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Investment in Electronic Commerce
– A Real Options Approach

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Investment in Electronic Commerce – A Real Options Approach[1]

Abstract: In recent years substantial investments have been made in eCommerce projects. Some of them seem to have been profitable. In other cases there has not yet been enough demand to generate a cash flow large enough to guarantee a financial viability of the projects. The purpose of this project is to develop a set of methods to be used in order to evaluate investments in eCommerce given an uncertain demand.

eCommerce investments are sequential in the meaning that initial "platform" expenditures for web services are to be followed by substantial outlays for marketing. In this paper a real options approach is used for their evaluation. Sales and sales income will be described in terms of a binomial process with declining growth rates. A decision to stop the investments in marketing is assumed to put a cap on that growth.

The paper shows that the real options approach is a suitable procedure to evaluate sequential decisions concerning investments in eCommerce. The method is applied on a real case study from a Swedish firm. It is demonstrated that the classical approach of adjusting the discount rate for risk may give quite misleading results.

Keywords: eCommerce, sequential investments, flexibility, declining growth rate, real options, case study

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1. Investment in eCommerce is a Risky Opportunity

Electronic Commerce - eCommerce - may be seen as an activity that make use of the Internet to purchase, market, sell, deliver and pay for products and services. Automobiles, books, financial instruments, flowers, groceries, music, toys and travel are good examples of products, which are traded over the Internet (see e.g. OECD, 1999, p.34). Products and services without physical deliveries seem to be the ones that have been most successful up to now. This segment includes tickets, hotel booking, and financial services.

Most decisions to perform eCommerce are associated with substantial investments especially in web-services and in marketing (for an overview, see Bergendahl 2002). The investment perspectives are different for companies that have already been active in selling products and services offline, and those which have not. The first category covers firms with classical telephone ordering and mail order systems, whose processes use the Internet instead of mail or phone. These companies with established brand names may be called firms, whose intention is to "Move to the Net" (*MTN*).

The second category concerns firms, who are formed just in order to market and sell commodities and services over the Internet. These firms often have a lack of experience from marketing and selling. On the other hand they may compensate that lack by a substantial knowledge about information technology. Let us call them for firms "Born on the Net" (*BON*).

MTN-firms are assumed to have an existing customer base offline, from which they may consider cross-selling eCommerce activities on the Net. They may use an existing customer base as a starting point for expanding their market share by selling them products and services over the net. Their next step being that they may widen their market segment to completely new customers. This indicates a welcome delay of substantial marketing investments.

> *Gap, Interflora and Nike are good examples of MTN-firms. Gap is a company that operates an own distribution chain with over 3000 retail stores. When investing in a new website, it may have expected that their total sales should grow substantially.*

However, one effect of this website has been that customers use the retail stores to try out clothes, which they then could order online. Other customers have used the web site as an alternative information channel, but have continued to shop offline (see McIntyre & Perlman, 2000:A). Consequently, the demand for online sales will become uncertain.

Interflora is a cooperative organization, which allows customers to enter a retail store in one city in order to order flowers to be sent from a similar retail store to a recipient in another city. As a chain it has established online sales of flowers as a complement to ordinary telephone sales. Interflora states that it reaches new customer segments through Internet without any considerable cannibalization on existing customers. A crucial factor is the speed at which Interflora reaches those customers (see Bergendahl, 2002, pp. 13-14).

Nike has never sold sporting goods directly to customers. Sales have been through separate retailers only. By investing in their own website, retailers can expect a transfer of customers from offline to online, i.e. a cannibalization on the customer base. However, the real advantage has come in terms of a large number of new customers (McIntyre & Perlman, 2000:B).

BON-firms will be directed to a selling of eCommerce activities to new customers only. This will create the demand for an immediate marketing investment in acquiring such customers.

Amazon is an example of a BON-firm set up to sell books over the Internet. It has invested heavily in information technology and in marketing. The sales growth has been very high, but it is a critical issue if that growth will continue and if the company may retain their customers (see e.g. Schwartz & Moon, 2000, pp. 66-70, Deitel et al., 2001, pp. 30-31)

In both cases one has to estimate the growth of sales volumes over a relevant series of time periods say quarter by quarter up to an horizon period, when the information technology equipment may become outdated.

It is obvious that the *growth rate* is a critical issue for the profitability of eCommerce investments. The quicker the growth in sales volume, the larger will the return on investment become. However, it seems to be a fact that *the growth in online sales is associated with substantial uncertainties,*

which may not be released until the investment in information technology is made, and the system is in operation.

This paper will develop principles for analyzing and evaluating multi-period investments in eCommerce when customer demand is uncertain. Section 2 gives an analysis of the economic consequences of such an investment program. Different demand scenarios are formulated in Section 3. Then, in Section 4, scenarios and consequences are put together in a dynamic (multi-period) model to be used to evaluate a given investment strategy. It is observed that the expected growth in demand is a crucial issue in order to obtain such a value. Consequently, a focus will be on a declining growth formulation.

Section 5 studies ways of introducing risk into the sequential investment planning process, where at each stage new information on sales growth is released, and new decisions may be taken in terms of marketing. The Real Option Valuation is preferred to Risk Adjusted Net Present Value. It combines uncertain rates of demand growth with risk free discount rates. Both methods are applied to the case of BlueMarx, in Section 6.

