Simulation discounted cash flow valuation for internet companies

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Abstract: Discounted cash flow (DCF) is the most accepted approach for company valuation. However, the DCF approach presents a number of serious weaknesses within the internet companies’ context. One of these weaknesses is tackling the uncertainty that characterise future cash flows of these companies. This paper looks at the way in which uncertainty can be incorporated into the DCF approach so that the latter, which is otherwise conceptually sound, becomes relevant. This is done by utilising a probability-based valuation model (using Monte Carlo simulation) to incorporate uncertainty into the analysis and address the shortcomings of the current model. The process leads to a probability distribution of the valuation criterion used, giving investors a quantitative measure of risk involved. The paper takes the case of a real internet company to illustrate the approach and highlight the benefits and the difficulties, which are encountered.

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


Biographical notes: Maged Ali is a Lecturer of Business and IT at Business School, Brunel University (UK). He has achieved a multi-disciplinary research background in information systems, cross-cultural studies and business management. He has been a Visiting Lecturer at several universities in UK and abroad (Egypt, Qatar, France, KSA). He is a Business Consultant for several companies in UK and abroad (Egypt, Qatar, China, KSA). He is a member of editorial committee of several journals, as well as co-and-mini-track chair to international conferences. He has edited special issue journals and publishes his scholarly work in well established journals and conferences.
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 utilised 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 characterise future cash flows of these companies (Mun, 2002; 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 characterised 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 lead to flawed valuation for these companies (Booth, 2003; 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 (Kelliher and 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 characterise 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 (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 (Kelliher and Mahoney, 2000). The present research is the first attempt to apply MC simulation to the DCF valuation of internet companies. The paper proceeds as follows: Section 2 (Damodaran, 2001a) proposes a simulation DCF approach for internet companies starting with building a deterministic DCF model in Section 2.1. Modelling the uncertainty in the DCF analysis using MC simulation is examined in Section 2.2. Section 4 (Graham and Harvey, 2001) concludes and summarises 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
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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 modelling 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

- \( V \) is the value of the internet company;
- \( FCF_t \) is the free cash flow of period \( t \);
- \( WACC \) is the weighted average cost of capital;
- \( T \) is the planning horizon period;
- \( TV \) is the 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).

\[
FCF = EBIT (1-t_c) - (CE - D_p) - CWC
\]

where

- \( FCF \) is the free cash flow;
- \( EBIT \) is the earning before Interest and Taxes = Revenue – cost of revenue – other operating expenses.
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 the 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; Reilly and Keith, 2003). Despite this difficulty, 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 emphasises 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. The 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 the 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).

\[
\text{WACC} = K_e \frac{V_E}{V_E + V_D} + K_d (1 - t_c) \frac{V_D}{V_E + V_D}
\]

Here

- \( K_e \) the cost of equity
- \( K_d \) the cost of debt
- \( (t_c) \) the tax benefits of borrowing
- \((V_E, V_D)\) 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
- \( \beta \) beta of company
- \( r_m \) 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 \((g)\):

\[
\text{Terminal value} = \frac{\text{FCF}_{n+1}}{(\text{WACC}_{n+1} - g)}
\]

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 gives 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 (2004) and Seila (2004), modelling uncertainty using MC simulation includes the following steps: identifying an internet company’s key cash flows that are heavily impacted by uncertainty (Maya, 2004). Determining the input models that reflect their randomness and match their uncertainty (Damodaran, 2001a). Implementing and run the simulation DCF model (Graham and Harvey, 2001). And finally, (Damodaran, 2001b) analyses 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 have little impact on value (Ragsdale, 2004). The reason for only modelling those stochastic cash flows assumed to be most important for the valuation is two-fold. 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 (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 et al., 1987; 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 utilised and distributions with rather transparent assumptions are applied (Bratley et 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 Figure 1):

- 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.

![Figure 1: Multi-value probability distributions](image)

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 ($\mu$), standard deviation ($\sigma$), median, minimum, maximum, and most likely value (Savvides,
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 (Kelliher and 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.

