

Incubating Real Options

**Can Option Pricing Theory
Help Investors Make Sense
of the
Business Models and Valuations
Of Internet Incubators?**

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Abstract

Internet incubators are a recent phenomenon – a product and some might argue a symptom of the Internet bubble of late 1999 and early 2000.

Created to spawn and nurture Internet start-ups, most Internet incubators are little more than start-ups themselves, with unproven business models and valuations that appear to defy rational thinking.

The business models of Internet incubators are examined in the context of Real Options Analysis, an emerging valuation methodology derived from Option Pricing Theory and applied to fields as diverse as oil extraction and biotechnology.

Real Options analysis has been championed by those who believe traditional discounted cash flow methodologies are unable to capture or quantify the value attached to the uncertainty that surrounds high growth industries.

The characteristics of Internet incubators are established and examined to see how an awareness of Real Options can help to enhance the value of the hatchlings in the incubator's portfolio.

Several different approaches to valuing hatchling companies are described, drawn mostly from attempts to value other assets such as drugs under development or research and development portfolios. Evidence of the usefulness of Real Options analysis in the valuation of start-up companies is surveyed and presented.

It is concluded that Real Options analysis offers great potential to help investors value a portfolio of Internet start-ups.

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1. Introduction

The explosive growth of the Internet and the valuations of many young Internet companies have caused both delight and dismay among investors who trade in Internet stocks.

Companies with no history, no profits and sometimes even no sales are trading at levels that appear to be irrational when viewed from the perspective of conventional discounted cash flow techniques.

But over the past few years, traditional valuation models have come under attack from those who believe that DCF is too rigid a framework in which to assess the worth of companies whose value is in their potential rather than their identifiable cash flows. Instead, they argue that Real Options analysis – a branch of option-pricing theory applied to real assets – is a more appropriate way to value high growth companies whose business models may be enhanced by uncertainty in the markets in which they trade. Moreover, Real Options analysis captures the flexibility that managers can exercise when making investment decisions that enhance the value of the company.

This dissertation attempts to apply Real Options ‘thinking’ to Internet incubators – investment companies that spawn and nurture Internet start-ups until they are ready for an independent existence.

A brief history of the Internet is presented in Chapter 2, followed by a description of Internet Incubators and their business models in Chapter 3.

Chapter 4 surveys recent attempts to make sense of how ‘mature’ Internet companies are valued by both academics and analysts studying the field.

Real Options are introduced in Chapter 5 and Real Options ‘thinking’ is applied to Internet incubators in Chapter 6, to see how managers can

increase the value of their ‘hatchling’ companies by identifying and influencing the values of the Real Options available to them.

Because most incubators are young, undiversified entities, there is little data with which to build and test a model capable of valuing an Internet incubator or even its start-ups. A formal valuation is, therefore, beyond the scope of this paper. However, several Real Options approaches drawn from fields such as drug development and R&D are described in Chapter 7 and similarities with Internet incubators are identified. Evidence that Real Options valuations may have some explanatory power when studying venture capital investments is also presented.

After highlighting some practical problems in the application of Real Options methodologies to the staged nature of incubator investments, Chapter 8 concludes that Real Options analysis may be a more useful tool with which to understand the business models and valuations of Internet incubators than traditional methodologies.

2. The Internet Revolution

The Internet is a technological revolution that unifies some of the greatest innovations of the last century. Computers, communications and mass media have been brought together into a global multimedia network that embraces commerce, education and entertainment.

The Internet began life as ARPAnet¹ in the late 1960s – a military project funded by the US Government to explore how electronic messages could be broken into ‘packets’ and sent across the country along different routes then recompiled at the destination. The idea was that if a ‘hub’ of the network was destroyed, those parts of the message that arrived safely could call back to the sender and ask for the missing packets to be re-routed.

The first manifestation of the Internet came in 1969 when computers at four US universities (UCLA, Stanford, Santa Barbara and Utah) were linked together into a network². The network spread slowly at first, taking another 20 years to reach 100,000 ‘host’ computers. Three years later in 1992, a million computers were linked to the Internet.

In 1990, Tim Berners-Lee, a scientist at the CERN research facility in Switzerland, created the World Wide Web when he developed a language for linking disparate pages of information together in a computer network. His work was further developed in 1992 by computer scientists at the National Centre for Supercomputing Applications in Illinois, who created the first user-friendly ‘browser’, called Mosaic. Internet ‘surfers’ could now experience the net as a multimedia entity rather than accessing it through a command line interface.

¹ ARPA stands for Advanced Research Projects Agency.

² Hobbes’ Internet Timeline gives a good account of how the internet developed at <http://www.isoc.org/zakon/internet/History/HIT.html>

Many of Mosaic's developers formed an Internet start-up called Netscape to create a new web browser of the same name. Netscape later become the first major Internet flotation in 1995. With the increasing popularity of the Internet, the first online shops appeared in 1994 and the first primitive radio and video broadcasts came the following year.

Now an estimated 72m computers have access to more than a billion pages of information and entertainment on the Internet ³. The online population is forecast to reach 490m by 2002, including nearly 18m users in the UK ⁴. Recent statistics suggest that the average American user logs onto the Internet six times a week, for an average of 32 minutes per visit ⁵. Unlike the UK, American surfers have the benefit of free local connections to the Internet – a fact that has accelerated its adoption in the US.

From a commercial perspective, the Internet is a huge emerging business that didn't exist a decade ago. Analysts at the Gartner Group predict that in the US alone, online shopping will reach \$29.3bn this year, up 75% from 1999. Amazon.com, the world's largest internet retailer, sold goods worth \$578m in the second quarter of 2000 ⁶, while Cisco Systems, which makes internet infrastructure products, posted sales of \$18.93bn in the year to 29th July ⁷. The majority of its products were ordered over the Internet. Overall, the 'Internet economy' is forecast to be worth \$850bn this year, according to researchers at the University of Texas ⁸.

Set against the backdrop of the longest bull market in many decades, the Internet has created an unprecedented opportunity for new and existing businesses to take advantage of its commercial potential.

³ Source: Network Wizards Internet Domain Survey: www.commerce.net/research/stats/results.html

⁴ Source: The Computer Industry Almanac, reported at www.cyberatlas.com

⁵ Source: Nielsen/NetRatings: www.nielsen.com

⁶ Source: Amazon press release, www.amazon.com

⁷ Source: Cisco press release, www.cisco.com

Since the browser developer Netscape floated in 1995 (and it was, at the time, the third largest initial public offering in the history of Nasdaq), a further 296 Internet companies have listed on Nasdaq ⁹.

Start-up activity, too, has reached record levels. Figures published recently by PricewaterhouseCoopers reveal that in the second quarter of 2000, venture capital firms invested a record \$19.58bn in new companies, of which \$11.67bn was shared by 776 Internet start-ups. In the first three months of 2000, venture capitalists poured \$10.85bn into 770 Internet companies¹⁰.

The fact that investment increased in Q2 suggests that venture capitalists seem untroubled by the serious Nasdaq correction of March and April, or by the apparent change in sentiment towards Internet stocks elsewhere in the investment community.

⁸ The Internet Economy Indicators: www.internetindicators.com

⁹ Source: www.internetstocklist.com

¹⁰ Source: www.pwcmoneytree.com

3. The Rise of the Internet Incubator

With so much capital pouring from venture capital funds into Internet start-ups, many entrepreneurs saw the opportunity to create a new kind of ‘dotcom’ company – the Internet Incubator.

Internet Incubators are investment companies that spawn or nurture Internet start-ups, providing them with capital, contacts and services until the “hatchling” is ready for an independent life.

Chinsomboon (2000) defines an incubator as:

“A controlled environment that fosters the care, growth and protection of a new venture at an early stage, before it is ready for a traditional means of self-sustaining operation.”

In fact, incubators are not a new idea. They have existed for many years as technology transfer companies clustered around universities in the US and UK. However, Hansen *et al* (2000) have found that the majority of incubators could be classed as start-ups themselves, being less than two years old.

Of UK Internet Incubators and investment companies, the 39 listed on the Alternative Investment Market are mostly less than 12 months old (see Appendix 1.). At present they command a combined market capitalisation of £1.5 billion – many times their net asset value.

Hansen *et al* identified 356 incubators around the world, of which 92 per cent focused on Internet investments. Nearly half specialise in a single sector, such as business-to-business companies, infrastructure, software or content.

Incubators differ from traditional venture capital funds in that they take a more ‘hands on’ approach with their hatchlings. Chinsomboon (2000) identifies nine characteristics of a typical incubator:

- They frequently provide seed capital for entrepreneurs and help to develop the business plan
- They provide services including legal advice, public relations and marketing
- They provide experienced staff to help the business
- They actively recruit new staff for the venture
- They share their business acumen with the hatchling
- They provide an instant infrastructure, including office space and computers
- They encourage ‘networking’ between hatchlings in the portfolio
- They provide useful business contacts beyond the incubator
- They provide technology through relationships with suppliers and developers who might not otherwise deal with small start-ups

Typically an incubator has eight companies in its portfolio and provides seed capital of less than \$1 million, which is below the entry threshold of most venture capital companies. For this reason, incubators are popular investments among venture capital firms because they gain preferential access when the hatchlings need to raise more money.

Most incubators take an equity stake in the companies they incubate (see Table 1.) and make money from ‘liquidity events’ – when the hatchling is sold or floated on the markets – although some charge fees for their services and some have a mixture of both types of income ¹¹.

