) for the estimate. This value is known as the deterministic result, and generally is referred to as the base estimate before adding contingency.

There are a number of software tool environments in which Monte Carlo simulations can be run with add-ins to spreadsheets being the most popular (such as Crystal Ball, @risk and ModelRisk commercial software packages).

4.2 PERT Probability Distribution Function

The PERT probability distribution function gets its name because it uses the same assumption about the mean as PERT (Program Evaluation and Review Technique) networks used in project planning. Technically, it is a version of the Beta distribution and is widely employed in risk analysis for modelling expert opinion of a variable's uncertainty. It is based on the assumption that the mean (μ) = (*minimum* + 4 * *most likely* + *maximum*) / 6, therefore, the mean for the PERT distribution is four times more sensitive to the *most likely* value than to the *minimum* and *maximum* values. It requires the same three parameters as the Triangular distribution (*minimum-a, most likely-b, maximum-c*) without suffering to the same extent the potential systematic bias problems of the Triangular distribution, that is in producing too great a value for the mean of the risk analysis results where the *maximum* for the distribution is very large. The standard deviation of the PERT distribution is also less sensitive to the estimate of the extremes and systematically lower than the Triangular distribution, particularly where the distribution is highly skewed. As for the Triangular distribution, the PERT distribution is *bounded* on both sides, hence, may not be adequate for some modelling purposes when it is desired to capture tail or extreme events. The equation of the PERT distribution is related to the Beta distribution as follows:

$$\text{PERT}(a,b,c) = \text{Beta}(\alpha_1,\alpha_2) * (c-a) + a$$

Where:

$$a_1 = [(\mu - a) * (2b - a - c)] / [(b - \mu) * (c - a)]$$
$$a_2 = [a_1 * (c - \mu)] / (\mu - a)$$

And the mean is:

$$\mu = (a + 4 * b + c) / 6.$$

The variance of the PERT distribution derives from the equation:

$$\sigma^2 = \frac{(\mu - a) * (c - \mu)}{7}$$

The probability density function of the PERT distribution is:

$$f(x) = \frac{(x - a)^{\alpha_1 - 1} * (c - x)^{\alpha_2 - 1}}{\text{Beta}(\alpha_1,\alpha_2) * (c - a)^{\alpha_1 + \alpha_2 - 1}}$$

4.3 The Application of the WLC Model to a Typical Fixed Asset

Prior to running the Monte Carlo simulation, the (deterministic) WLC model is applied on a 1.000,00 sq.mt of gross floor-area typical fixed asset (office building) with a two-year pre-construction period (for land purchase, design/engineering and issuing of construction permits) and a three-year physical construction period starting from the second year of the pre-construction period. The asset, after its completion, is assumed to be operated, repaired and maintained by the developer for rental purposes for a time horizon of forty-five years. Finally, the disposal (end of life) period is one year and, hence, the total analysis period (property whole-life cycle) is fifty years. The assumptions made concerning the model's required single-point input rates and values according to the current Greek economic environment pertaining land and property prices and financial rates.

Assuming that all independent (input) variables of the model are following the PERT probability distribution function (as previously described), the dependent (output) variable VALUE (for property valuation) are recalculated under uncertainty by assigning to each independent variable minimum, most likely and maximum values. These values differ among countries and depend on the current economic situation of each country. In addition, these values obviously may change during the property life-cycle. The minimum, maximum and mean values for each independent (input) variable are provided in Table 1 and are based on historical and current data from the Greek economy. The most likely value is the same value of the (deterministic) model under certainty.

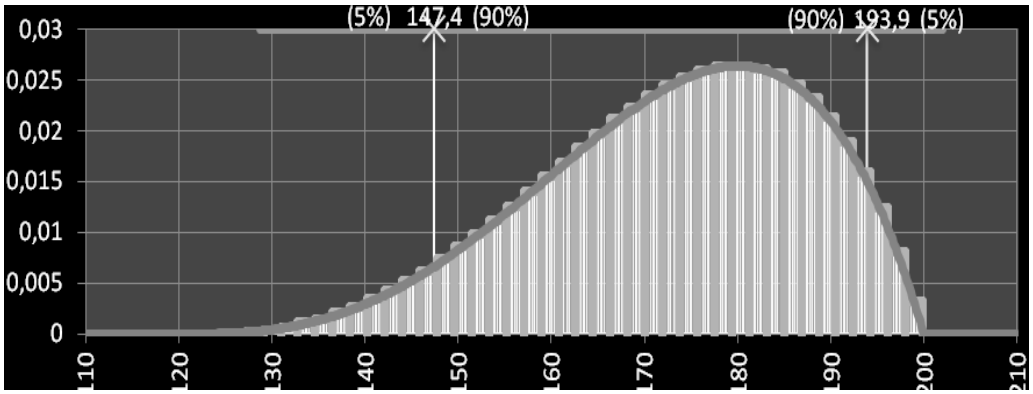
Table 1 Descriptive Statistics of PERT distribution for each independent variable