2. Uncertainty and Flexibility.

An eCommerce firm is an organization that operates online with purchasing, selling and information. In order to become profitable the net benefits between sales revenues and variable costs of operation (the "eCommerce Margin") must be large enough to cover the investment costs. The calculation of these "net benefits" will usually be based on the following three assumptions:

1. The economic life of a system for web-services is often estimated to a maximum of three to four years, which is a rather short time period for an investment. The lifetime may be somewhat longer for an investment in marketing, i.e. in systems set up to reach and retain customers as well as for systems to sell products and services to these customers.

2. The cost of operating sales, supply, inventories, and distribution will vary dependent on the type of product or service. It is evident that electronic services (like bookings of hotels and air flights, signing of insurance policies and electricity services) are supposed to require fewer resources than a delivery of physical products such as groceries.

3. The cost of payments and financial resources will depend on the earlier financial records of the company. A *BON* firm is assumed to have higher capital costs than a *MTN* firm, which may have a long-term record from classical retailing.

Consequently, the conditions for investments in eCommerce may be positive as soon as the fixed costs for information technology, customer acquisition, and logistic services are smaller than the discounted net benefits. The purpose of this paper is devoted to the development of a method to determine *the best time-phasing of investments given an uncertain growth in customer demand.*

In principle, there may be *four stages of investment in eCommerce* that should be sequenced over time:

Stage 1. The investment in an information technology (IT) system mainly for web-services.
Stage 2. The investment in logistic facilities to meet the demand for online services.
Stage 3. The investment in advertising offline in order to obtain an initial base of online customers (an *initial branding*).
Stage 4. The investment in additional advertising offline to obtain new customer segments (a *complementary branding*).

Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
IT-facilities	Logistics	Initial Branding	Complementary Branding

/_____/_____/_____/_____> Time
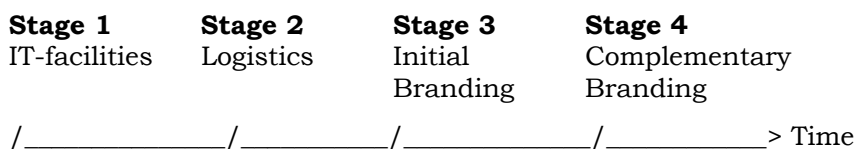
Several options may be available for these four stages. An *accelerated* one implies that all four stages may be performed simultaneously. However, such a strategy may become a risky one as it is difficult to estimate to which extent customers are willing to go online.

A more *flexible and cautious* one is to start with Stages 1 and 2 and then observe the market acceptance. The larger the sales to the initial customers the less is the immediate need for an investment in a complementary branding. Furthermore, the larger the retention of initial customers the more profitable will it be to defer investment in marketing to reach new customers (Stage 4). On the other hand, if the sales information shows that not enough customers are available, the eCommerce project may have to be abandoned.

MTN-firms often have considerable advantages over BON-firms as they often have the knowledge and the logistics to go ahead with the physical distribution associated with online sales. This implies that Stages 2 and 3 will become substantially less costly for MTN-firms.

Obviously, uncertainty concerning the customers´ propensity to go online plays a crucial role in obtaining profitable investments in eCommerce. That kind of uncertainty will only be resolved over time, and it will have a direct effect on the decision to invest more marketing resources on new customers (see Brach 2003, Ch. 4).

MTN-firms often spend the main part of their investments on information technology and relatively small amounts on marketing offline. The prudent investment in marketing may result in a slow growth in sales. BON-firms belong to the category of firms with little offline experience. Consequently, they must be prepared for substantial investment outlays in order to obtain high rates of sales growth.

Uncertainty Related to the Investments in Four Stages.

Stage 1. *IT-Investment*. The main uncertainty concerns the suitable design of the web-services. Do the customers demand interactive facilities or just one-way ordering systems? Which will be the best size of the system dependent on the amount of customers that will show up? A prudent strategy may be to start with a not too large system and expand it after 1-2 years if the number of customers grows rapidly. Consequently, profitability depends to a large extent on the rate the demand will grow.

Stage 2. _Logistics._ A considerable uncertainty concerning distribution is related to the size, timing, and regularity of deliveries booked online. The larger the size and the more regular the demand, the better are the economics of online services. As business customers often show a larger and a more stable demand than the private ones, they may become a prime target for eCommerce associated with substantial physical deliveries. Consequently, the less dependent on logistic management the more suitable for eCommerce.

Stage 3. _Initial Branding._ Investment in advertising offline may become rather costly when not directed towards relevant and specific customer segments. These costs may be minor for those MTN-firms for which the target is an existing customer base that should be convinced to switch from offline to online. In that case there is always an opportunity to postpone parts of this stage until the firm has learnt more about the customers´ propensity to switch.