¹¹ According to Hansen *et al*, 55% of incubators surveyed have an equity-only model, 4% charge fees and 41% have a mixture.

Table 1. Equity stakes taken by incubators

Size of stake in Hatchling	% of Incubators
Less than 15%	21%
15 – 29%	27%
30 – 49.5%	26%
50 – 75%	18%
More than 75%	7%

Source: The State of the Incubator Marketplace, Harvard Business School.

This reliance on cash generated by the sale of equity after a flotation has caused many observers to question the viability of the incubator model, especially after the market collapse of April, which turned general investor sentiment against Internet stocks ¹². Incubators that saw their market values soar in the Internet frenzy of early 2000 now face an uncertain future because they are less able to float their hatchlings and achieve a quick and successful exit.

¹² Journalists Chris Ayres of *The Times* and John Waples of *The Sunday Times* sum up this change in investor sentiment in the articles reproduced in Appendix 2.

4. *The Challenge of Valuing the Internet*

The decline in fortunes experienced by Internet Incubators reflects a general downturn in the valuations of Internet companies. Many bellwether dotcoms are now trading well below their all-time highs. For example Amazon, which reached \$113 in December 1999, has dropped back to \$36.50, valuing it at \$13bn today ¹³. Formed in 1995, the company is typical of the sector in that it has yet to make a profit, yet its market value is six times the combined value of its high street rivals Borders and Barnes & Noble ¹⁴.

The highs and lows of other Internet stocks, including UK bellwethers Freeserve, QXL and Lastminute.com, are listed in Table 1 below.

Table 2. The performance of bellwether US and UK Internet stocks

Company	52-week high \$	Price at 7/9/2000 \$	Market Cap. \$bn
Amazon	113.00	43.50	15.48
Cisco Systems	82.00	66.25	470.14
CMGI	163.50	43.19	12.75
Freeserve	159.75	45.00	4.53
Healthon	75.19	17.94	3.93
Lastminute.com	46.50	13.06	0.40
Priceline	104.25	25.94	4.32
QXL	117.38	4.56	0.31
Real Networks	96.00	49.06	7.67

¹³ As at 22nd August, 2000.

¹⁴ To be fair, Borders and Barnes & Noble have not diversified as much as Amazon, although its main business is still selling books.

Webvan	34.00	4.03	1.90
Yahoo	250.00	106.94	58.74

Source: Stockpoint. (www.stockpoint.com)

Perkins and Perkins (1999) have documented the roller coaster ride of Internet stocks in their book *The Internet Bubble*. Writing in early 1999 they say:

“By our calculations, the 133 Internet companies that have gone public since Netscape in 1995 could be overvalued by as much as \$230 bn.”¹⁵

In fact, a look at the Hambrecht & Quist Internet Index (Figure 1.) shows how much further the Internet bubble would inflate before it burst in April.

Figure 1. The Hambrecht & Quist Internet Index from 01/01/98 to 07/09/00.



Source: Bloomberg

¹⁵ Perkins and Perkins, (1999) p3.

The apparently irrational pricing of Internet stocks has been the source of much discussion both in the press and in academic literature.

Copeland (2000) argues that an Internet company should be valued by assessing how much it could increase the value of an acquirer. For example, an Internet start-up whose technology could allow AOL to increase its growth rate by 1% a year would add \$10.8 billion to the present value of AOL¹⁶. Shareholders should be prepared to pay up to this amount if it created value, even if the start-up had never returned a profit.

Shiller (2000), on the other hand, cites the example of two toy retailers – one on the Internet, the other in the shopping malls of America:

“Consider, for example, eToys, a firm established in 1997 to sell toys over the Internet. Shortly after its initial public offering in 1999, eToys’ stock value was \$8bn, exceeding the \$6bn value of the long-established “brick-and-mortar” retailer Toys “R” Us. Yet in fiscal 1998, eToys sales were \$30 million, while Toys “R” Us sales were \$11.2 billion, almost 400 times larger. And eToys profits were a negative \$28.6 million while Toys “R” Us profits were a positive \$376 million.”¹⁷

Irrational Exuberance - the title of Shiller’s book - may yet turn out to be the most reasonable account of why shares in such young, profitless companies soared to such stratospheric levels. Low inflation, the rise of mutual funds and the increased (and increasingly urgent) media reporting of business matters are contributing factors, according to Shiller¹⁸.

¹⁶ Copeland (2000) p29.

¹⁷ Shiller (2000), p176.

¹⁸ *ibid*, p17.

Perkins and Perkins (1999) cite momentum trading through Internet-based brokers and the relatively small free floats of Internet companies as supply and demand factors contributing to the speculative bubble ¹⁹.

With no earnings to discount, very little trading history to study and few comparable businesses against which to benchmark, investment analysts have struggled to project future cash flows or make sense of the valuations before them in the market.

A frequent argument was that the valuation rules of Graham and Dodd (1934) no longer applied to companies whose assets were less bricks and mortar and more intangible concepts such as management skill, branding, customer databases and 'first mover advantage'.

Although Price / Earnings ratios offer a convenient shorthand for discounted cash flows – the traditional measure of worth - allowing analysts to estimate a firm's share price by comparison with its rivals, the fact is that most Internet companies have few comparable rivals and even fewer earnings. Even those Internet companies returning profits have flummoxed most observers when their P/E ratios were calculated. Yahoo! has seen a P/E ratio of 1900, compared with an average of 31 for companies in the S&P 500²⁰.

The absence of earnings (and sometimes, even revenues!) has led many analysts to use other benchmarks such as Price / Sales ratios or metrics based on traffic statistics. The reasoning goes that if company X has a market capitalisation of \$2bn and 2 million users, it is worth \$1000 per unique user. A rival company Y, which has a million users, should be worth \$1bn.

¹⁹ Op cit. p25. It is estimated that more than 7m day traders are active in Nasdaq, which is dominated by retail investors.

²⁰ Perkins and Perkins (1999), p21.

Damodaran (2000) has produced a practical model for the relative valuation of young firms with no earnings history and no comparable firms, using Amazon.com as an example.

The unpredictable nature of future cash flows is embraced and quantified rather than rejected as “noise” and the result is a range of valuations based on assumptions about compound annual growth rates and pre-tax operating margins over the next 10 years. The figures are summarised in Table 3. below.

Table 3. The value of Amazon.com shares calculated under different assumptions about 10-year compound annual growth rates and pre-tax operating margins.

10 year Revenue Growth	Pre-Tax Operating Margin				
	<i>6%</i>	<i>8%</i>	<i>10%</i>	<i>12%</i>	<i>14%</i>
<i>30%</i>	- 1.94	2.95	7.84	12.71	17.57
<i>35%</i>	1.41	8.37	15.33	22.27	29.21
<i>40%</i>	6.10	15.93	25.74	35.54	45.34
<i>45%</i>	12.59	26.34	40.05	53.77	67.48
<i>50%</i>	21.47	40.50	59.52	78.53	97.54
<i>55%</i>	33.47	59.60	85.72	111.84	137.95
<i>60%</i>	49.53	85.10	120.66	156.22	191.77

Source: Damodaran Online

At the time of Damodaran’s analysis, Amazon’s shares traded at \$84, suggesting that investors were assuming a compound annual growth rate of around 55% and margins of 10%, or 50% growth and margins of about 13%.

The shares now trade at \$43.50²¹, implying at least 50% growth and 8% margins or 45% growth and 10% margins. Not even Microsoft has sustained growth rates of 50% for such a long period.

Damodaran comments:

“For any investor or analyst the follow-up question becomes a pragmatic one: What are the odds of such an occurrence, and if the odds are low, do you want to tie an investment decision (buying Amazon) to an optimistic scenario that has a low probability of occurrence?”²²

Amazon is also the subject of a valuation by Desmet *et al* (2000), who combine a traditional DCF analysis with microeconomic analysis and probability-weighted scenarios to value Amazon at \$23 billion or around \$66 per share at the end of 1999.

Most academic research on Internet stock valuations has attempted to identify the drivers of Internet stock prices by studying the correlation between stock prices and accounting variables or non-financial data such as traffic statistics. Firms such as Media Metrix and Nielsen//NetRatings produce weekly summaries covering variables including unique visitors to a web site, the number of pages viewed and the time spent on the site²³. Intuitively, the more visitors a site receives, the greater should be its worth for exactly the same reason that the most popular TV shows command the highest advertising rates.

²¹ As at 7/9/00

²² Damodaran (2000) p42.

²³ A unique visitor is counted only the first time they view a page from a web site in a set period. However, they may view 10, 100 or 1000 pages (page views) during their visits to the site.

Trueman *et al* (2000a) found a negative association between bottom-line net income and market prices, although gross profits were positively and significantly associated with market prices²⁴.

Furthermore, the numbers of unique visitors and page views provided incremental explanatory power for stock prices, although the latter metric was more important for retail sites than portal/content sites²⁵.

In a follow-up paper²⁶ the same authors find that analysts' forecasts underestimate the future revenues of Internet companies by about 11 per cent, suggesting that they fail to make use of all the financial and non-financial data available to them²⁷. Consistent with their previous paper, estimates of traffic growth are also important in predicting revenues, but more so for retailers than portal/content sites.

