SIMULATION DISCOUNTED CASH FLOW VALUATION FOR INTERNET COMPANIES

Maged Ali, Brunel Business School, Brunel University, UK, Maged.Ali@brunel.ac.uk

Ramzi El-Haddadeh, School of Information Systems, Computing and Mathematics, Brunel University, UK, Ramzi. El-Haddadeh@brunel.ac.uk

Tillal Eldabi, Brunel Business School, Brunel University, UK, Tillal.Eldabi@brunel.ac.uk

Ebrahim Mansour; Applied Science University (ASU), Amman, Jordan. ibraheem.m@asu.edu.jo

Abstract

Discounted cash flow (DCF) is the most accepted approach for company valuation. It is well grounded in theory and practice. However, the DCF approach, which is commonly used for traditional companies valuation, presents a number of serious weaknesses within the Internet companies' context. One of these weaknesses is tackling the uncertainty that characterize future cash flows of these companies. Specifically DCF assumes that future cash flow streams are highly predictable. The effects of uncertainty are therefore tackled implicitly by discounting the expected value of the cash flows at a risk-adjusted interest rate. However, under uncertainty, future cash flows of these companies can no longer be characterized by a single value but rather by a range of values of its possible consequences. This paper looks at the way in which uncertainty can be incorporated into the traditional DCF approach so that the latter, which is otherwise conceptually sound, becomes relevant. This is done by recognizing that the DCF input variables are uncertain and will have a probability distribution pertaining to each of them. Thus by utilizing a probability-based valuation model (using Monte Carlo Simulation) it is possible to incorporate uncertainty into the analysis and address the shortcomings of the current model. The MC simulation assigns a range of values in order to cope with uncertainty underlies each key cash flow variable. The process leads to a probability distribution of the valuation criterion used, giving investors a quantitative measure of risk involved.

Keywords: cash flow valuation; uncertainty; risk; Monte Carlo simulation; Internet companies

.

1 INTRODUCTION

Internet companies have unique business models, significant growth opportunities, and high uncertainty regarding the future potential of the firm (Maya,2004) . Valuing such companies is a major challenge faced by most investors (Damodaran, 2001a) . Discounted Cash Flow (DCF) is usually utilized to complete the valuation (Graham and Harvey, 2001) . DCF approach is well grounded in theory, simple to use mechanistically and works well in stable environments (Damodaran, 2001b) . It is also the foundation on which all other valuation approaches are built (Damodaran, 2001b) . However, the conventional DCF approach, which is commonly used for traditional companies' valuation, presents a number of serious weaknesses within the Internet companies' context. One of these weaknesses is tackling the uncertainty that characterize future cash flows of these companies (Mun, 2002) , and (Booth, 2003) . Specifically, DCF assumes that future cash flows are all highly predictable and deterministic (Mun, 2002) . The valuation therefore proceeds by aggregating the future cash flows in one single estimate, the expected value, and discounts them by a risk-adjusted interest rate. However, in a high uncertain environment like the Internet, the cash flows can no longer be characterized by a single value but rather by a range of values of its possible consequences (Mun, 2002) . In such stochastic world, using deterministic models such as DCF model may leads to flawed valuation for these companies (Booth, 2003) , and (Damodaran, 2001a) .

To account for this drawback in valuation, analysts often supplement the existing DCF models with sensitivity analysis or scenario analysis (Savvides, 1994) . Sensitivity analysis, in its simplest form, involves changing the value of a variable from its base case in order to test its impact on the final result (Taylor,2004) . It is often undertaken to complement a DCF analysis to identify those uncertain or risk variables that are likely to have the most significant effect on DCF value if they move from their base-case values (Ragsdale, 2004) . While sensitivity analysis provides an insight into a DCF model, a limitation of this technique is that it does not take into account interdependencies between variables since the ceteris paribus assumption made when changing one variable at a time is rarely realistic (Kelliherand Mahoney, 2000). In addition, sensitivity analysis fails to adequately capture the likelihood of outcomes occurring as it delivers point outcomes only (Ragsdale, 2004) . Furthermore, when many variables are uncertain, sensitivity analysis of the effect on DCF value for more than just few variables becomes tedious and difficult to interpret (Taylor,2004) . Scenario analysis remedies one of the shortcomings of sensitivity analysis by allowing the simultaneous change of values for a number of key value drivers thereby constructing an alternative scenario for the DCF value. Pessimistic and optimistic scenarios are usually presented. Useful though, the analysis can show only the range of outcomes, but not the probability of their occurrence (Goldman and Emmett, 2003) .