### 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 organised 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; Powell and Baker, 2004).
Figure 2  Monte Carlo simulation sampling process

1. Sample the probability distribution for the key uncertain cash flows every year.
2. All years completed?
   - No
   - Yes
   - Calculate and record the net present value
   - All iterations completed?
     - No
     - Yes
     - Summarise the results and draw a distribution for net present value
3. Stop
3 Case study example

The case example used to illustrate the model involves a typical internet company. Due to confidentiality reasons, the name Virtual Firm is used to refer to the company being reported. Virtual Firm further referred to, as VF, is a start-up B2B marketplace. VF wants to offer online auctions as well as individual procurement solutions for enterprises and virtual marketplaces. Besides the required software applications, it also offers several services in order to provide optimal support for its clients to undertake successful transactions. Its business activities will be focused on the electronic and computer industry, so that VF can be considered as a vertical marketplace.

3.1 Valuation problem

Valuation of VF presents several challenges. The company does not yet produce the cash flows or accounting earnings that typically drive comparable and DCF valuations. The company also operates in a new and uncertain industry. Although many investors and analysts may use DCF approaches in order to value the company reasonable. But DCF as a stand-alone approach has many flaws. One important issue is that DCF assumes the future evolution of VF is known with certainty. Given that the future events that affect the company’s future cash flows are highly uncertain, there is often little confidence in its accuracy. To account for uncertainty inherent in the DCF valuation, we develop a simulation-DCF model for VF following the methodology presented in the previous section.

3.2 Building a deterministic DCF model for VF

The first stage in the VF’s valuation is to develop a DCF model for the firm. Since VF is a start up, the firm has no historical record yet, it is therefore not possible to use forecasting techniques (e.g. time-series and regression to estimate the model’s cash flows. Despite the evident valuation problems and to construct the DCF model for VF we will rely on the consensus estimates made by VF’s financial analysts. The analysts’ estimates are based on the long-run Institutional Brokers’ Estimate System - I/B/E/S. The I/B/E/S is a system that gathers and compiles the different estimates made by stock analysts on the future revenues and earnings for the majority of US publicly traded companies. The analysts’ estimates for VF’s cash flows and the other inputs assumptions are shown in Table 1. The results of the DCF analysis based on these assumptions are as follows:

\[
\begin{align*}
\text{PV Free cash flow} &= \$115.617 \text{ million} \\
\text{PV Terminal value} &= \$429.312 \text{ million} \\
\text{Total value of Virtual Firm} &= \$544.929 \text{ million} \\
\text{Value per share} &= \$14.34 \ ($544.929 \text{ million}/38 \text{ million share})
\end{align*}
\]

The full set of valuation calculations are available to interested readers and may be obtained from the first mentioned authors of this paper.
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Table 1 DCF model assumptions for VF

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast period</td>
<td>10 years (2004–2013)</td>
</tr>
<tr>
<td>Revenue growth rates</td>
<td>56%</td>
</tr>
<tr>
<td>Terminal growth rate</td>
<td>3%</td>
</tr>
<tr>
<td>Tax rate</td>
<td>34%</td>
</tr>
<tr>
<td>Cost of sales</td>
<td>10.4% of revenues</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>36.8% of revenues</td>
</tr>
<tr>
<td>Depreciation</td>
<td>5.5% of revenues</td>
</tr>
<tr>
<td>Operating expenses</td>
<td>80% of revenues in 2004 decreasing to 20% by 2013</td>
</tr>
<tr>
<td>Capital expenses</td>
<td>45% of revenues in 2003 decreasing to 10% by 2013</td>
</tr>
<tr>
<td>WACC: cost of equity</td>
<td>$17.96%$ ($\beta$: 1.5, $r_f$: 6.71%, $r_m$: 7.50%)</td>
</tr>
<tr>
<td>Capital structure has no debt</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Modelling VF’s DCF model uncertainty

The DCF analysis in the previous section provides a useful first step for valuating VF. However, single point estimate of growth rates, costs, capital expenditures, working capital and other financial variables was used to predict a point estimate for the company stock value. Given that the major variables applied in the DCF model do vary to a certain extent according to different market circumstances, there is often little confidence in its accuracy. In reality a large degree of uncertainty is associated with their true future values. These uncertainties underlie the cash flow estimates were therefore overlooked in the DCF valuation. In addition, implicitly underpinning the DCF model is the going concern assumptions and that VF will be in a healthy financial state until infinity. The model therefore, neglects the possibility that the company may go bankrupt. Yet, the recent overall economic downturns reality shows that this assumption does not generally hold. Particularly every day we see concrete evidence of internet companies’ bankruptcy risk. To account for these uncertainties, we use MC simulation techniques to model the stochastic process underlying the VF’s cash flows following the methodology presented in the previous section.