Rajgopal *et al* (2000) also report the importance of traffic measures for explaining stock returns after controlling for accounting variables such as book value and earnings. However, contrary to Trueman *et al* (2000b) they found weak associations between traffic and sales levels or sales growth. By looking at acquisitions of Internet companies, Rajgopal *et al* found that firms were willing to pay an average of \$167 per monthly unique visitor and that traffic measures accounted for 77 per cent of the cross sectional variation in acquisition prices.

However, Hand (2000a) found that web traffic statistics and supply and demand factors were poor explanations for the high valuations of Internet companies. Accounting fundamentals in the form of current book equity,

²⁴ They argue that the bottom line often includes large transitory items such as merger costs which investors are unlikely to factor into a valuation.

²⁵ A portal, such as Yahoo! or Freeserve, is a web site that aggregates diverse content and services.

²⁶ Trueman *et al*, (2000b).

²⁷ Shiller (2000), p31, suggests such underestimates are part of a game played by firms' investor relations departments in order to produce pleasant 'surprises' when the numbers are published. Analysts, he says, tend to play along in order to maintain good relations with the company.

forecasted one-year earnings and forecasted long-term growth were the main drivers of stock prices. Apart from the fundamentals, only one traffic measure – unique visitors – was reliably albeit weakly associated with stock prices. Beyond these factors, proxies for supply and demand such as public float, short interest and institutional holdings provided incremental explanatory power, but only for firms with no business-to-consumer traffic. Market values were not related to the number of page views or time spent on the web site.

Hand (2000b) also reports that market values are linear and increasing in book equity, concave and increasing in both positive net income and marketing costs, especially when the firm is losing money.

Rejecting the argument that the pricing of Internet stocks is “a chaotic mishmash defying any rules of valuation”²⁸ he concludes that “there is a high degree of method in the pricing of Internet stocks: Net firms’ market values are strongly correlated with accounting data in the logarithmic scale.”²⁹

Others, too, argue that the pricing of Internet stocks is more rational than at first appears. Mauboussin and Hiler (1999) point to value drivers that are “not obvious and are, in some cases, counterintuitive.”³⁰ Among them are favourable cash inflows³¹, a ‘network effect’³² and embedded ‘options’, such as the option for the bookseller Amazon to expand into music and video sales, or for Yahoo! to become an online broadcaster³³.

²⁸ Wall Street Journal, 27/12/99, quoted in Hand (2000b) p2.

²⁹ Hand (2000b) p3.

³⁰ Mauboussin and Hiler, (1999) p2.

³¹ For example Amazon, which charges the buyer’s credit card almost immediately but which pays its suppliers 45 days later. With just two weeks inventory, it can generate additional cash from working capital.

³² Imagine an online auction site with 10 customers selling goods to each other every day, thus generating 100 transactions. Adding another customer creates 11² or 121 transactions, an increase of 21%.

³³ Which it became with the acquisition of Broadcast.com in 1999.

Schwartz and Moon (2000) develop a rational pricing model for Internet stocks using option pricing theory and Monte Carlo simulation and arrive at a baseline value for Amazon.com of \$5.45 bn as at 31st December 1999.

At \$12.42 per share, the valuation was significantly below the \$76 per share seen in the market that day and was also below the valuations obtained by Desmet *et al* (2000).

However, they observe:

“...depending on the parameters chosen, the value of an Internet stock may be rational, given high enough growth rates in revenues. Even with a very real chance that a firm may go bankrupt, if the initial growth rates are sufficiently high, and if there is enough volatility in this growth over time, then valuations can be what would otherwise appear to be dramatically high.”³⁴

In effect, what they are saying is that investors are pricing the company's potential above and beyond the present value of its identifiable future cash flows. They are adding Real Options to the valuation.

³⁴ Schwartz and Moon, (2000), p 4.

5. A Primer on Real Options

A call option is a financial instrument that grants its owner the right, but not the obligation to buy an asset - usually a share - for a given price on or before a given day. A put option gives its owner the right to sell for a given price. Although the owner pays a premium for this right, the premium costs significantly less than the underlying asset on which it is based. If the price of the asset – the spot price (S) - rises above the agreed buying price – the strike price (X) – then exercising the option results in a profit. At worst, the option can expire worthless, where $S - X$ is less than zero, so the buyer loses only the premium. The distribution of returns is therefore asymmetric, protecting the buyer from downside losses but allowing potentially large profits.

The most common method of pricing a call option is the Black-Scholes model ³⁵, where the cost of the option (C_0) is:

$$C_0 = S_0 N(d_1) - Xe^{-rT} N(d_2)$$

where $d_1 = \frac{\ln(S_0 / X) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$ and $d_2 = d_1 - \sigma\sqrt{T}$

$N(d)$ is the probability that a random draw from a standard normal distribution will be less than (d).

³⁵ Black, F. and Scholes, M., (1973), “The pricing of options and corporate liabilities”, *Journal of Political Economy*, 81.

The cost of the option is dependent on five variables:

S_0 = the current stock price

X = the exercise price

r = the risk free rate of interest

T = the time left before the option matures

σ = the volatility of the underlying asset (normally measured as the standard deviation of the annualised, continuously compounded rate of return of the stock.)³⁶

Table 4. shows the cost of a call option where all the variables except the volatility are held constant.

Table 4. Cost of a call option as a function of volatility

S	90	90	90	90
X	100	100	100	100
r (%)	5	5	5	5
T (years)	1	1	1	1
σ (%)	20	30	40	50
Cost	5.09	8.66	12.25	15.82

It can be seen that increasing volatility increases the value of the call option. This volatility reflects the uncertainty as to the actual share price after one year. Higher volatility means a higher potential share price at maturity, although it could just as easily be ‘out of the money’, in which case the option expires worthless.

Following the development of the Black-Scholes model³⁷, option-pricing theory was employed in an attack on the discounted cash flow techniques that dominated capital budgeting approaches to projects that involved

³⁶ Definition taken from Bodie, Z., Kane, A and Marcus, A.J., (1999), *Investments*, Irwin/McGraw Hill.

tangible and intangible assets, in particular research and development projects which appeared to have the same payoff structure as a call option.

The term “Real Options” was coined by Myers (1984) to capture the flexibility available to managers when considering the investment opportunities available to them.

Conventional capital budgeting measures the present value of the investment required by a project against the present value of the cash flows it will generate. These cash flows are discounted using an appropriate ‘discount rate’ that captures management’s perception of the project’s level of risk. Often, several discount rates are used to capture the level of risk at different stages of the product. The result is called the project’s Net Present Value. As a rule, managers should not undertake projects with a negative NPV. Moreover, faced with several alternative projects generating positive values, they should chose the one with the highest NPV.

This approach has been criticised as naive because it assumes that investments are one-off, now or never projects that will be seen through to completion and which will not open up any hidden opportunities to make new and profitable investments^{38 39}, or to abandon or change the plan if required.

In the context of the Internet incubator, NPV fails to take account of the value added by shrewd management or the staged nature of the investment process, which has several ‘proceed or abandon’ decisions, each of which is influenced by information gained after the previous investment round was committed.

³⁷ Which was enhanced by Robert Merton in 1973 to take account of dividend payments

³⁸ See Dixit and Pindyck, (1995), p106 for a typical critique.

³⁹ Luehrman (1998) makes the point that net present value is equal to the value of a call option at the time of expiry, because when $T=0$ there is no volatility and no time value. The equation simplifies to $S - X$,

Consider a simple real-world example:

In the late 1980s, television audiences tuned in to follow the fortunes of a group of barflies in the hugely popular TV series *Cheers*. Had a television company wanted to buy the rights to the series, it might have relied on a traditional NPV analysis to assess the value of repeats as TV stations around the world re-ran the series many years after it was first shown.

Let us imagine that these re-runs would generate cash flows with a present value of \$10m. However, the owners of the series are asking \$11m for the rights. The net present value of the investment is $\$10\text{m} - \$11\text{m} = -\$1\text{m}$ and at first sight the investment looks like poor value for money.

However, a canny producer might have spotted the potential to take the show's bumptious psychiatrist, Frasier Crane, out of the famous Boston Bar and relocate him to Seattle to host a daily radio programme. Indeed, the spin-off series *Frasier* is arguably more successful than the series from which it was spawned.

Now let us apply the Black-Scholes model to some hypothetical figures to try to quantify what this real option is worth. Imagine that the new series will cost \$5m to produce ($= X$) and will generate \$6m in cash flows ($=S$). The producer believes he can start work in two years time ($T=2$) and the risk free rate of interest is 5%. Let us assume that historic data on returns from TV programmes suggest that the project's cash flows will have a standard deviation of 30%. Using the Black-Scholes formula we find that the option to produce the new series is worth \$1.8m. Remember, however, that the producer is not obliged to make the new series.

which represents the value of the asset less its cost. Therefore, in the absence of uncertainty, traditional NPV methods are the best approach.

Amram and Kulatilaka (1999) define the total value of the project as its net present value plus the value of all its embedded options⁴⁰ so in our hypothetical example, value total value of the rights to *Cheers* would be

$$\$10\text{m} + \$1.8\text{m} = \$11.8\text{m}$$

and the project is now worth more than the asking price, \$11m, so it has a positive net present value. In this case the real option is the option to develop a 'hidden' asset uncovered by skilful management.