Consequently, to address the problem of uncertainty and risk that characterize the cash flows of Internet companies and hence, its DCF valuation, this research proposes an alternative approach based on stochastic or Monte Carlo (MC) simulation. MC simulation is considered to be a technique, using random or pseudorandom numbers, for solving certain stochastic or deterministic problems where the passage of time plays no substantial role (Law and Kelton, 2000) . It is a proven efficient technique in the assessment of risks and uncertainties surrounding a decision problem Powell and Baker, 2004) . MC simulation allows the analysts to assign for each key uncertain cash flow a probability distribution, which represents the range of possible values for each variable Powell and Baker, 2004) . And then, through random sampling of these distributions, determine the distribution of all potential outcomes that could occur under these uncertainties. The decisions thus, can be made with the knowledge of the whole distribution rather than one aggregate value, which ensures an adequate consideration of risk (Winston, 2004) . As a form of risk analysis MC simulation was initially developed in the early 1960s and one of its first proponents was Hertz (Hertz, 1964) whose classic article in the *Harvard Business Review* did much to bring the technique to a wider audience. He applied MC simulation in capital budgeting decisions in order to evaluate risk and uncertainty inherent in investment decisions. Since then, a number of models have been developed covering investment evaluation decisions in various industries (Kelliherand Mahoney, 2000). The present research is the first attempt to apply MC simulation to the DCF valuation of Internet companies. The paper proceeds as fellow: Section(Damodaran, 2001 a) proposes a simulation DCF approach for Internet companies starts with building a deterministic DCF model in (2.1). Modeling the uncertainty in the DCF analysis using MC Simulation is examined in (2.2). Section (Graham and Harvey, 2001) concludes and summaries the main points of the paper.

2 SIMULATION-DCF VALUATION FOR INTERNET COMPANIES

The computer simulation model developed by the authors in this study involves two-stages. In the first stage we start by building a typical DCF model. A typical DCF model states all relevant revenue and cost components as well as planning horizon, discount rates and terminal value. Single-point estimates describe the relationship between inputs and outputs at this stage and the model is considered to be deterministic. After the basic model is constructed, the second stage entails the use of MC simulation technique to model the stochastic process underlie the cash flows, thus enabling the DCF model to incorporate the impact of the uncertainty of these cash flows on the firm value. This section will outline the core components of this modeling process.

2.1 Building a Deterministic DCF Model

The DCF analysis measures the value of an Internet company as a function of three variables - how much it generates in cash flows, when these cash flows are expected to occur, and the uncertainty associated with these cash flows (Copeland et.al, 2000) . Specifically, DCF analysis estimates the value of an Internet company as the sum of the present value of its free cash flows over a forecast period (usually called planning horizon) between five to ten years and a terminal value at the end of this forecast period, based on the weighted average cost of capital (WACC) as the discount rate (Higson and John, 2000) . Mathematically, DCF approach is expressed as follows:

$$V = \sum_{t=1}^{T} \frac{FCF_t}{(1+WACC)^t} + \frac{TV}{(1+WACC)^T}$$

Where, V: Value of Internet Company, FCF_t: free cash flow of period t, WACC: weighted average cost of capital, T: planning horizon period, and TV: terminal value in period T.
It appears from the equation above that in order to estimate the value of an Internet company using DCF approach, three steps are necessary (Copeland et.al, 2000) . First, an Internet company's future free cash flows for an explicit forecast period are determined. Then, a discount rate representing different risk inputs must be assessed. Third, a terminal value for the period of stable growth after the explicit forecasted period has to be estimated.

2.1.1 Estimating free cash flows for an explicit forecast period

The free cash flow of an Internet firm is its operating profit less taxes, less the cash it must reinvest in assets to grow, whether it is reinvestment in long-lived assets (capital expenditure) or short-term assets (net working capital) (Higson and John, 2000) .

$$FCF = EBIT\,(1-t_x) - (CE - D_p) - CWC$$

Where, FCF: Free cash flow, EBIT: Earning before Interest and Taxes = Revenue – cost of revenue - other operating expenses, t_x: Tax Rate, CE: Capital Expenditures, D_p: Depreciation and CWC: Change in Non-cash Working Capital.
According to this definition the steps in estimating FCF to an Internet company are as follows: first, is to forecast its revenues in future years usually by forecasting the revenue growth rate in each year. Second, is to forecast its costs, whether its costs of revenue or other operating costs. And third is to forecast its reinvestments needs for growth (Fernandez, 2001) .