Stage 4. _Complimentary Branding._ Here is the case where the focus is on completely new customer segments. Many firms have spent large resources on offline marketing as they expect that their potential customers are less accustomed to using online services. However, this investment step should be considered as the most suitable one to postpone until the firm knows for sure which propensity customers have to switch from offline to online. On the other hand, in those cases where the competition is intensive, a postponement may result in a too small customer segment.[2]

3. Different Demand Scenarios for eCommerce Services

The online sales volumes (s_t) during a time period (t) may come either from a cross-selling to an existing customer base or from sales to new customers. Actually, the evolution of these sales volumes is a crucial factor in obtaining profitability from eCommerce. Following the experience from marketing research (see e.g. Batten, Barton, Durstone & Osborn 1967, Rogers 1995) one may assume that the sales s_t during a single time period t will depend on preceding sales as well as on preceding outlays for marketing support such as advertising. To begin with we will formulate this dual influence on sales as a recursive formulation:

$$s_t = f_t(s_{t-1}, I_t) \ (t = 1, 2, 3, ..., T) \qquad (1)$$

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[2] Korper & Ellis (2000, p.44) stress that "tremendous expenditures in marketing" generated by early movers to online services have been paid off just because they have been early.

Here I_t stands for fixed outlays (investments) in advertising at the beginning of time period t.

For eCommerce this growth in sales has two salient features:

- It starts from a "basis" volume (s_1), which has to come from a market segment being well acquainted with the operational conditions of the Internet. Usually that implies younger customers in large cities.

- A lasting impression is to be made from a series of marketing campaigns (I_1, I_2,..,I_T). However, recalls of a campaigns ($I_2 = I_1$; $I_3 = I_2$; etc) may lead to decay in case less and less attractive market segments are approached. Consequently, there is often a decreasing return to scale in advertising[3].

First consider a *Scenario A* where *a given investment program (I_1, I_2 ,..., I_T)* is assumed to generate a *steady growth rate* (g). That would imply that sales (1) may be reformulated as:

$$s_t = s_1(1+g)^t \qquad\qquad\qquad (2)$$

where s_1 refers to sales to an expected initial customer base.

Such a steady growth model has been used in order to analyze the profitability of two cases of eCommerce investment, namely the ones of BlueMarx and Interflora (Bergendahl 2002, pp. 22-24). BlueMarx was a *BON*-firm with substantial investments made in marketing, which have to be covered by net benefits in order to arrive at profitability in the long term. Interflora is a *MTN*-firm equipped with an existing customer base. In that case the marketing investments play a minor role.

Then turn to a *Scenario B*, where an investment program *(I_1, I_2 ,..., I_T)* is supposed to generate a *declining rate of growth*. Such a declining rate is

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[3] Rules of Thumb: 1) The permanency of advertising increases by repetition, 2) The shorter the interval between exposures, the greater the cumulative effect, 3) Discontinuities in advertising may result in losses which are difficult to recover (see e.g. Batten et al. 1967).

supposed to come from a decreasing return to scale in advertising. Therefore let sales (s_t) start with an initial growth rate of g_1, which will decline period by period with a factor α according to the theories of diffusion. In this way a date will come when switching from growth to decay (see e.g. Rogers 1995, pp. 313-330, Bollen 1999, p. 676). This implies that a steady growth will become an extreme case, where the decay factor α is equal to zero.

Mendelson (2000, pp. 12-13) has demonstrated a declining sales scenario for Dell Direct, a department of Dell Computer Corporation. Dell's sales on the web expanded from \$1 Million a day in December 1996 to \$40 Million a day in May 2000 (50% of total sales). Then it levelled off around \$50 Million a day at the end of the year 2000.

For Scenario B let g_t denote the growth in sales between time periods t and t+1. Consequently we obtain:

$$s_{t+1} = s_t(1 + g_t) \tag{3}$$

Then sales will grow period by period, but the rate of growth will contract: as follows:

$$g_{t+1} = g_t - \alpha \tag{4}$$

given initial values g_1 and s_1. That implies a growth of:

$$s_{t+1} = s_1 \prod_{\tau=0}^{t-1} \left[1 + g - \alpha\tau\right] \; \textit{for (t=1, 2,..)} \tag{5}$$

Consequently, sales will grow as in Table 1:

Table 1. Declining Growth of Sales

Time Period (t) Sales $\left(s_t\right)$

Time Period (t)	Sales (s_t)	
1	s_1	
2	$s_1(1+g_1)$	$= s_1[1+g]$
3	$s_1(1+g_1)(1+g_2)$	$= s_1(1+g)(1+g-\alpha)$
4	$s_1(1+g_1)(1+g_2)(1+g_3)$	$= s_1(1+g)[1+g-\alpha][1+g-2\alpha)$

4. A Dynamic Investment Evaluation

Investments in eCommerce are good examples of sequential investment decisions, where investments in distribution services (Stage 2) and marketing (Stages 3 & 4) are complementary to the *platform investments* in web-services (Stage 1). Assume that the web-services are established at a date t=0 and that the complementary investments may take place on a series of dates denoted by t = 1, 2, ...T. Such an investment strategy will become *dynamic* and an important task will be to determine which outlays (I_0, I_1, I_2,..., I_T) that will lead up to the highest profit (or to the minimum costs).