Independent Variable	Most Likely	Minimum	Maximum	Mean	Std Deviation	Variance	Skewness	Kurtosis
Tax on Income	33%	25,49%	37,41%	32,42%	2,32%	0,000538627	-0,2513823	2,417601
Tax Indirect (VAT)	23%	18,38%	24,97%	22,50%	1,27%	0,000160729	-0,39442	2,540903
R / rates/sq.m	180	124,64	199,87	173,33	14,25	203,1874	-0,4676397	2,624835
% cost NCC (Land)	20%	18,08%	21,95%	20,00%	0,76%	5,71476E-05	0,000112591	2,333509
C / rates/sq.m	1000	856,61	1.097,41	991,67	46,83	2192,677	-0,1779896	2,375841
Property Tax	1%	0,50%	1,93%	1,08%	0,28%	7,63942E-06	0,301439	2,454474
NCC (Land) / rates/sq.m	600	507,05	649,04	591,67	27,64	763,918	-0,3013603	2,454061
O / rates/sq.m	10	9,03	10,96	10,00	0,38	0,1428709	-9,65497E-05	2,33357
Credit Spread	3%	2,04%	3,96%	3,00%	0,38%	1,42872E-05	-8,71677E-05	2,333604
S	40%	20%	78%	43%	11%	0,01222338	0,3015306	2,454782

M / rates/sq.m	12.5	11,06	13,94	12,50	0,57	0,3214583	-1,47959E-05	2,333485
Inflation Rate	2%	0,20%	2,50%	1,75%	0,43%	1,87503E-05	-0,5770728	2,776507
OC / rates/sq.m	18	16,04	19,92	18,00	0,76	0,5714932	-0,00015698	2,333701
Depreciation, a	2%	1,81%	2,19%	2,00%	0,08%	5,71488E-07	0,000134851	2,333601
RV / rates/sq.m	10%	9%	11%	10%	0%	1,42873E-05	0,00001391	2,333762
DC / rates/sq.m	50	40,40	54,94	49,17	2,76	7,639898	-0,3016715	2,45537
Risk Premium Λ	5%	4,50%	5,49%	5,00%	0,19%	3,57193E-06	-5,97767E-05	2,333936
Growth Rate g	0.10%	0,09%	0,11%	0,10%	0,00%	1,42874E-09	-4,52972E-06	2,333775
Free risk rate i*	2%	1,80%	2,95%	2,13%	0,20%	4,12787E-06	0,6569393	2,911047

Figure 1 provides an example of the assignment of the PERT distribution to input variables of the model – Rents per sq.m per year (R), PERT (*120,180,*200)

Figure 1 PERT distribution for Rents

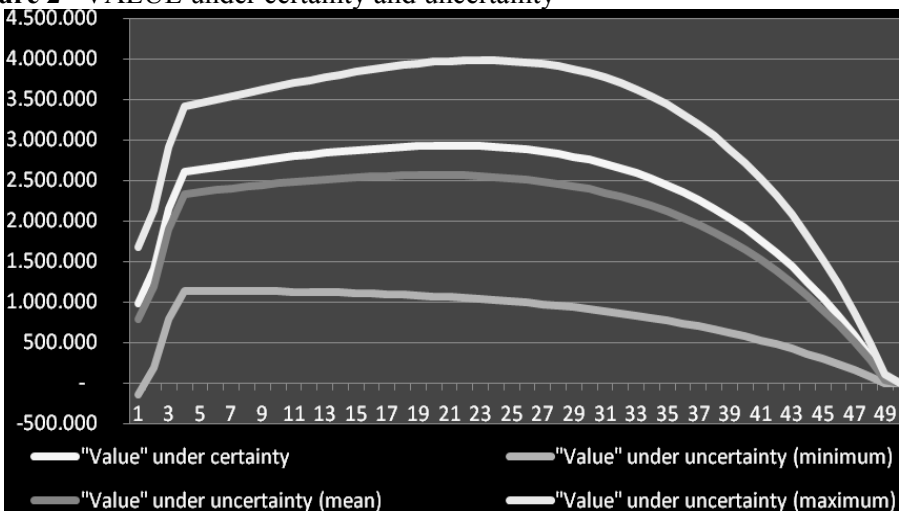


After this, Monte Carlo simulation is used to recalculate the Value curves using the Latin Hypercube sampling method (see Iman *et al.*, 1980) with 10.000 iterations.
For *valuation* purposes, we perform *sensitivity analysis* on VALUE (output-dependent variable) per year of property life-cycle in order to assess the mean estimate under uncertainty and a confidence interval of project's VALUE per year (Table 2 and Figure 2).