Trigeorgis (1995)⁴¹ identifies several types of real options:

- **Option to defer**

When management holds a lease on valuable land or resources but is under no immediate pressure to exploit the asset, it may be more profitable to wait and see how prices develop. For example, a company may have an option to develop an oil field if oil prices rise, but it is under no obligation to develop the field if prices fall. An incubator may like a business idea but may want to defer committing funds. The form of this deferral may be seed funding to develop a more detailed feasibility plan and a good market analysis. The seed investment may be considered a call option on the next round of funding.

- **Time to build option (staged investments)**

Staging investments allows management the flexibility to monitor the progress of a project and abandon it if unfavourable conditions arise, either in the market or within the project itself. For example, all research and development projects can be considered as staged investments, especially in the pharmaceutical industry where numerous regulatory hurdles must be overcome. Venture capital investments, such as those made by incubators, are also staged investments. Each stage can be regarded as an option on the value of the next stage and valued as a compound option.

- **Option to alter (expand, contract, shut down and restart)**

Depending on market conditions, management can increase or decrease production and even call a temporary halt until conditions improve. For

⁴⁰ Amram and Kulatilaka (1999), p102.

⁴¹ Trigeorgis (1995), p3

example, taking an option on machine capacity to take advantage of 'fads' in fashion, or mothballing an airliner if demand falls too low.

An incubator can scale up the development of a company and invest more if market forces warrant the extra effort. Moreover, it can change the business plan to take advantage of new opportunities when they arise. It can also mothball a business plan until conditions become more favourable.

- **Abandonment option**

If market conditions deteriorate, an incubator can close a start-up it is developing. Its assets, if any, can be sold and funds diverted into ventures with greater potential. Likewise, new products can be withdrawn after test marketing has shown them to be unsuccessful. Because it offers protection against a downward movement in prices, an abandonment option can be considered a put option, exercisable at any time⁴².

- **Switching options (inputs or outputs)**

If market conditions change, firms can switch inputs or outputs to take advantage of the prevailing conditions. In the case of inputs, a factory may switch from gas to electricity if gas prices become prohibitive. Output switches might involve dropping the production of low margin goods to make way for high margin goods. An incubator can shift money from one hatchling to another depending on how the market develops.

- **Growth options**

These are typical of industries where an initial investment leads to new opportunities, for example new products, new markets or the uncovering of new options embedded in the original project. A venture capital company investing in an incubator can be thought of as buying a growth option allowing it to invest in new projects that arise within the incubator. Many VC funds have committed funds to incubators even before they had any hatchlings.

- **Multiple interacting options**

Most projects are a collection of interacting options, for example a staged R&D investment includes a call option (to take part in the next round of funding if the project is good) and a put option (the option to abandon the project if it is bad). Because options like these interact,

⁴² In which case it is like an American option which, unlike a European option, can be exercised before its maturity date.

their additional value may not be simply the sum of the two option values.

In addition, Boer (1999) identifies other sources of value in technology options that may apply to incubators and their portfolio companies⁴³.

Technology pairing arises when the development of one technology boosts the development of another. For example, a new type of small colour display screen could boost the sales of handheld computers if it offered TV quality pictures. A new battery that offered significant power to weight advantages over existing batteries could spur the development of next-generation mobile Internet devices that require more power than existing technologies. A new type of compact memory device could also boost the sales of handheld computers.

Moreover, the creation of a new technology platform can spur third party developers to create new applications. A good example of this is Palm Computing and its Palm range of handheld computers. Having established a market-leading device, Palm has licensed its developers' kit to more than 10,000 programmers. The company has recently launched an incubator to nurture promising developers through their early stages. Not only will Palm benefit from equity ownership, but its devices will gain the functionality of the programs being developed. This, in turn, adds value to the Palm proposition.

It is clear that all of these options – and the value they add – arise because of uncertainty in the market. Waiting for new information to resolve that uncertainty can enhance profits or at least avoid losses.

⁴³ Boer (1999) p311.

Amram and Kulatilaka (1999) argue that “uncertainty creates opportunities”⁴⁴. Managers are making “contingent decisions” to invest or exit depending on unfolding events and net present value analysis alone cannot capture or quantify this flexibility.

Real options analysis is most useful:

- When there is a contingent investment decision (i.e. when the decision will be made based upon information gathered in the future).
- When the uncertainty surrounding the project is large enough to warrant delaying the investment decision until positive information emerges.
- When uncertainty is large enough to demand a flexible approach to how the investment project is managed by the firm.
- When the value of the project is captured in future possibilities rather than the present value of identifiable cash flows.
- When the project has embedded into it the opportunity for updates based on new information and for changes in strategy.⁴⁵

However, real options thinking need not be applied to every situation. If there are no real options in a project, or very little uncertainty regarding its outcome, then the tools of traditional capital budgeting are preferable.

⁴⁴ Amram and Kulatilaka, (1999) p13.

⁴⁵ Ibid, p24.

6. Pulling the levers of option value

Looking back at the option pricing theories of Black and Scholes (1973) and Merton (1973) we see that there are six inputs into the value of a call option. Leslie and Michaelis (1997) call these the ‘levers’ of option value and identify their counterparts in real options. They are:

- **Stock price (S)**
Present value of cash flows expected from the investment opportunity on which the real option is “purchased”
- **Exercise price (X)**
Present value of all fixed costs expected over the life of the investment opportunity
- **Volatility (σ)**
Uncertainty about the cash flows the investment will generate
- **Dividend payments (δ)**
Leakage in the value of the option, for example the cost of keeping the option open during its lifetime
- **Time (T)**
The period for which the investment opportunity is available, e.g. the lifetime of a patent
- **Risk-free rate (r)**
The risk-free rate of interest

Table 4. demonstrated that the value of a call option increases with volatility. In fact, the value of the call option will also increase if the stock price (S), time to expiry (T) and risk-free interest rate (r) increase. The call option will be worth less if the strike price (X) and dividend payments (δ) increase.

Of all these factors, S and X have the biggest influence on the value of the call option ⁴⁶. For financial options, (S) moves with the market while the rest of the variables are fixed at the time the contract is agreed ⁴⁷.

However, with real options, managers have the opportunity to influence each of the variables except the risk-free rate of interest. By exercising “proactive flexibility” they can increase the value of the options they possess, and so increase the total value of the investment project they are undertaking.

This flexibility is directly relevant to Internet Incubators because of their “hands on” approach to nurturing their hatchlings. If we regard the value of an early-stage hatchling as more potential than identifiable cash flows, then following Trigeorgis ⁴⁸ and Chorn ⁴⁹ it becomes clear that the value of the hatchling can be regarded as an option on the value of the next stage.

The management of an Internet Incubator can pull the levers on the inputs of the next stage to increase the value of the “option” they are already holding. Adopting a framework laid out by Leslie and Michaelis ⁵⁰ this “proactive flexibility” is identified below in the context of an Internet Incubator:

Lever 1: Increase the present value of the operating cash flows (S)

The incubator can improve a hatchling’s projected revenues by drawing on its network of contacts to guarantee sales and by negotiating inter-group sales between hatchlings. Thus a software company in the incubator would sell its software to other hatchlings in the portfolio. In addition, the incubator can provide sales,

⁴⁶ Leslie and Michaelis (1997) demonstrate the sensitivity of an option value to a 10% change in all the variables on p15.

⁴⁷ In fact, options traders make a living by ‘disagreeing’ with the level of volatility implied by the price of the call. The share price can become more volatile over the life of the option.

⁴⁸ Op. cit. p3

⁴⁹ Chorn, (2000), p2

⁵⁰ Leslie and Michaelis, (1997) p3.

marketing, advertising and public relations expertise to boost the hatchling's profile and increase its revenues.

Lever 2: Decrease the present value of expected operating costs (X)

Inter-group sales can help to reduce development costs and the incubator may be able to negotiate group discounts from outside vendors through collective buying. The incubator can also reduce costs by housing its hatchlings in its own offices, providing them with low-cost office services and by deploying in-house expertise, for example in website or database development, sales and marketing etc.

Lever 3: Increase the uncertainty of expected cash flows (σ)

Although this sounds somewhat counter-intuitive when considered in an NPV framework⁵¹, increasing uncertainty increases the value of the option. An incubator can achieve this by endowing the hatchling with the flexibility to expand into new areas not yet envisaged in the business plan⁵², perhaps by employing creative entrepreneurs.

Lever 4: Extend the duration of the investment opportunity (T)

This might involve buying the hatchling's closest rival to prevent competition and a drain on future cash flows. Another way of extending an option's duration is through patents. However, because of its reliance on liquidity events to realise a profit, the incubator cannot allow this variable to increase too much. Incubators have been built on the expectation that their hatchlings will come to market very quickly. Any delays can be disastrous and leave the incubator funding the hatchling for longer than it expected.

Lever 5: Reduce the value lost by waiting to exercise

In a financial option, dividend payments reduce the value of the option. In real options this "leakage" may be sales lost owing to the entry of a competitor. As with lever 4, the incubator can buy the rival.

Lever 6: Increase the risk-free rate of interest

This is beyond the scope of even the best incubator.

⁵¹ In the NPV world, increased uncertainty usually results in a higher discount rate.

⁵² Consider the online retailers Amazon and CDNow and how much flexibility is implied in their names.

It is clear then, that Internet incubators can enhance the value of their portfolios – and increase their own value - by identifying the real options available to them and taking actions that increase the value of those options.