Consequently, we will not only focus on if the initial investment (I_0) will be profitable or not, but also if certain complementary investments (I_1, I_2,..., I_T) are viable from an economic point of view or not.
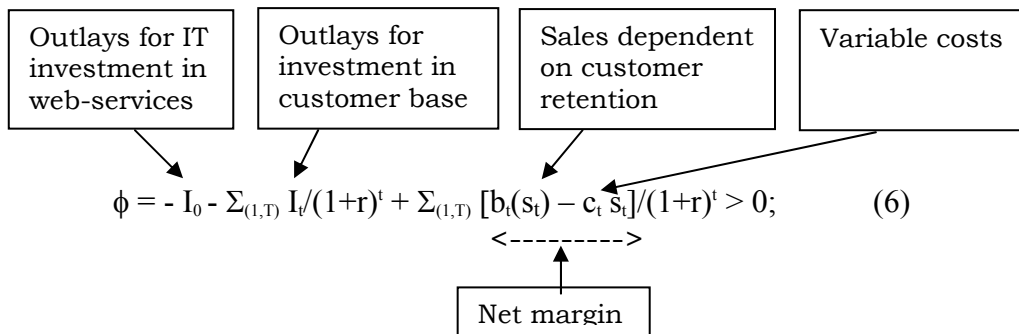
Marglin (1963) was among the first economists to analyze the optimal dates of investments. He focused on the advantage of postponing an investment in case demand was expected to grow over time[4]. He declared (1963, p.2) that:

> *"Although all decision rules that have gained acceptance do so in that they reflect a project's potential benefits and costs over a substantial period, they do not take time into account in a way equally essential: they do not reflect the impact of a project's pay-off of delaying its construction. And it is by this latter quality that we distinguish dynamic from static rules in this study."*

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[4] In fact Marglin (1963) previously observed that a positive net present value (NPV) is necessary but not sufficient for investment in case projects are interdependent. For example, even if a project demonstrates a positive net present value (NPV) today it should be postponed if the NPV of tomorrow will be even larger. Bergendahl (1969 A & B) developed these principles further in order to determine the optimal timing and staging of road investment projects. However, at that time set-up costs and economies of scale, but not uncertainty, were the main reasons for postponing and staging. Marglin just noted that "uncertainty will reduce the temptation to build ahead of demand in order to profit from these economies of scale" (Marglin 1963, pp. 71-72). Manne (1961) was probably the first one to consider the effect of uncertainty in dynamic investment planning. He looked for the best investment strategy assuming that the growth in demand will follow a Markov process. That approach for dynamic investment planning may be seen as a forerunner to the real options valuation.

Marglin observed that an ignorance of timing may lead to incorrect decisions[5]. He found it not sufficient to start a project on the basis that it generates a net present value. It is equally important to identify the gain in net benefits coming from either a postponement of the initial investment date or from a program of complementary investments[6].

Given that sales will grow according to a declining rate (5) we should look for an investment program (I_t) that will maximize the net present value (NPV) given as:

Outlays for IT investment in web-services	Outlays for investment in customer base	Sales dependent on customer retention	Variable costs

$$\phi = - I_0 - \Sigma_{(1,T)}\, I_t/(1+r)^t + \Sigma_{(1,T)}\, [b_t(s_t) - c_t\, s_t]/(1+r)^t > 0; \qquad (6)$$

<------------>

Net margin

where:

I_0 = the *fixed costs* from an investment in information technology (web service) and logistic support.

I_t = the *fixed costs* from an investment in marketing campaigns in order to obtain a sufficient customer base.

s_t = the *sales volume*, which may be measured as the number of customers per time period.

b_t = the *net revenue* during time period t given as a function of the sales volume (s_t)

c_t = the *variable costs* of sales, supply, inventory, distribution and payment ("logistics").

r = the discount rate

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[5] He demonstrated this statement with an example from mining, where "the net present value ... increases with postponement of construction for more than fifteen years after the mine is first ´justified´ that is for more than fifteen years after construction first yields a positive net present value".

[6] Marglin illustrated that case (1963, p. 12) with the somewhat unrealistic example of an investment to meet a sudden "spurt" twenty years ahead in the demand for uranium However, it seems unrealistic to assume that any decision-maker will have the complete information of such a spurt 20 years ahead.

Then key issues for investment in eCommerce are:

1. Which effect will alternative marketing programs (I_t) have on the sales volumes (s_t)?

2. How to account for uncertain sales volumes in the investment evaluation?

The final model for investment evaluation under a declining growth will then be to find the strategy that maximizes (6) subject to (5). However, observe that so far this model is *deterministic*. In the next section we will introduce uncertainties in terms of the sales growth.

5. A Real Options Approach.

A classical approach to evaluate uncertain investments would have been to use the *Risk Adjusted Discount Rate* approach, i.e. to adjust the discount rate (r) upwards by a risk premium. In our case that would imply to maximize (6) subject to (5). However, while this approach is suitable for single date decisions ("Now-or-Never"), it is less useful for (market) investment in stages. In this latter case, new information about demand may be used to abandon later stages in case demand is not picking up.

The real options valuation (ROV) makes it possible to introduce the distribution of forecasted sales volumes directly into the investment evaluation in terms of a lattice instead of adjusting the discount rate upwards. Below we will show how to formulate the sales expansion – and thus the value of the investment – in terms of a binomial lattice over a series of dates t = 1, 2, …, T.

The procedure will be given below and visualized in Figure 2:

- Date 1: Assume that an initial demand s_1 and an expected growth rate $g_t = g$ may be estimated with a rather good precision and that growth rate will be related to a specific market segment A.