Identifying VF’s key uncertain cash flows

To identify VF’s critical cash flows, a sensitivity analysis in the form of tornado chart with the deterministic model is performed (Figure 3). Tornado chart is a deterministic sensitivity analysis in which we vary each parameter independently to evaluate which parameters most affect the valuation. The analysis is based on the assumption that each parameter in the model varies up and down by the same percentage (10%) of its base-case value. The results suggest that the VF’s valuation is most dependent on four parameters: revenue growth rate, R&D as a percentage of revenues, beta, and the market risk premium. Since the value of beta can be estimated with reasonable accuracy from the performance of comparable companies, our uncertainty analysis focuses on the other three parameters.
Specifying the input models for VF’s key uncertain cash flows

Once VF key uncertain cash flows in the DCF model are identified, the next step is to select the Input models or pdfs that represent their randomness and match their uncertainty either subjectively based on experts’ opinions or objectively from past empirical data. Since VF’s historical data is not helpful to identify the pdfs of key uncertain cash flows. The subjective probabilities based on the financial analysts as expert judgments are therefore, used. After considerable revision about the uncertainties governing each of these parameters, the following probability distributions were adopted:

- **Revenue growth rate**: Normal, with a mean of 65% and a standard deviation of 5%. Based on the mean and standard deviation of the analysts’ forecasts.

- **R&D as a percentage of revenues**: Triangular, with a minimum of 32%, most likely value of 37%, and a maximum of 42%. Based on the minimum, median, maximum of the analysts forecasts.

- **Market risk premium**: Uniform, with a minimum of 5% and a maximum of 10%. Based on the empirical research that risk premium was historically between 5–10%.

Implementing and run the simulation model

Having built the deterministic DCF model for VF and specified the pdfs for key uncertain cash flows in the model, it is technically possible to advance to step of implementing the
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Simulation DCF model and create the simulation runs on the model. To create the simulation runs, an MC sampling procedure with Crystal Ball added in software was used to value VF for a large number of iterations (Crystal Ball is a simulation add-in package for Excel which provides several features that are not included in Excel basic spreadsheet and automates some of the more complex task required in MC simulation) (Goldman and Emmett, 2003). As more sample experiments are drawn, VF’s stock value (NPV) distribution becomes more stable as the statistics describing the distributions change less until they converge. The results presented here are based on 10000 sample simulation experiments. Because the simulated distribution of results changed very little as more sample experiments were used, it can be concluded that the number of samples was sufficient to provide stable outcomes. After the simulation there is a vector of realisations of all key figures for VF’s stock value that we are interested in. This is the basis for analysis and evaluation presented next.

Analysis of simulation results for VF

The simulation results are presented in the form of a probability distribution of the possible outcomes of VF’s stock value (Figure 4). The probability distribution includes the entire range of possible outcomes, the most likely outcomes and the probability of its occurrence. The simulation DCF model produces an expected value or a mean of $16.86 for VF stock value and standard deviation of $8.8, accounts for 52% of the distribution mean. Minimum value however, is equal to $1.54 and maximum value is $39.68. The certainty level that the company share price would equal to its market price $28 or above is only 12% and the possibility of firm going bankrupt under analysts’ assumptions is zero. Beside graphical formats, the simulation results are also reported various measures of location, dispersion, skewness, and kurtosis of the stock value probability distribution (Figure 4). Figure 5 reports a positive skewness (1.22). Positive skewness indicates the possibility of a very high stock value.

Figure 4 The distribution of VF’s stock value
4 Conclusions 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 criticised 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 characterises their cash flows. MC 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 MC 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 analyse 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