Of course, managers need to be aware of what options are out there. Some investments – even if they fail – can be regarded as “learning options”. For example, funding a business plan in a particular area of commerce will result in useful intelligence on the state of the market and this can be used to determine the viability of other investments. Also, investing in a rival incubator can create value-enhancing synergies for companies in both portfolios and can create opportunities for follow-on investments⁵³.

As a general strategy, the incubator’s goal is to reduce the private risk associated with each of its portfolio companies. This will increase the probability of their success. Remember that the *uncertainty* input in the option pricing model reflects uncertainty about the market in which the hatchling will operate. Private risk reflects the possibility that the start-up could fail because of *internal* factors such as the failure of its R&D, poor management, the loss of key staff or liquidity problems.

Boer (2000) gives a simple example of how private risk affects the value of an option: An oil company has paid \$1m for a four year lease on an oil field and an exploratory well. Its geologists estimate a 25% chance of finding oil in the field. If it finds oil, it will develop the field at a cost of \$20m, but the value of the oil in the field is also \$20m at current prices. The risk-free rate of interest is 5% and the historic volatility of oil prices is 30%.

⁵³ Several UK incubators have taken stakes in other incubators, at home and abroad.

At first sight, the investment looks to have a net present value of -\$1m
 { Value of cash flows (\$20m) – Cost of lease (\$20m) – cost of development (\$1m)}

Using the Black-Scholes formula to price the option value, the inputs are:

$$S = \$20\text{m}, X = \$20\text{m}, T = 4 \text{ years}, \sigma = 30\%, r = 5\%$$

Giving an option value of \$6.33m.

However, the field has a 25% chance of producing oil, so

$$\$6.33\text{m} \times 0.25 = \$1.58\text{m}$$

Adding the value of the option to the NPV already calculated, the option-adjusted net present value of the project is

$$\$1.58\text{m} - \$1\text{m} = \$0.58\text{m}$$

and it is clear that the oil field has more option value than cash flow value, even after accounting for the risk of failure – i.e. the risk of not finding oil.

Boer comments:

“Unique risk can be analysed with the use of probabilities. Market-based risk can be analysed by well-known tools of corporate finance; the Black-Scholes formula or the binomial approximation. They have diametrically opposing characteristics – unique risk lowers value and market-based risk increases it.”⁵⁴

This is important to remember in the context of Internet incubators. Not all of their hatchlings will succeed and result in liquidity events that return cash to the fund. Moreover, like the oil field example, the value of an Internet start-up is more likely to be found in its real options than its identifiable cash flows.

⁵⁴ Boer, (2000), p2.

7. A real options approach to valuing the portfolio

The previous chapter showed how real options thinking can help the managers of an incubator enhance the value of their portfolio companies. The next task is to examine if and how the methodology can be applied to the valuation of the incubator itself.

Larson (2000) suggests that the value of an incubator has four elements: Cash on hand (less debt); publicly traded shares; privately held shares and future value-creating ability (i.e. real options).

In the UK, GAAP requires that investments in other companies are recorded in the balance sheet at market value if they are traded on the Stock Exchange, or at the lower of cost or realisable value if they are held privately⁵⁵. Not all incubators disclose the cost of their privately held stakes to the Stock Exchange and cash is recorded at face value in the accounts. Thus, the balance sheet offers little help, especially in the UK, where the majority of incubators have yet to float one of their hatchling companies on the market.

Moreover, the valuation of a hatchling must take into account its risk of failure as well as the stepped nature of its funding and how this affects the incubator's ownership stake. Venture capital investments are staged so that investors can monitor the entrepreneur's progress and maintain the option to abandon or expand the project when the present round of funding ends. According to Gompers and Lerner (1999)⁵⁶, agency costs increase as the tangibility of the assets declines and as the contribution of growth options in the overall valuation increases.

⁵⁵ UK GAAP, p883

⁵⁶ Gompers and Lerner (1999), p139

In addition, the project will become less risky as it matures through funding stages towards an IPO and this will be reflected in the return on investment required by the company's shareholders.

Frequent monitoring and control, in the form of staged investments, is a means of keeping the entrepreneur's interests in line with those of the investors. Staging investments allows the appropriate investment to be injected into the company at the right time.

As more cash is injected into the company, its ownership structure changes. An incubator will see its equity stake diluted unless it participates in further rounds of funding. A typical hatchling may receive seed funding and three extra cash injections before it floats on the market or is sold. Unless the incubator has agreed to sell some of its shares in the flotation, it is likely to have a post-IPO 'lock-in' period during which it cannot sell its shares.

Unfortunately, the embryonic and turbulent nature of the Internet incubator sector and the paucity of liquidity events mean there is little hard evidence with which to study ex-post incubator valuations. The approach taken in this chapter, therefore, will be to survey recent literature and identify other investment situations that resemble Internet incubators.

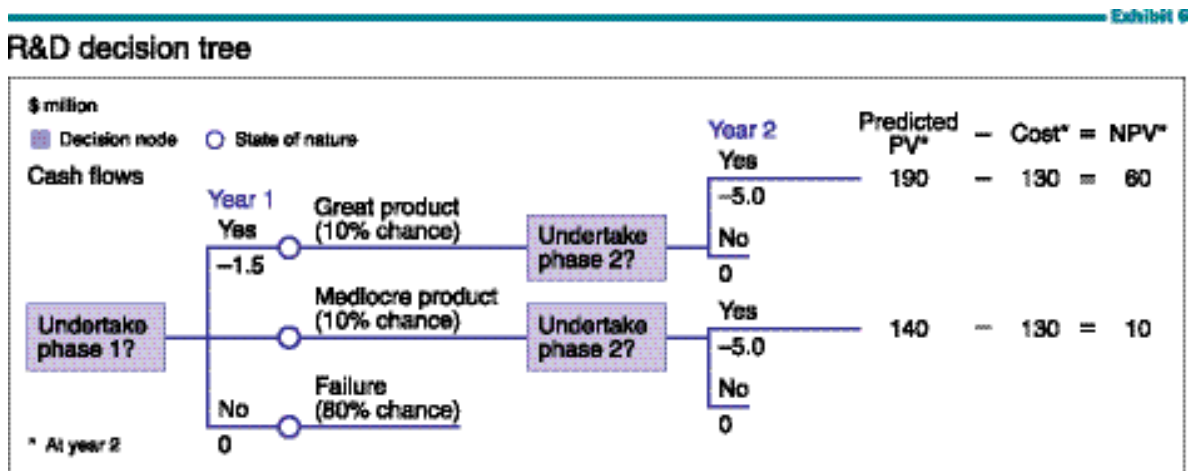
Decision trees

The first approach to valuation might be to attempt a discounted cash flow analysis supported by a decision tree in which different scenarios are modelled using different assumptions about the probabilities of each outcome.

This is similar to the approach of Desmet *et al* (2000)⁵⁷. The probability-weighted cash flows are discounted back by an appropriate discount rate and combined to give an expected present value.

A typical decision tree is reproduced below from Copeland and Keenan (1998b). In this case, the net present value of the project is -\$0.1⁵⁸

Figure 1. Typical decision tree for a simple R&D project.



Source: Copeland and Keenan (1998b) p140.

Most authors argue that the DCF / decision tree method fails to capture the uncertainty of the outcomes. Instead it requires estimates of terminal values for each outcome. These estimates may be wrong and this can affect the decision to invest. Moreover, it may be difficult to determine the probability of success at each stage and so assign an appropriate discount rate.

⁵⁷ Desmet *et al* (2000), p151

⁵⁸ At Year 2 the probability of a successful outcome is 40% and the probability of failure is 60%. The discount rate is 10%. The authors state that a real options analysis gives a net present value of +\$0.4 but fail to show how!

Amram and Kulatilaka's valuation of a start-up.

Amram and Kulatilaka (1999) value a brewery start-up using both DCF and real options analysis to show how the values differ⁵⁹. The brewery requires an initial investment of \$4m (spread evenly over eight quarters) and a further \$12m to launch if, after two years, their expected value exceeds the value of the investment. Annual sales are forecast at \$6m after launch and an analysis of the sector suggests a Price/Sales ratio of 3.67 should be applied, giving a value of \$22m (See Appendix 3). The firm's cost of capital is 16% and a discounted cash flow analysis suggests that the net present value is

$$\$14.46\text{m} - \$14.69\text{m} = - 0.23\text{m}.$$

Because the net present value is negative, traditional capital budgeting techniques suggest it is a poor investment.

Using an options analysis, where the initial \$4m investment creates the right to invest \$12m after two years, the following inputs are used in the Black-Scholes model:

$S = \$14.46\text{m}$ (the present value [at $T=0$] of the company after the investment)

$X = \$12\text{m}$ (the investment at $T=2$)

$r = 5\%$ (the risk-free rate of interest)

$T = 2$ (when the follow-on investment is made)

$\sigma = 40\%$ (the estimated volatility of the firm's cash flows)

giving an option value of \$4.96m. After subtracting the present value of the initial investment the net present value of the option analysis is:

$$\$4.96\text{m} - \$3.83\text{m} = \$1.13\text{m}.$$

Now the project has a positive net present value. The difference between the DCF and real options analyses is

$$\$1.13\text{m} - (-\$0.23\text{m}) = \$1.36\text{m}$$

which captures the uncertainty surrounding the brewery's future cash flows. They could be greater than \$6m a year or less, but the potential for upside is worth pursuing. This illustrates that the value of the start-up is in its options, not its identifiable cash flows, which in this example are actually negative.