Forecasting revenue growth

Forecasting revenue growth is crucial first step, and involves a difficult task of predicting the future development of aspects like technology, financials, management, and markets. Brealey and Myers, 2000) , and (Reilly and Keith, 2003) . Despite this difficulty, Damodaran (Damodaran, 2001a) suggests that revenue growth rates can be estimated in three different ways: first, historical growth rates can be adapted, acknowledging that the future is a condition of the past. A second way is using analysts' estimates, also suggesting that growth is exogenous. A third way is to see growth as a function of quality and quantity of firm investment. This endogenous approach emphasizes the importance of the present and bases growth on a firm's fundamentals.

Forecasting costs and reinvestments needs

After forecasting the revenue growth, the next step is to forecast the company costs and reinvestment needs. The common procedure in valuation is to take the revenue forecasts as a reference and estimate these components of FCF as a function of revenue. This procedure is called the *Percentage of sales approach* and is based on a reasonable assumption that revenue is in effect the main driver for these costs and reinvestment needs Brealey and Myers, 2000) . To apply this method, there are basically two available techniques. Simple one uses the historical average of these components as a percentage of revenue and multiplies it with the forecasted revenue to estimate these cash flows. The problem with this method is it assumes that the relationships that have held consistently in the past will continue to hold in the future (at the same level) which is not always a reasonable assumption Brealey and Myers, 2000) . Second and more accurate method uses casual forecasting to determine the extent to which change in revenue causes change in these cash flows (Benninga, 2001) . Regression is the most commonly used form of casual forecasting. In its simplest form regression fits a straight line to the scatter plot of two variables that are suspected of being related. This line can be then used to predict the value of one of the variables given the value of the other (Benninga, 2001) .

2.1.2 Estimating Discount Rates

The DCF valuation states that the value of an Internet company is the sum of all future cash flows to their owners discounted at their required rate of return. A discount rate therefore describes the opportunity costs borne by investors (equity and debt holders) when buying into a company's assets or providing capital. The opportunity cost weighted by their relative contribution to the company's total capital is called weighted average cost of capital (WACC) (Copeland et.al, 2000) .

$$WACC = K_e \frac{V_E}{V_E + V_D} + K_d (1 - t_x) \frac{V_D}{V_E + V_D}$$

Here, $K_{e:}$ the cost of equity, $K_{d:}$ the cost of debt, (t_x): the tax benefits of borrowing and ($V_{E,}$ V_D) the weights of debt and equity.

Calculating the WACC for an Internet company requires three estimations, the cost of financing for both debt and equity and their relative weights in the financing structure (Higson and John, 2000) . The cost of debt is the current rate at which an Internet firm can borrow, adjusted for any tax benefits associated with borrowing (Fernandez, 2001) . The cost of equity on the other hand is the rate of return that equity investors in an Internet firm expect to make on their investment. To estimate the cost of equity the Capital Asset Pricing Model CAPM is usually applied (Graham and Harvey, 2001) . The cost of equity according to CAPM is composed of two elements: the risk-free rate and the risk premium appropriate for an Internet company.

$$K_e = r_f + (r_m - r_f)\ \beta$$

Where, K_e: cost of equity, $r_{f:}$ the Risk-free rate, β: Beta of company and r_m: the market rate of return.

The *risk-free rate* is the return on a security that has no default risk and is completely uncorrelated with returns or anything else in the economy (Higson and John, 2000) . In practice, returns for government securities are applied. The *risk premium* represents the extra return demanded by an investor for shifting his money from a risk less investment to an average risk investment. The CAPM suggests that risk premium is related to *beta* – whether historical or implied. The *beta* is a relative measure of risk. It measures risk added on to a diversified portfolio, rather than total risk (Reilly and Keith, 2003) .

2.1.3 Estimating the Terminal Value

The terminal value reflects the value of all expected future cash flows beyond the explicit forecasting period (Higson and John, 2000) . To estimate the terminal value the constant growth model of Gordon is usually employed (Copeland et.al, 2000) . The Gordon model assumes that a company's cash flow beyond the terminal year will grow at a constant rate (*g*) forever, hence, satisfying a necessary condition for infinite discounting (Reilly and Keith, 2003) , in which case the terminal value in year n can be estimated by dividing the free cash flow in year n+1 by the WACC less the constant growth rate (*g*):

Terminal value = FCFn+1 / (WACCn+1 - g_n)

Having estimated the cash flows over a forecast period and the terminal value, the value of the company is the sum of the PV of those two components. Finally, to get the value *per share*, the values of the company's liabilities—debt, preferred stock, and other short-term liabilities should be subtracted to get *Value to Common Equity,* divide that amount by the amount of stock outstanding give us the *per share or stock value* (Damodaran, 2001b) .