Table 2 . VALUE per year, WACC and Descriptive Statistics of PERT Distribution

Dependent Variable	VALUE						WACC
Year of Life-Cycle	1	10	20	30	40	50	
Minimum	- 146.979	1.323.008	1.241.185	1.016.912	614.364	-	4,17%
Maximum	1.669.288	3.683.622	3.932.355	3.799.189	2.739.788	-	7,46%
Mean	782.503	2.462.664	2.566.381	2.391.364	1.644.789	-	5,91%
Std Deviation	272.706	359.721	419.960	444.042	345.859	-	0,49%
Variance	74368380000	1,29399E+11	1,76367E+11	1,97173E+11	1,19618E+11	-	2,35782E-5
Skewness	-0,04294818	-0,0297919	0,01506659	0,0391492	0,06081767	-	-0,0555672
Kurtosis	2,770156	2,700201	2,653505	2,587451	2,527745	-	2,923244

Figure 2 VALUE under certainty and uncertainty



It should be emphasized that by using the PERT probability distribution function, discounted cash-flow (DCF) of a fixed asset is compatible with accounting thoughts and processes as previously mentioned.

5. Conclusion

In this study the accounting framework of tangible assets using IFRS and US GAAP are examined. The main characteristics and uses of assets are analyzed, as well as the portfolio categorization and the accounting treatment under each one of the GAAPs studied.

The contribution of the paper consists of: a framework of good practices in tangible assets management building upon the assertion that WLC is fundamental for securing *best value for money* on property valuation; a critical perspective of the used accounting frameworks, providing comparison for each framework and each portfolio; a literature view (IFRS and US GAAP principles and accounting standards for fixed assets); a proposed and – exclusively under the authors' opinion – fair framework for valuing, managing and monitoring all kinds of fixed assets by using a consistent WLC mathematical model in which the input variables are following the PERT probability distribution function, so that a practical and easy to implement management and valuation tool can assist professionals in the valuation of fixed assets throughout the asset's whole-life cycle; the uniqueness of the model is founded on the dynamic integration of WLC fundamental concepts with the widely used investment appraisal measures for fixed assets and the critical variables imposed by the economic and taxation environments and the incorporation of the quantitative risk analysis (Monte Carlo simulation) with the use of the PERT distribution in order to address uncertainty. Through the analysis of the asset's capital requirements, owners (developers) can assess the net contribution of the investment to their equity and the effects of potential changes in the cost and value of main decision parameters and financing schemes.

The fixed asset management is not an easy case. Management of the firm must 'confront' several difficult issues when acquiring an asset, such as the classification, the valuation method and measurement, the monitoring, and the effects of each decision, relating to fixed assets, in the income statement and shareholder's equity. Given today's uncertain economic conditions the real property industry is operating in, some of the effects of changes in tax rates and/or market prices on asset's valuation were assessed and explained through the PERT distribution by using *minimum*, *maximum* and *mean* values for each independent variable. The proposed methodology and procedure in this article is strictly compatible with the accounting thoughts and processes, under the accounting principles and proposed instructions for estimations applied by IFRS.

References

Bennett, J., Ormerod, R.N. (1984) 'Simulation Applied to Construction Projects', *Construction Management and Economics*, *2*, 225-263.

BSI (2008), 'BS ISO 15868-5:2008 Building and Constructed Assets – Service Life Planning; Part 5 – Life Cycle Costing', *British Standards Institution*, United Kingdom.

Bull, J.W. (1993), 'The Way ahead for Life Cycle Costing in the Construction Industry', *Life cycle costing for construction*, Blackie Academic & Professional, Glasgow, United Kingdom.

Constructing Excellence (2003), 'Fact Sheet: Whole Life Costing', *Published by Constructing Excellence in the Built Environment Ltd*., United Kingdom.

Dietrich, J. R., Harris, M. S., and Muller, K. A. (2000) 'The Reliability of Investment Property Fair Value Estimates', *Journal of Accounting and Economics*, 30(2), 125–158.

Evans, R., Haryott, R., Haste, N. and Jones, A. (1998) 'The Long Term Costs of Owning and Using Buildings', *Royal Academy of Engineering, London*, United Kingdom.

Ferry, D.J.O., Flanagan, R. (1991) 'Life Cycle Costing – A Radical Approach', *CIRIA Report no.122*, London, United Kingdom.

Flanagan, R., Norman, G. (1987) 'Life Cycle Costing: Theory and Practice', *RICS, Surveyors Publications Ltd*., London.

French, N., Gabrielli, L. (2004) 'The Uncertainty of Valuation', *Journal of Property Investment & Finance*, 22 (6), 484-500.

Herrmann, D., Saudaragan, S.M. and Thomas, W.B., (2006) 'The Quality of Fair Value Measures for Property, Plant, and Equipment', *Elsevier Accounting Forum*, 30, 43-59.