A refinement of the model uses a binomial option pricing approach to factor in the possibility of abandoning the investment at any quarter over the initial two years (Appendix 4). This increases the value of the firm to \$1.74m because abandoning the investment allows the investor to redirect their money into a more profitable venture. Again, investors may believe it is worth paying a premium for this flexibility.

Although the models were applied to a brewery, there is no reason why they should not also be applied to an Internet start-up. Amram and Kulatilaka warn, however, that Internet start-ups are “options on options on options on options to generate cash flows”⁶⁰; that is, they are compound options.

Chorn's model of venture capital investments as compound options

Chorn (2000) presents a real options analysis of more than 100 software firms using their terminal values as the starting point and working backwards to calculate the value of the first investment⁶¹.

⁵⁹ Amram and Kulatilaka (1999) p143.

⁶⁰ Amram and Kulatilaka (1999) p70.

⁶¹ Remember that the option-calculated value may exceed the paid-for value for early stage companies.

The proprietary model used in the analysis treats the value of the company at each stage as the value of a call option on the next stage of investment, so it is calculating the value of a series of compound options which, when exercised, generate a new option⁶².

Using the Black-Scholes model the inputs are: S = exit valuation at end of funding round; X = investment required to begin round; t = time to next investment round (calculated from the start-up's cash burn rate), σ = volatility, r_f = risk free rate. From these the call option C is calculated and this corresponds to the exit valuation (S) of the previous round. Chorn reports a strong correlation between the valuation at the seed funding stage and the IPO market capitalisation or sale price, with $R^2 = 0.87$.

Because of the proprietary nature of the model there is no detailed discussion of how the model incorporates the probability of success at each stage of funding, and how the chance of success changes as the start-up matures. However, Chorn uses figures of 25% for market (i.e. late funding stages) and 90% for earlier stages in which technological uncertainty has been resolved. These figures are held constant for all companies in the analysis to ensure comparability.

For incubators, this method offers great promise because it explicitly looks at venture capital investments. However, the model is backward looking rather than predictive and uses terminal values to calculate initial investments.

⁶² In fact, Copeland and Keenan (1998a,b) characterise start-ups as compound rainbow options, the former accounting for the staged nature of the investment and the latter accounting for multiple sources of uncertainty.

In a personal communication Chorn comments:

“I believe a set of well constructed proformas for the period leading up to a market event (IPO or acquisition) provides the appropriate scenario format for a real options analysis. By generating a suite of possible outcomes, the VC investor now has a road map to guide the investment process. This would give clear metrics on when to invest, how much to invest at each round and when to exit a deal gone bad.”

Willner’s Jump Model

Willner (1995) presents a model for growth option valuation that captures the stepped nature of venture capital investments. The underlying asset is the value generated by the investment and the strike price is the cost of that investment.

The model assumes the value of the investment drifts upward in an exponential manner, jumping up or down occasionally with new information or because of the actions of a competitor. For example, negotiating a sales contract will increase value, while the emergence of a rival will reduce it.

The model derived is given by

Value of the start-up = Value of growth options + NPV of existing assets

or

$$P(T_0) = \int_K^{\infty} (P - K) f_{P(T)} dP + NPV$$

where P_t = value of start-up at time = t , K = cost of investment, $f_{P(T)}$ = the distribution of $P(T)$, which in turn is given by

$$\Gamma\left(\frac{Q}{\beta}, 1\right)$$

in which Q is the intensity of the jump and β is jump-dampening factor⁶³.

Willner argues that the model can be applied to stepped venture capital investments, which are characterised as compound options where the value of one stage is regarded as a call option on the value of the next.

Otto's model for emerging firms

Otto (2000) criticises the DCF approach as “at its worst, meaningless” because of its failure to capture flexibility and because of the “imprecise task of delivering equilibrium risk premiums, which must be added to the risk-free rate to determine the appropriate discount rate”⁶⁴.

Instead, he models an emerging firm as one that buys an option to develop a new technology, product or service. The model assumes that two rival firms are engaged in a “winner takes all” race to patent the same technology. The option is exercised when the R&D process is successfully completed.

The model⁶⁵, below, is a probability-adjusted variant of the Black-Scholes option-pricing model showing the value of the growth option G_X :

$$G_X = \frac{f(X_H)}{f(X_L) + f(X_H) + r} \{V_1 N(d_1) - K(0) N(d_2) e^{-t(a_h - a_k)}\}$$

⁶³ Willner doesn't define λ ! However, if there is a jump at time i , the new value of P will be $P \times a$, where $E(a) = \lambda/\lambda - 1$ if λ is greater than 1. See p227.

⁶⁴ Otto (2000), p27

⁶⁵ Ibid., p65

where V_1 = gross project value; $K(0)$ = expected exercise price;

$f(X_H)$ = probability of company's success; $f(X_L)$ = probability of rival's success; $(\alpha_h - \alpha_k)$ = risk-adjusted rate of return.

Ottoo refines the model to incorporate an option to invest in advertising and marketing (G_M)⁶⁶ so that the overall option value, G_H , is given by:

$$G_H = G_X + G_M e^{-rt}$$

There are obvious parallels between R&D in the biotechnology industry and hatchling companies in an Internet incubator. Both develop in a staged manner, where private risk is reduced at each stage and the probability of success increases.

Drugs under development must go through several stages of testing and regulatory approval and will receive further funding only on the successful completion of each stage. When they reach the market, there is no guarantee of success and cash flows are likely to be volatile.

Likewise, Internet start-ups pass through the monitoring processes of their backers, receiving funding only if the project is still likely to produce a good result. After the IPO, the company's share price – and hence the stake held by the incubator - will be volatile.

However, Internet start-ups differ from biotechnology R&D projects because they are not usually involved in a “winner takes all” situation where the winner is rewarded with a patent that will protect its cash flows for several years. Even Amazon - the Internet's most successful retailer -

has many rivals, although they are much smaller and generate less sales revenue. Therefore, the probability weighting assigned to the option value is more likely to derive from traditional methods of estimating market share and revenues, such as those employed by Desmet *et al* (2000).

Kellogg, Charnes & Demirer's valuation of a biotechnology firm

The work of Kellogg *et al* (2000) on the valuation of a biotechnology firm provides more insights into how incubators may be valued using real options methodologies. Citing the work of Grabowski and Vernon (1994) which suggests that most biotechnology R&D has a net present value of zero, the authors comment:

“Many biotech firms have significant valuations, yet do not have profits from which to value the firm using traditional methods, because their products are in the early stages of development.”

They employ both decision tree and binomial lattice methods⁶⁷ to value an R&D project and argue that the value of the firm is simply the sum of the values of its current projects. In addition, building on the work of Lander and Shenoy (1999), they use “influence diagrams” as a simpler alternative to decision trees, and arrive at the same values - \$4.31 per share - for the project using these two techniques.

In the binomial analysis, Kellogg *et al* calculate the value of the asset (A)⁶⁸ using a seven period lattice. The probability of the drug reaching the next stage is factored into the option value by simple multiplication. To the final values they add the value of a growth option, arguing: “The idea is that

⁶⁶ Ibid. p40

⁶⁷ Binomial option pricing methods were developed by Cox, Ross and Rubinstein (1979) as a simpler way to value options using a binomial tree with two possible values for the asset at time t=1 etc. The binomial model approximates to the Black-Scholes model when the time interval becomes extremely small. An example is seen in Appendix 4.

engaging in the development of an initial new molecular entity (NME)⁶⁹ is similar to purchasing a call option on the value of a subsequent NME.” In effect, they are adding on the value of an as-yet-undiscovered compound to the value of the drug under development.

The binomial analysis produces a value of \$4.51 per share, or 4.6% higher, showing that unlocking ‘hidden’ potential can boost company value.

In the context of a hatchling company within an incubator, this approach may be useful in factoring in future possibilities not yet envisaged in the business plan under development. However, it differs from the approach of Chorn (2000), which treats the value of each stage of development as a call option on the next round of financing⁷⁰.

Seppa and Laamanen’s valuation of venture capital investments

Seppa and Laamanen (2000) tested a risk-neutral binomial valuation model with the ex-post valuation data from 429 US venture capital investments and 178 IPOs.

Each stage of venture capital investment is modelled as a one-step binomial process with the outcomes ‘good’, which increases the company’s value by k and ‘bad’, which decreases its value by $1/k$. The ‘bad’ stage can include the abandonment of the project leading to a value of 0.

The final stage is the exit value of the firm. The outcomes of previous stages are found by backward iteration from the final values.

⁶⁸ The drug under development

⁶⁹ A biochemical compound thought to have pharmaceutical potential

⁷⁰ This illustrates the complexity of valuing an incubator using real options. Combining the approaches of Kellogg *et al* and Chorn produces two sets of options – staged or compound options on the financing rounds followed by a growth option to account for hidden potential. One might also add third option - an abandonment option - that also adds value.

Their model gives the value of the asset, S , as being equal to its probability-weighted expected values at the end of a time period t , discounted by a risk-adjusted rate of return R , so that

$$S = \frac{pS^+ + (1-p)S^-}{(1+R)^t}$$

where S^+ and S^- are the two possible values of the asset at time t .