2.2 Modelling the uncertainty in the DCF analysis using MC Simulation

Once the deterministic DCF model is developed, the second stage entails the use of MC simulation technique to model the stochastic process underlying the cash flows, thus enabling the DCF approach to incorporate the impact of uncertainty on the firm value. According to French and Gabrielli (French and Gabrielli, 2004) and Seila (Seila, 2004) , modeling uncertainty using MC simulation includes the following steps:(Maya, 2004) Identifying an Internet company's key cash flows that are heavily impacted by uncertainty.(Damodaran, 2001 a) Determining the input models that reflect their randomness and match their uncertainty.(Graham and Harvey, 2001) Implementing and run the simulation DCF model. And finally,(Damodaran,2001 b) analysis the results and assess the effects of uncertainty on the firm value.

2.2.1 Identifying Key Uncertain Cash Flows

While most cash flows (e.g. revenue, costs) in a DCF model are to some extent uncertain, only critical cash flows are chosen as key uncertain cash flows. This is in the sense that a small deviation from its projected value has significant impact on the firm value. Other uncertainties will invariably also has little impact on value (Ragsdale, 2004) . The reason for only modelling those stochastic cash flows assumed to be most important for the valuation is twofold. First, to keep the model practicable and reasonably transparent as the greater the number of probability distributions employed in a random simulation, the higher the likelihood of generating inconsistent scenarios because of the difficulty in setting and monitoring relationships for correlated variables. Second, the cost (in terms of expert time and money) needed to define accurate probability distributions and correlation conditions for many variables with a small possible impact on the result is likely to outweigh any benefit to be derived (Ragsdale, 2004) . Despite the fact that, there is no simple rule as to which cash flow variables should be included and which should be simplified, Sensitivity analysis usually precede simulation to determine which variables are important so that special care may be taken to obtain their precise probability distributions; and which are not so that a single estimate of the variables may suffice (Savvides, 1994) .

2.2.2 Specifying the Probability Distributions for Key Uncertain Cash flows

Once the key uncertain cash flows in the model are identified, the next step is to select the input models or probability distributions pdfs that represent their randomness and match their uncertainty either subjectively or from historical data. There are a number of choices within either discrete probability distributions (e.g. binomial or Poisson) or continuous distributions (e.g. the normal or lognormal distribution). According to Damodaran (Damodaran, 2002) making this choice, should consider the following factors:

- The range of feasible outcomes for the variable. The costs for example cannot be less than zero, ruling out any distribution that requires the variable to take on large negative values, such as the normal distribution).
- The experience of the company on this variable. Data on a variable, such as historical revenue, may help to determine the type of distribution that best describes it.

While no distribution will provide a perfect fit, the distribution that best fit the data should be used. In fact in the case of an existing data track record, it is easy to estimate an appropriate theoretical distribution (e.g. by using the Maximum Likelihood Method) and to test the estimated distribution empirically (e.g. by using the Chi-Square Goodness-of-Fit Test, Kolmogorov-Smirnov Test or the Cramer von Mises Goodness-of-fit Test) (Bratley at.al, 1987), and (Winston, 2001) . However, for a stochastic variable, data may be incomplete or do not exist at all. In that case, mostly evaluations by experts are utilized and distributions with rather transparent assumptions are applied (Bratley at.al, 1987). In addition, in the case of a lacking data history there are distribution types that reflect the data problem adequately (Winston, 2001) (see Figure1):

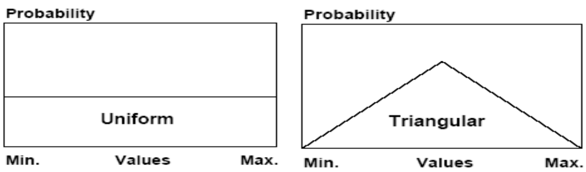

Fig. 1. Multi-value Probability Distributions

- Triangle random distribution: only three parameters are needed, the most probable case and a left and right border of the distribution.

- Continuous uniform distribution: this distribution can be chosen, if no perceptions about a most probable case are available, but the parameter values are believed to be distributed within two borders.