- Date 2: A market segment B is approached. If the marketing for that segment turns out to be successful, demand will grow by the

declining rate (g-α). If the marketing is less successful, then the demand will remain on the level *s₁(1+g)* from date 1. Consequently, we will have two alternative outcomes.

- Date 3: If the market segment B has been captured at date 2, then we may approach market segment C at date 3. Now if we will capture segment C we expect that the growth rate will decline to (g-α), as more and more segments are captured. If we are not successful, then we will remain with segments A and B. On the other hand, if segment B was not captured at date 2, then we may approach that segment at date 3, etc.

The real options approach developed her uses a binomial lattice in the following way. At each time period sales may be either grow by a certain expected rate or remain constant. Thus, the sales s_t will move in either of the following two directions

a. No Growth
This case implies that $s_t = s_{t-1}$.

b. Growth by a Declining Rate
This case implies that the growth in sales g_t will follow the above trajectory of declining rates (5). This implies that *the expected maximum sales* may grow by an initial rate of *g* (%). Then that maximum rate will decline period by period with a factor α.

As a consequence, the customer base will either grow or remain constant between two consecutive dates. If it grows, the rate will depend on earlier growth rates. In this way sales may develop according to the *binomial lattice* (s_{it}) given in Table 2.

Table 2. Binomial Lattice for Sales

Date 1	Date 2	Date 3	Date 4
s_1	$s_{12} = s_1(1+g)$	$s_{13} = s_1(1+g)[1+g-α)$	$s_{14} = s_t(1+g)[(1+g-α][1+g-2α]$
	$s_{22} = s_1$	$s_{23} = s_1(1+g)$	$s_{24} = s_1(1+g)[1+g-α]$
		$s_{33} = s_1$	$s_{34} = s_1(1+g)$
			$s_{44} = s_1$

The formulation of the demand evolution in terms of a binomial tree will allow us to evaluate the project as a function of the customer base (see

Figure 2). At each date the underlying asset can only move to two possible values. At the horizon date, we estimate the residual value (if any) of the project.

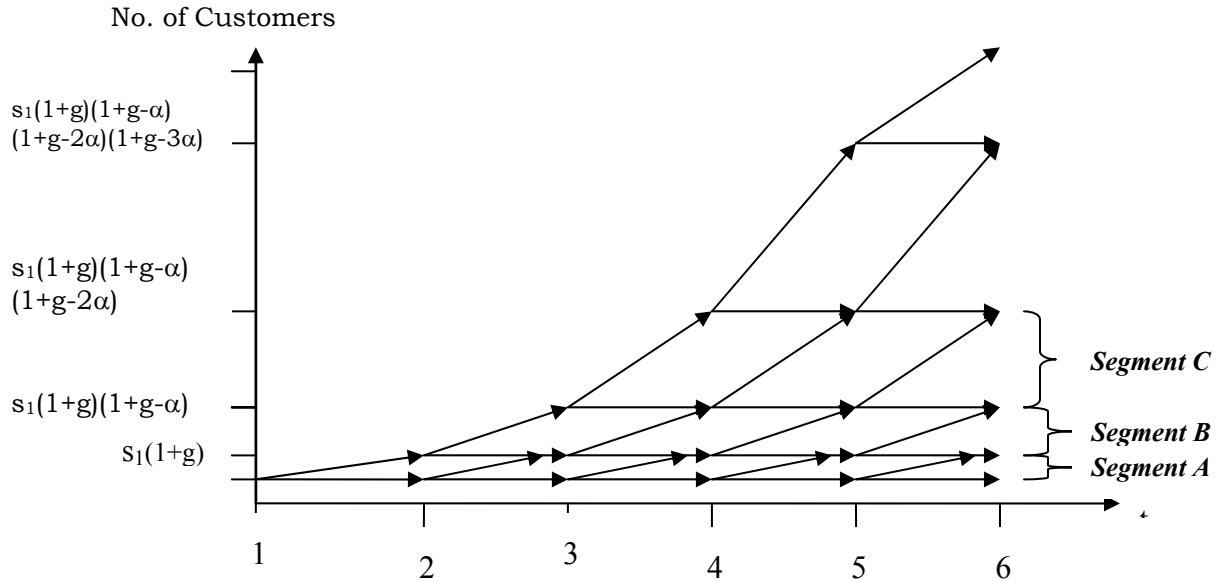**Figure 2. The Lattice for Customer Expansion over Time Periods**

Figure 2 illustrates the demand expansion assuming a complete program of marketing investments (I_1, I_2,..,I_T). However, if the marketing investments are halted at a certain date, say Date 3, then we assume that the lattice will not expand. As demonstrated in Figure 3, there will be a "cap" on $s_1(1+g)(1+g-\alpha)$.