This is modified to define the risk-neutral probabilities where

$$S = \frac{qS^+ + (1-q)S^-}{(1+r_f)}$$

and solving for a one-period risk-neutral probability q for stage i

$$q_i = \frac{S_i(1+r_f)^{t_i} - S_i^-}{S_i^+ - S_i^-}$$

where $S^+ = kS$ and $S^- = (1/k)S$.

The step-up value k is solved as

$$k = \frac{S(1+r_f) \pm \sqrt{S^2(1+r_f)^{2t} - 4S^2q(1-q)}}{2Sq}$$

and the risk-neutral probabilities of the model reflect the probability of stepping up the funding of the start-up.

Using a risk-neutral model allows the use of the risk-free rate throughout the process and avoids the need to assign risk-adjusted discount rates to account for the different risk profiles of the start-up as it passes through different stages of investment.

It also avoids the need to distinguish between the private and market components of risk when determining the discount rate.

The authors state:

“The Capital Asset Pricing Model suggests that the private risk should be reflected by the success probabilities and the market-priced part of risk should be included in the risk-adjusted rate of return” and argue that many venture capitalists may be unable to distinguish between the two components of risk ⁷¹.

Instead of studying valuations directly, Seppa and Laamanen took pairs of observed valuations (where S_i is followed by S_j) and calculated the risk-neutral probabilities implied by those valuations.

Even though there may have been ‘gaps’ in the funding rounds between S_i and S_j , the probabilities they calculated could be used to test four hypotheses developed from previous research into venture funding ⁷².

The results are summarised below in Table 5.

Table 5. Support for four hypotheses tested using valuations from the binomial model.

Hypothesis	Support?
The risk-neutral success probability of reaching the next stage of financing is positively related to the level of the stage where the observation period began	No support

⁷¹ Seppa and Laamanen (2000) p5.

⁷² The data was split into two halves; one to develop the model and the other to test it.

The risk-neutral success probability of reaching the next financing round is negatively related to the length of the observation period	Support
The risk-neutral success probability of achieving the next financing round is positively related to the number of previous financing rounds	Support
The risk-neutral success probability of achieving the next financing round is dependent on the industry in which the start-up operates	Support

Source: Seppa and Laamanen (2000) p19.

In short, their model confirms research suggesting that as a start-up matures through stages of finance, its chances of success increase, the rate of return required by investors decreases and the step-up in valuation⁷³ decreases.

Because the risk-neutral probabilities implied by the observed valuations are consistent with previous findings, it suggests that the binomial option-pricing approach is a good model with which to study venture funding.

The model appears capable of forecasting step up values with the equation

$$\frac{S_n^+}{S_j} = \frac{1}{\prod_{i=j}^n \frac{q_i}{(1+r_f)^{t_i}}}$$

where the step-up is from round j to round n ⁷⁴. The binomial model is reported to explain 39.3% of the variation in step-up values, whereas a DCF model explained less than 19%. However, the overall standard deviation of forecasts using the binomial model is large (84%), implying

⁷³ The step-up is the later valuation divided by the valuation at the last round.

⁷⁴ In this case, S_- is set to zero to reflect that fact that a ‘bad’ outcome will usually result in the failure of the start-up because no further funding will be committed.

that although the forecasts seem to correct on average, errors tend to be large. The authors state:

“The result is not a surprise, since previous research on venture capital has shown that the outcomes of venture capital investments include both extreme returns and total losses – these investments result in anything but the average.”⁷⁵

Furthermore they conclude:

“The main theoretical implication is that option-pricing theory seems to have relevance in venture capital applications. The risk-neutral model provides a much-needed methodology for analysing the risk-return structure of these investments.”⁷⁶

⁷⁵ Op. cit. p25.

⁷⁶ Ibid. p26.

8. Problems and conclusions

The previous two chapters have shown that real options “thinking” can offer significant insights into both the business models and valuations of Internet incubators. Often, these insights come from another high growth industry – biotechnology – which has experienced its own roller coaster ride on the financial markets.

By identifying available options, the managers of incubators can take actions that enhance the value of their investments. Investors using real options techniques can begin to understand the valuations of incubators, which may otherwise appear to be trading at irrationally high multiples of their net asset value.

The work of Chorn (2000), Kellogg *et al* (2000) and Seppa and Laamanen (2000) has demonstrated that real options valuation methodologies may have more explanatory power than traditional DCF techniques when valuation data is analysed *ex-post*. Unfortunately, such data is not yet available for Internet incubators, most of which are less than two years old.

Furthermore, Kellogg *et al* and Willner (1995) suggests that real options models may have some power to predict valuations, although more evidence is required to confirm this.

For those attempting to value Internet incubators using real options analysis there remain numerous practical problems. Of these, identifying and mapping the options available, and then selecting the appropriate model is probably the most difficult. Chapter 7 showed six different approaches to the problem.

Damodaran (2000b) poses three questions that must be answered in the affirmative when considering whether an option creates value ⁷⁷:

- Is the first investment a pre-requisite for the later investment or expansion? If not, how necessary is it?

A firm cannot create R&D options unless it funds the initial R&D, nor can it develop an oil field without first buying a license. It may be necessary for a venture capital fund to invest in an Internet incubator in order for it to participate in future funding rounds of the incubator's hatchlings.

- Does the first investment buy exclusive rights to the later investments? If not, does it confer significant competitive advantages?

As with the example above, funding an R&D project will lead to exclusive rights to any technologies that emerge. The value of the initial option depends on the excess cash flows generated by the second (the option to begin manufacturing the technology). If a firm shares the R&D costs it will forego a portion of the subsequent cash flows. Given that incubators take equity stakes in their hatchlings, it is not in their interests to have their ownership diluted. However, funding the company through subsequent rounds may not be a good idea because it will reduce the funds available for other (diversifying) projects.

- Are the competitive advantages sustainable?

Excess profits attract new entrants and this, in turn, reduces excess profits. An incubator must invest in projects that have a high chance of creating sustainable competitive advantages. Gaining patents or developing standard 'platforms' are good examples, as are exclusive sales deals with major customers.

There are constraints on time and effort, too. A typical incubator has several investments, often in different industries, and trying to understand disparate business models and industries poses a challenge to anyone wishing to determine company values several years out.

⁷⁷ Damodaran (2000b) p 51.

One approach might be to look at the IPO values of rival companies and try to estimate a valuation from these.

Another problem is the lock-in period. Incubators may be prevented from selling all or part of their stakes until a certain time after the IPO. Although the post IPO performance of the shares can easily be incorporated into a Black-Scholes model in the form of volatility, the timing of liquidity events may be hard to predict.

The hatchling's probability of success may be dealt with in the manners suggested by Ottoo (2000), Kellogg *et al* (2000) and Boer (1999), though the decision to use risk-neutral or risk-adjusted probabilities appears to depend on the model being used. As to the appropriate discount rate, Seppa and Laamanen (2000) point out the difficulty of assigning such a figure to stepped investments where each stage has a different risk profile – assuming private and market risk can be distinguished.

Then there is diversification. Modern portfolio thinking suggests that there is an optimum level of diversification at which company-specific risk is eliminated⁷⁸. Intuitively, this ought to apply to incubators as well.

However, investing solely in Internet companies is not exactly a diversifying strategy, even if the portfolio consists of infrastructure, technology, business-to-business, content and consumer plays. Boer (1999)⁷⁹ points out that diversifying an R&D portfolio will increase value for a given level of risk. In the context of an Internet incubator, it will also help to create synergies between hatchlings.

However, the managers of an incubator might argue that a smaller portfolio actually reduces unsystematic risk because they can devote more time and

⁷⁸ See Markowitz, H., (1959), *Portfolio Selection*, John Wiley and Sons for the classic treatise.

⁷⁹ Boer (1999) p317.

attention to each company. More research will be needed to prove the point either way.

Cash, too presents an intriguing problem when it comes to valuation. One might argue that cash in hand should be valued as such, but some UK incubators have actually traded at below cash value for short periods in late spring, when investor sentiment turned sour.

It is beyond the scope of this study to analyse how cash is valued, but a possible approach might be to perform a regression analysis on market capitalisation, cash value and funds invested to see if any patterns emerge.

In a study that offers a parallel with unspent cash, Quigg (1995) uses a real options analysis to value empty land and finds that buyers are willing to pay a premium for undeveloped land in the hope that the market conditions change to make the land more valuable. An uninspiring patch of land may be worth keeping vacant until the local area moves 'upmarket', enabling the owners to develop luxury flats or office space.

Damodaran, (2000b) states that keeping a cash fund or maintaining an excess debt capacity can add value because the firm has the resources available to invest in unexpected, high return projects. However, he argues that these funds have 'option' value only in industries where such investment projects come along - typically the high growth industries such as the Internet. For this reason, investors are likely to value £1m in cash held by an Internet incubator as worth significantly more than £1m in cash at Coca-Cola.

Leakage is another problem that must be taken into account when applying real options thinking to investment projects. Maintaining a plot of empty land imposes costs on the owner that reduce the value of its options.

Likewise, deferring a product launch or waiting to test-drill an oil field impose costs, either directly or in the form of opportunity costs.

These losses are like dividend payments in a financial option. Amram and Kulatilaka (1999) identify several sources of leakage including explicit positive cash flows such as dividends, rental payments, income and royalty fees, and cash outflows such as storage costs, taxes and insurance costs⁸⁰.