Next to the distribution choice, the parameters of the pdfs chosen have to be estimated. The pdf's parameters are defined by common statistical parameters such as mean ($\boldsymbol{\mu}$), standard deviation ($\boldsymbol{\sigma}$), median, minimum, maximum, and most likely value (Savvides, 1994) . The number of parameters will vary from distribution to distribution; for instance, the mean and the variance have to be estimated for the normal distribution, while the uniform distribution requires estimates of the minimum and maximum values for the variable (Ragsdale, 2004) . Ultimately the pdf's size, shape, location, and dispersion parameters affect the range of values that the input may use during each iteration of the simulation model (Goldman and Emmett, 2003) .

Correlations

One additional factor to be considered to execute a realistic simulation is the correlations between variables. These correlations allow variables to be linked across time (*serial correlation*) or for one variable to be linked to another (*inter-variable correlation*). A serial correlation is used to model the relationship of a particular variable from year to year (e.g. the revenue growth rate). Inter-variable correlation is used when there is a relationship between two variables. An example of an inter-variable correlation is between sales and expenses (Kelliherand Mahoney, 2000).

2.2.3 Run the Simulation DCF Model

The simulation runs step is the part of the valuation process in which the computer takes over. Once all assumptions, including correlation conditions, have been set to DCF variables, the computer selects randomly within the specified ranges and in accordance with the set probability distributions and correlation conditions and generates many sample paths of the values of the cash flows components (Seila, 2004) . The cash flow components of each iteration are then discounted using the corresponding discount rates; a net amount is calculated for each iteration, and the average of all the net amounts provides an estimate of the value of an Internet firm along with its expected value, standard deviation and other statistics. The process is repeated many times, until a sufficient number of simulations have been conducted (usually when the simulated distribution of results changed very little as more sample experiments are used) (Savvides, 1994) . In general, the more complex the distribution in terms of number of values that the variable can take on, the number of parameters needed to define the distribution and the greater the number of variables, the larger this number will be (Mun, 2003) . The simulation process as a cycle that is repeatedly undertaken to perform the calculations required to build up the distribution of an Internet company value is outlined in Figure 2 below.

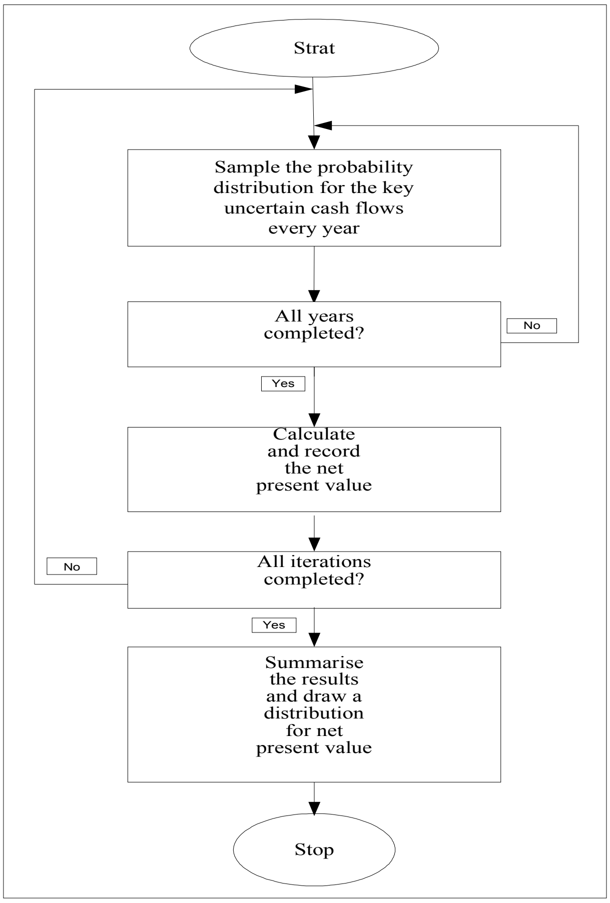

Fig.2. Monte Carlo Simulation Sampling Process

2.2.4 Analysis of the Simulation Results

In this step analysis and interpretation of the simulation results should be completed. The simulation results are organized and presented in the form of a probability distribution of the possible outcomes of an Internet company value. The probability distribution includes the entire range of possible outcomes, the most likely outcomes and the probability of its occurrence. Beside graphical formats, the simulation results are also reported various measures of location, dispersion, skewness, and kurtosis of the stock value. In addition, certainty ranges or degree of confidence (e.g. 95%) can be set to determine the probability that the forecast will exceed some minimum value (Law and Kelton, 2000) , and Powell and Baker, 2004) .