Figure 3. The Lattice for Customer Expansion over Time Periods with Marketing Investments at Dates 1 and 2 but not at Date 3 and onwards
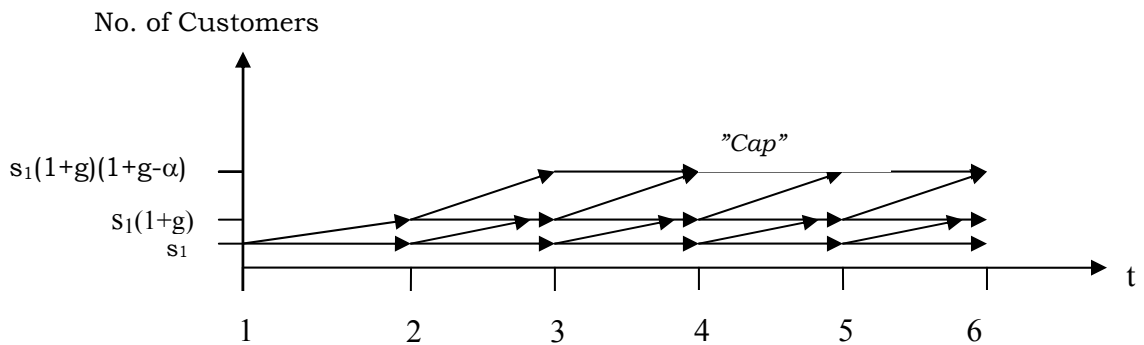
Consequently, the real options approach when sales are uncertain will imply an adjustment of the investment decisions period by period as information on sales will be revealed. With such a *flexibility* strategy the decision maker will take advantage of the *embedded options* included in the project, like[7]:

> 1. *options to alter or to defer* marketing investments in case sales will not show a sufficient growth. The option to change the scale of a project in order to save certain advertising expenditures may be seen as a *put option* on the project value (see for example Trigeorgis 1996, p.125 and Zhu 1999).

> 2. *options to expand* marketing investments to new segments in case the initial growth (g) is substantial and the declining rate (α) is small. Such an option may be treated as a *European call option* on part of the project.

> 3. *options to abandon* further marketing investments or even the whole project in case of a small sales expansion or a high declining rate. The option to cancel the project during its construction may also be seen as a *European call option* on part of the project (a compound option, see Trigeorgis 1996, p. 358).

Options to alter and to defer investments in marketing will give a manager an option to invest in stages just in order to scale up projects when needed. Options to alter, to defer, or to expand marketing investments may be treated as *learning options*. That implies that the holder of such an option may pay to learn about the uncertain sales (see e.g. Copeland & Keenan 1998:A & 1998:B, Benaroch & Kaufman 1999, Herath & Park 1999, Park & Herath 2000, Nembhard, Shi & Park 2000, Amram 2002, pp. 69-77).

The classical theory behind real investments tells us that an investment should be performed as soon as the net present value (NPV) is positive or when the internal rate of return (IRR) is larger than the discount rate. It

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[7] See e.g. Amram & Kulatilaka (1999), Brennan & Trigeorgis (2000), Copeland & Antikarov (2001), Dixit & Pindyke (1994 & 1995), Trigeorgis (1996), and Luenberger (1998).

should be denied if the NPV is negative. The basic assumption behind the use of real options for investment evaluation under uncertain demand is based upon the principle that we must also consider the options to alter, expand, defer, or abandon these investments. This implies representing uncertainty in terms of a binomial lattice and then working backwards to find the value of the project (see e.g. Luenberger 1998, pp. 337-344). Let us illustrate such an evaluation with the case of BlueMarx (see below).

6. The Case of BlueMarx

The Swedish company BlueMarx started on February 2000 with sales revenues around 75.000 SEK per week. After 9 months (39 weeks) it delivered technical products to about 500-550 customers per week generating a sales volume of SEK 3-3.5 million per week. That implied an average purchasing volume per customer per week of SEK 3.25 million/525 = SEK 6180. Assume that this average volume per customer were stable. That means that there should have been approximately 75.000/6.180 = 12 customers the first week.

An expansion from 12 to 525 customers per week over nine months implies an average growth rate of 10.45% per week. If such a growth rate would continue it would lead up to over 300.000 customers per week in two years time (see Scenario A below)[8]. Such a rate is especially remarkable as BlueMarx has observed that only 18% of the customers were repeat purchases.

Let us then consider a case of a "declining growth rate". In this new case we will assume the same initial customers as above (12 per week) and the same amount of customers after three quarters as above (about 525 per week). However, in this case growth is supposed to follow a declining rate according to (4). For purpose of illustration assume a higher initial growth rate (g= 0.1312) combined with a declining growth factor (α = 0.00144)

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[8] It is obvious that the growth in demand cannot continue at such a stable rate. Bergendahl (2002, pp. 22-23) considered a case where the number of customers with BlueMarx will grow and continue to grow at a weekly rate of *a stable growth g* % calculated as:

$$12(1+g)^{38} = 525 \qquad => \qquad g = 0.1045$$

resulting in about the same number of customers after 39 weeks as well as a market saturation after almost two years time. Scenario B gives us the demand under a declining growth (see below).

Week	1	13	26	39	52	65	78	91	104
Scenario A: Stable Growth	12	40	144	524	1908	6947	25290	92065	335158
Scenario B: Declining Growth	12	48	178	523	1228	2290	3379	3929	3584

As a consequence we will estimate the following *average sales per quarter:*

Quarter	1	2	3	4	5	6	7	8
Stable Growth	23	85	309	1125	4097	14913	54291	197642
Declining Growth	27	106	339	869	1778	2897	3780	3818

Conclusion: An assumption of a declining growth instead of one of a stable one will lead to a substantial reduction in sales and thus in profitability. However, such an assumption will correspond much better to the assumption that an S-curve may describe the growth of a new product (see Figure 1 below). Such an S-curve is based upon a long term experience that the sales of a new product will grow quickly in the beginning, while the growth will decline as it becomes more cumbersome to reach additional customers.