In spite of all these challenges, the ability of real options analysis to account for and quantify uncertainty presents a strong case for using this emerging methodology when valuing Internet incubators. With further research, and as more data is gathered on hatchling valuations, new models will emerge that will help investors make informed decisions on how to value Internet start-ups.

⁸⁰ Op. cit p127

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Appendix 2.

Recent articles on Internet incubators

Investors fall out of love with the Internet incubators

By Chris Ayres

THE list of City celebrities was dazzling. The smell of money was overwhelming. During the dot-com boom of late 1999 and early 2000, anyone who was anyone wanted to get involved with an "Internet incubator".

Shami Ahmed, founder of Joe Bloggs jeans; Charles Cornwall, chairman of Eidos, the computer games company behind Lara Croft; and Luke Johnson, founder of PizzaExpress, are just some of the celebrities who created the fledgling Internet investment funds that became known in the City as incubators.

Even figures such as Matthew Freud, the public relations guru, and Sir Richard Needham, the former Tory minister, got involved in the business of nurturing loss-making baby Internet companies into profitable adults.

Today it is a different story. Five of Britain's most famous Internet investment companies - New Media Spark, eVestment, Convergence, Legendary and Oxygen - have seen more than £1 billion wiped off their stock market value since December.

There are another 40 or so languishing on the stock market. Most are running out of cash, having ploughed most of their shareholders' money into ventures that now look ludicrously over-valued. JellyWorks has been bought out, while Enterprise Asia is facing a humiliating shareholder revolt. The colourful characters behind them, meanwhile, are keeping a low profile.

Incubators were perhaps the shortest-lived financial fad ever to grip the City. As Howard Shore, founder of Shore Capital, the specialist investment bank, says: "There were a lot of blue-chip City houses trying to back these sorts of ventures simply because they were fashionable at the time. I remember the same happening in the late 1980s; it was exactly the same behaviour, but with property rather than technology companies. It's a feature of the late stages of a bull market."

Shore took advantage of this in July by acquiring JellyWorks, one of the City's most famous Internet incubators, for £60 million in shares. At the height of the stock market boom, JellyWorks had been valued at £276 million.

Britain's incubators were inspired mainly by the kind of US investment funds that help technology entrepreneurs to turn their ideas into commercially viable ventures. These funds provide wide-eyed boffins with cash, offices, financial advice and industry expertise. In return, the funds take generous equity stakes in the fledgeling ventures - in the hope that they will one day be worth billions of pounds.

The incubators that floated on London's Alternative Investment Market (AIM) - a less regulated version of the London Stock Exchange - were mainly bastardised versions of these US funds. At the same time, countless other incubators were set up, some by management consultancies such as Bain & Co's Bainlab, others by individuals, such as Azeem Azhar's eSouk. Everyone paid for everything in shares. Apart from the banks, of course.

The sheer adrenalin of the "dot-com" boom meant that the management teams behind many incubators raised hundreds of millions from over-excitabile investors, even though they had, at best, unproven track records.

Oliver and Thomas Vaughan managed to raise millions for eVestment, even though Mountcashel, their "old economy" investment company, suffered a disastrous year in 1999. One newspaper columnist quipped that the company had "taken the art of stock picking to a new low". This did not stop investors giving eVestment £10 million in December and a further £44 million in February.

One of Mountcashel's most disappointing investments was in Utility Cable, a communications company that collapsed in 1998, having been valued at nearly £60 million four years earlier. Interestingly, Utility was backed by Luke Johnson, the restaurateur who is a non-executive director of New Media Spark, another Internet incubator. Investors who bought into New Media Spark in December when it was worth £540 million are now nursing huge losses. The company is currently valued at a mere £190 million.

Other incubators that managed to gain investor support in spite of curious management teams included StartIT.com, headed by Philip Brown. Brown was formerly a board member of Ionica, the telecoms venture that went spectacularly bust in 1998, one year after raising £147 million through a stock market flotation. Shares in StartIT, which raised £1.8 million through its flotation in August, have lost a thumping 85 per cent of their value since February.

Investors in StartIT were so sure of the company's ability to spot winners on the Internet that they gave its management £10 million to set-up another investment company called Enterprise Asia. As the name suggests, Enterprise Asia's brief was to invest in Asian start-up companies.

All did not go to plan. Enterprise - which still has £8 million of shareholders' cash in the bank - is now facing a shareholder revolt. Stephen Dean, the building entrepreneur who holds a 21 per cent stake in Enterprise Asia, has proposed an extraordinary meeting to oust Brown and Siu Fai Ng, his business partner, as directors. Unsurprisingly, Dean has his own incubator plans, and recently transformed his Bickerton building group into an investment outfit called Envesta.

To be fair, the description of incubator fits some investment companies better than others. Brainspark is perhaps the best example of a "pure" incubator. Headed by Stewart Dodd, a former Panmure Gordon investment banker, Brainspark claims to offer young companies all the support they need to get started.

The company's trendy office in London's Clerkenwell, which is full of beanbags and topped with a roof terrace, is a dot-com entrepreneur's dream. The company is even converting part of its ground floor into a juice bar. But Brainspark has ploughed cash into the kind of online retailing ventures that are now deeply unfashionable in the investment world. Petspart, for example, sells pet food over the Internet, while EasyArt sells framed pictures online.

Convergence, on the other hand, is one of the many investment outfits that insists it is not an incubator. The company, backed by Eidos's Charles Cornwall and John Beckwith, property tycoon and uncle of "it girl" Tamara, says it invests in well-funded technology businesses rather than dot-com ventures. The company also makes the point that it has never "raided the market for cash" - all its resources come from its founders.

In spite of this, Convergence has seen its market value crash from £113 million to £31 million since February. Many incubators argue that it is easy to criticise for over-exuberance after a stock market crash. They add that many incubators had blue-chip backers, convincing many private retail investors to pile in regardless.

New Media Spark, for example, had backing not only from Luke Johnson but also from Michael Whitaker, the respected founder of Collins Stewart, the stockbroker. Initial investment came from big City names such as Mercury Asset, Prudential and Schroders. This allowed New Media Spark to accumulate a massive cash pile. Since its flotation in October it has invested £150 million in more than 40 fledgeling ventures, and still has £45 million in the bank. The company has even bought two rival incubator companies, Sofittechnet and Scandinavia's CELL Technology. The company's current projects include EO, an online share offering platform, and Skillvest, a corporate training collaboration with Bainlab.

Although the stock market is still flooded with struggling Internet incubator and investment companies, there is one easy way to spot the most shrewd: they have not spent a penny since flotation. This is almost true of Internet Indirect, backed by the likes of Clear Channel's Roger Parry. It has spent £3 million since flotation and still has £75 million left in the bank.

"We are not an incubator," insists Parry, who charmed the City as chief executive of More Group, the outdoor advertising business that was taken over by America's Clear Channel. "We all say that a lot, and say it to each other," he adds. "We are a specialist investment fund. We have spent not a nickel on staff or premises. What we are doing is purely looking to invest in infrastructure companies."

Eyebrows might be raised, however, by the fact that Internet Indirect's portfolio is being managed on a day-to-day basis by Mark Slater, son of Jim Slater, whose financial empire, Slater Walker Securities, had to be rescued by the Bank of England in the

1970s. Slater Sr has since become something of a stock-picking guru for private investors.

But does Parry feel guilty for tapping the market at its peak for £75 million? "It is a question we've thought about," he says. "All I can say is that when we did it we didn't do it to be spivvy. That was the value that people were then putting on Internet investment companies. Our investors were all consenting adults."

The Times, August 19th, 2000.

Investors pay dear for faith in dotcoms

By John Waples.

FORGET Dick Turpin. Today's highway robbers are more sophisticated. They are the financiers who have managed to float more than 40 internet incubators on the Alternative Investment Market.

At the peak of their stock-market values, six incubators - Jellyworks, New Media Spark, Oxygen, Convergence, Interregnum and Internet Indirect - were worth a staggering £1.48 billion combined.

For those investors who piled in, it has proved to be an expensive venture.

They bought shares in the hope that the incubators would uncover unique internet investment opportunities that could potentially vastly increase the value of their stakes. At first the shares did shoot up but they have since come back to earth. Now the combined worth of the super six has slumped to £332m.

Dozens of other stocks have had rollercoaster rides and the malaise is not just confined to quoted funds. Last week ESouk axed two-thirds of its staff and others will be forced to follow suit.

While a number of incubators are still sitting on cash piles raised during their flotations and are backed by strong management teams and knowledge banks, many are struggling to find investment opportunities.

This much is clear from the fact that some incubators have now been reduced to buying stakes in each other. Meanwhile those with cash, such as Softtechnet.com, are being swallowed up by larger incubators that want access to more capital.

A handful of incubators, advised by tertiary stockbroking firms, are still managing to find their way onto the market. But whereas the debutantes a few months ago could raise as much as £50m, the new arrivals are lucky to get £2m.

The issues have been snubbed by fund managers and instead stockbrokers are turning to private clients to provide the capital. Anyone offered such an opportunity should treat it with caution.

Turpin needed a gun to rob his victims, whereas in the past few months all that was required was a star-spangled prospectus containing within it a collection of City names and entrepreneurs who claimed to have talent to spot internet investment opportunities.

Investors have now realised that in many cases they have had their pockets emptied.

The Sunday Times, June 11th 20

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Author: Carl Franklin
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