3 CONCLUSION AND FUTURE RESEARCH

The Simulation DCF approach has been put in this research as a complementary or an extension for the traditional DCF for valuing Internet companies as the DCF approach has been criticized for failing to account properly for uncertainty characteristics of these companies' cash flows and hence, does not value them correctly.
DCF valuation is the most accepted and widely used approach for company valuation. However, the model in its traditional version is of limited use for valuing Internet Companies where a high uncertainty characterizes their cash flows. Monte Carlo simulation that incorporating the stochastic processes underlies the cash flows has made it easy to quantify uncertainty into the DCF model. Unlike traditional single-point estimates that often ignore uncertainty, the quantitative results of Monte Carlo simulation may help appraisers and investors better understand the impact of uncertainty on their estimates of market value. Ultimately, this may result in more accurate, efficient, and effective investment decisions. A probabilistic model can better analyze the interactions between uncertain inputs that are represented by a range of possible values, or by data that may not be normally distributed. In future research the researchers will validate the proposed model by conducting case study(s).

References

Benninga, S. (2001) Financial modeling, Second edition, The MIT Press, Cambridge, London, 2001.
Bratley, P., Bennett, L. F. and Linus, E. S. (1987) A guide to simulation, Second edition, Springer-Verlag.
Brealey, R and Myers, S. (2000) Principles of corporate finance, Sixth edition, McGraw Hill, College Division, USA.
Booth, L. (2003) Discounting expected values with parameter uncertainty, Journal of Corporate Finance 9(5), 505-519.
Copeland, Koller, T. and Murrin, J. (2000) Valuation: measuring and managing the value of companies, New York, NY: John Wiley and Sons.
Damodaran, A. (2002) Dealing with distress in valuation, Working Paper, Stern School of Business, New York University, Available at: http://pages.stern.nyu.edu/~adamodar/
Damodaran, A. (2001a) The dark side of valuation: valuing old tech, new tech, and new economy companies, First edition, Prentice Hall, Upper Saddle River, NJ.
Damodaran, A. (2001b) Investment valuation, preliminary second version, available at: www.damodaran.com
Fernandez, P. (2001) Valuation and Value-Creation in Internet-Related Companies, Working Paper, IESE Business School, Barcelona, Spain, available at: www.ssrn.com.

French, N. and Gabrielli, L. (2004) The uncertainty of valuation, Journal of Property Investment and Finance, 22(Booth, 2003), 2004, 484-500.

Goldman, L. and Emmett, H. (2003) Crystal ball for six-sigma tutorial, In proceedings of the 2003 Winter Simulation Conference, New Orleans, LA, 293-300.

Graham, R. J. and Harvey R. C. (2001) The theory and practice of corporate finance: evidence from the field, Journal of Financial Economics 60 (2-3), 187-243.

Hertz, D. B. (1964) Risk analysis in capital investments, Harvard Business Review, 42: (January-February), 95- 106.

Higson, C. and John, B. (2000) Valuing Internet businesses, Business Strategy Review, 11(1), 10-20.

Kelliher, F.C and Mahoney S. L. (2000), Using monte carlo simulation to improve long-term investment decisions, The Appraisal Journal, 68(1), 44-56.

Law, A. M. and Kelton, W.D (2000) Simulation modeling and analysis (Singapore: McGraw-Hill.

Maya, C. (2004) In search of the true value of a start-up firm: creative destruction and real options approach (CD-ROM), In Proceedings of the 8th Annual International Conference on Real Options, Montréal Canada, 200-268.

Mun, J (2002) Real options analysis: tools and techniques for valuing strategic investments and decisions, Wiley Finance, New York NY.

Mun, J. (2003) Applied risk analysis: moving beyond uncertainty in business,Wiley Finance, New Jersey, NJ: John Wiley and Sons.

Powell, S.G and Baker, K. R (2004) The art of modeling with spreadsheets, Hoboken, NJ: Wiley.

Ragsdale, C.T (2004) Spreadsheet modelingand decision analysis, Mason, OH: Southwestern.

Reilly, F. K. and Keith, C. B. (2003) Investment analysis and portfolio management, Southwestern: Thomson.

Savvides, C. S. (1994) Risk analysis in investment appraisal, Project Appraisal, 9(1), 3-18.

Seila, A. F. (2004) Spreadsheet simulation, In the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C, USA

Winston, W. (2004) Operation research, Volume two: Probability models, Belmont, CA: Thompson.

Winston, W. (2001) Financial Models using Optimization and Simulation Il, Third edition, Palisade, Newfield: NY.