Figure 1. Growth of eCommerce Customers
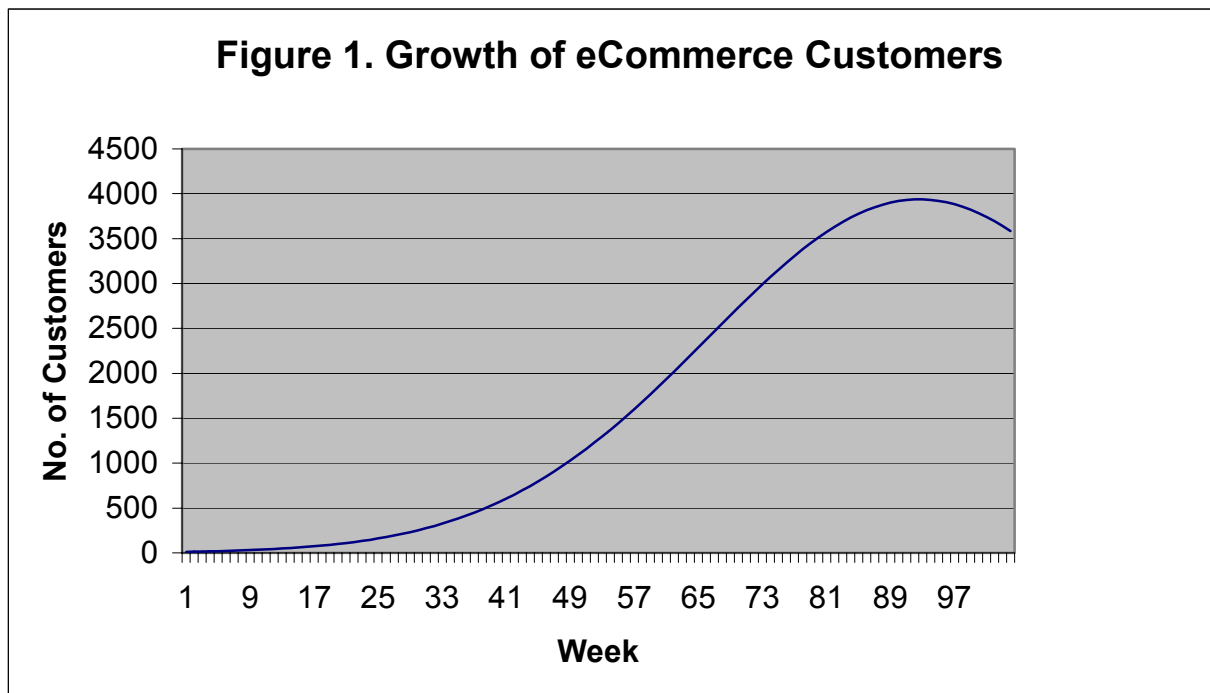
6.1 A Risk Adjusted Discount Rate.

Based upon the Blue Marx Annual Reports, we can estimate the total annual variable costs (including sales, supply, inventory, distribution and payment – the "logistics") to:

- Personnel	SEK 11.0 million
- Administration	SEK 0.6 million
- Transportation	SEK 3.0 million
- Credit control	SEK 0.3 million
Totally	SEK 14.9 million

That implies an approximate variable cost (c_t) of SEK 696 per customer.

The order margin (m) lies between 6%-35% per order. Assuming an average order margin of 20% for an average order on SEK 6180 leads us to a net revenue (b_t) of SEK 1236.

Then we may calculate the net present value (NPV) based upon the following cost data:

The *fixed costs* (I_0) from an investment in Information technology (web-service): Week 1 - SEK 3.0 million

The *fixed costs* (I_t) from an investment in marketing campaigns:

Quarter 1 (week 13)- SEK 6.0 million
Quarter 2 (week 26)- SEK 7.0 million
Quarter 3 (week 39)- SEK 7.0 million

The high marketing costs originates from an aggressive marketing in the daily press as well as from a direct advertising of over 450 products
Then follow the declining growth model as specified in (5). Consequently, the net present value will estimated as:

$$NPV = -I_0 + \Sigma[b_t s_t - c_t s_t - I_t)/(1+r)^t = -3.0 + [0.434-0.244-6.0]/(1+r)^{1/4} +$$
$$+ [1.703-0.959-7.0]/(1+r)^{1/2} + [5.447-3.067 -7.0]/(1+r)^{3/4} +$$
$$+ [13.963-7.863]/(1+r) + [28.569-16.087]/(1+r)^{5/4} +$$
$$+ [46.548-26.212]/(1+r)^{3/2} + [60.737-34.201]/(1+r)^{7/4} +$$
$$+ [61.348-34.545]/(1+r)^{2}$$

Now assume that the risk-free discount rate is 10%. Then we shall allow for a risk premium to be added to that rate. Therefore, consider two cases - one with moderate risks assuming a risk premium of 10%, and one with extremely high risks leading to a risk premium as high as 20%. That results in the following net present values:

Moderate Risks (Discount Rate 20%):

  a. After one year: NPV = -3.0 -5.55 -5.71 -4.03 +5.09 = - 13.26 million SEK.
  b. After two years: NPV = - 14.05 + 9.94 + 15.47 + 19.29 +18.65 = 49.30 million SEK.