Hertz, D.B. (1964), 'Risk Analysis in Capital Investment', *Harvard Business Review*, 42, 95-106.

Hoar, D.W. (1993), 'An Overview of Life-Cycle Costing Techniques', *Property Management*, 6 (2), 92-98.

Iman, R.L., Davenport, J.M. and Zeigler, D.K. (1980), 'Latin Hypercube Sampling', *Technical Report SAND79-1473*, Sandia Laboratories, Albuquerque, NM.

International Accounting Standards Board Exposure Draft (2009) 'Fair Value Measurement'.

International Accounting Standards Board (2008), 'International Financial Reporting Standards Including International Accounting Standards'.

Kehily, D., Hore, A. (2012) 'Life Cycle Cost Analysis under Ireland's Capital Works Management Framework', *Proceedings of the Joint CIB W070, W092 & TG72 International Conference on Facilities Management, Procurement Systems and Public Private Partnership.*

Kirk, S.J., Dell' Isola, A.J. (1995), 'Life Cycle Costing for Design Professionals', New York, McGraw-Hill Book Company.

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N. and Sun, M. (2003) 'Whole Life Costing in Construction: A State of the Art Review', *The RICS Foundation Research Paper Series*, April 2003, 4 (18), 1-39.

Langdon D. Management Consulting (2007), 'Life Cycle Costing as a Contribution to Sustainable Design: A Common Methodology – Final report', available

http://ec.europa.eu/enterprise/construction/compet/lifecyclecosting/indexlifecycleen.htm

Liapis, K.J., Christofakis, M.S. and Papacharalampous, H.G. (2011), 'A New Evaluation Procedure in Real Estate Projects', *Journal of Property Investment & Finance*, 29 (3), 280-296.

Liapis, K.J., Kantianis, D.D. and Galanos, C.L. (2014), 'Commercial Property Whole-Life Costing and the Taxation Environment', *Journal of Property Investment & Finance*, 32 (1), 56 – 77.

Lin, Y. C., Peasnell, K. V. (2000), "Fixed Asset Revaluation and Equity Depletion in the UK", *Journal of Business Finance and Accounting*, 27(2/3), 161–182.

Loizou, P., French, N. (2012), 'Risk and Uncertainty in Development: A Critical Evaluation of Using the Monte Carlo Simulation Method as a Decision Tool in Real Estate Development Projects', *Journal of Property Investment & Finance*, 30 (2), 198-210.

Lorance, R.B., Robert, V.W. (1999), 'Basic Techniques for Analyzing and Presentation of Cost Risk Analysis', *AACE International Transaction*s, Association for the Advancement of Cost Engineering.

Missonier-Piera, F. (2007), 'Motives for Fixed-Asset Revaluation: An Empirical Analysis with Swiss Data', *The International Journal of Accounting*, 42, 186-205.

NAO (2005), "Report on Improving Public Services through Better Construction", *National Audit Office*, web site: www.nao.org.uk

Norman, G. (1993), 'Life Cycle Costing', *Property Management*, 8 (4), 344-356.

Olubodun, F., Kangwa, J., Oladapo, A. and Thompson, J. (2010), 'An Appraisal of the Level of Application of Life Cycle Costing within the Construction Industry in the UK', *Structural Survey*, 28 (4), 254-265.

Thalassinos I.E., Liapis J. K., Thalassinos E.J., (2013) "The Role of the Rating Companies in the Recent Financial Crisis in the Balkan and Black Sea Area", Book Chapter in A. Karasavvoglou and P. Polychronidou (eds.), Economic Crisis in Europe and the Balkans, Contributions to Economics, Springer International Publishing Switzerland, DOI IO.1007/978-3-319-00494-5_6.

Thalassinos, E.J., Liapis K. (2011), "Measuring a Bank's Financial Health: A Case Study for the Greek Banking Sector", *European Research Studies Journal, Vol. XIV(3)*, 135-172.

Thalassinos, I.E. and E.D. Politis, (2011), "International Stock Markets: A Co-integration Analysis", *European Research Studies Journal*, Vol. XIV(4), 113-130.

Tsalavoutas I., Evans L. (2008), 'Comparing International Financial Reporting Standards (IFRSs) and Greek GAAP: Financial Statements Effects', University of Edinburgh, Accounting University of Stirling.

Vose, D. (1996), 'Quantitative Risk Analysis: A Guide to Monte Carlo Simulation Modelling', John Wiley and Sons Ltd., United Kingdom.

Watts, R. (2003), 'Conservatism in Accounting – Part I: Explanations and Implications', *Accounting Horizons*, 17(3), 207–222.

Woodward, D.G. (1997), 'Life Cycle Costing – Theory, Information Acquisition and Application', *International Journal of Project Management*, 15 (6), 335-344.