Extremely High Risks (Discount Rate 30%):
  a. After one year: NPV = -3.0 -5.44 -5.48 - 4.62 + 4.69 = - 13.85 million SEK
  b. After two years: NPV = - 13.85 + 8.99 + 13.72 + 16.76 + 15.86 = 41.48 million SEK.

According to this calculation, BlueMarx will become profitable after 8 quarters,
A. if it can sell at an initial growth rate over 13% per week.
B. if the market will not be saturated until after almost 2 years´ time.
C. if it may obtain a profit margin as high as 20%.
D. if it can provide finance to its investments at an average cost of 20% (the discount rate).
Observe that the choice of risk premium has very little influence on the profitability.

6.2 The Real Options Approach

Let us introduce a binomial lattice for BlueMarx based upon the two strategies, no growth or a growth by a declining rate. For purpose of illustration, the calculations will be performed quarter by quarter. However, there is no problem to follow the growth week by week.

a. No Growth
This case implies that $s_t = s_{t-1}$.

b. Growth by a Declining Rate

This case implies that the maximum growth g_t will follow the above trajectory of declining rates (3), (4), and (5). This implies that *at maximum* sales will grow by an initial rate per period of g (%). Then that maximal rate will decline period by period with a factor α.

Given these assumptions we obtain a *binomial lattice* for the number of customers to BlueMarx. Below we illustrate that lattice for quarterly intervals over a two-year time period that is for quarters Q1, Q2,.., Q8. The data are derived by using the Declining Growth Model given above:

Quarter /	Q1 /	Q2 /	Q3 /	Q4 /	Q5 /	Q6 /	Q7 /	Q8 /
Week 1	13	26	39	52	65	78	91	104
12	48	178	523	1228	2290	3379	3929	3929
	12	48	178	523	1228	2290	3379	3929
		12	48	178	523	1228	2290	3379
			12	48	178	523	1228	2290
				12	48	178	523	1228
					12	48	178	523
						12	48	178
							12	48
								12

Now assume that the investments in Web-services and in marketing have no residual value after two years time (week 104). Then we may start the evaluation (in SEK 1´000) at that week and work backwards quarter by quarter.

Week 1	13	26	39	52	65	78	91	104
2.66	11.55	27.65	45.50	61.34	62.26	50.86	27.58	0
	0	7.20	21.77	36.88	41.77	39.37	25.13	0
		0	6.20	18.35	23.32	24.58	18.21	0
			0	7.59	10.55	12.73	10.53	0
				2.74	3.89	5.18	5.10	0
					1.44	1.69	1.81	0
						0.82	0.54	0
							0.14	0
								0

Legend. The first element of column 91 (end of Q7) is calculated as:

3929   * [1236-696]   *   13 $= 27.58 * 10^3$

[Ave. customers]   x [ave. margin] x [no. weeks]   = value 91 (row 1)

The first element of column 78 (end of Q6) is calculated as:

$0.5[3780+3379]* [1236-696] * 13 + [0.5 * 27.58 + 0.5 * 25.13]/(1+0.1)^{0.25} = 50.86 * 10^3$

[exp customers]   *   [as above]   + [up-state value + down-state value]/[discount factor]

Then work backwards quarter by quarter. Observe that the investment costs of SEK 6, 7, and 7 million have to be deducted in Quarters 1, 2, and 3 respectively. In three cases it will result in a negative value. For them the best strategy would be to abandon the project with a value of 0. For example, consider the fourth element of week 39, which may be calculated as:

$$0.5[12+48] * [1236-696] * 13 + [0.5 * 12.66 + 0.5 * 5.06]*10^3/(1+0.1)^{0.25} - 7.0 = - 443 *10^3$$

[As above] + [up-state value+down-state value]/[discount factor]-investment = prelim. Value Q7

Consequently, we conclude that it is favourable to abandon the project to a cost of 0 instead of $-443*10^3$.

Finally, we arrive in Quarter 1 where the value is estimated to SEK 5.66 million. Then subtract the initial investment of SEK 3 million resulting in a real option value of (5.66-3) = 2.66 million SEK. That value is substantially lower than the optimistic net present value of SEK 49.4 million found with the Risk Adjusted Model (see Section 6.1).

Observe that the lattice is assumed to give a complete description of the uncertain demand. Consequently, the cash flows are discounted to a risk free rate (10%). The positive option value of this investment program is based upon the assumptions that the investment in web service have a life of two years and that sales will grow continuously over that time period. The value of the project will be substantially reduced if those conditions cannot be fulfilled.

7. Conclusions

This project concerned the use of a real options analysis for investments in eCommerce under uncertainty. The purpose was twofold. The first one was to develop principles for an evaluation of real options related to investments in information technology and marketing. The second one concerned how to apply these principles to a case study of eCommerce. It was shown that a Real Options approach will consider the uncertainties in the demand growth in a much better way than the classical net present

value method with a risk adjusted discount rate. I will also allow for new information concerning how the growth in sales may decline over time.

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