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Limits to growth on the new economy: An exploration of the 'get big fast' strategy in dot.com's[1]

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Many Internet companies have decided to follow a 'get big fast' strategy: they invest heavily in marketing to build their user base and market share. At least for now, the capital markets seem to encourage this strategy: the stock price of the leading competitor in a category (say, Amazon in online book selling) typically trades at a significant premium to the stocks of other category competitors, as a multiple of revenues or users.

Is this behavior rational? We believe that a SD model could shed some light on the issue. We build a generic model that reflects a particular industry within e-commerce (say, booksellers), capturing the characteristics of the main competitors -- their basic economics (how they make money), operating and financial strategies -- and the behavioral decision rules for consumers, managers, and investors in the enterprise. The purpose of this model is to evaluate the different growth strategies seen in Internet businesses, explore their sustainability under different competitive scenarios, and to test the 'rationale' that capital markets are using to value these companies. We identify a typology of strategies and the range of scenarios under which each of those strategies is successful. Finally, we explore the reference modes for the eventual reduction of the 'speculative excess' in dot.com stocks and the return to more traditional valuation heuristics (multiples of earnings, discounted cash flow analysis).

[1] A version of this paper has been submitted to the Sloan School of Management, MIT in Partial Fulfillment of the Requirements for the Degree of Master of Science in Management of Margin Giese. The full reference for that document is: Guiese, M. 2000. Managing Hyper-Growth – A System Dynamics Analysis of Competitive Dynamics in Business-to-Consumer Electronic Commerce.

1. Introduction

"We argue that capital market participants should have seen the problem coming. They should have known that valuation levels were absurd, based in large part on the greater fool theory. The data to anticipate the problem were readily available before the industry shakeout began and stock prices collapsed."[2]

These words were written in 1985 and refer to the rise and collapse of the Winchester Disk Drive industry. The development of hard disk companies of the early 1980s and the development of hot Internet stocks today show many similarities. In the early 1980s, record level venture capital investments and a receptive public market allowed an entire industry to defy profitability in the pursuit of growth.

Today we experience all-time record highs in venture capital (VC) investments and initial public offerings (IPO). In the first quarter of 2000, Internet-related startups raised $17.05 Billion in venture capital, thereby accounting for over 75 percent of all venture funding raised.[3] 139 companies went public in the first quarter of 2000 with an average offer size for venture backed IPOs of $102 million.[4] And again growth, not profits is the current matrix for success. The typical Internet retailer[5] is expected to lose $43 million in 2000[6], mainly for advertising to stimulate growth.

Critical voices warn about a dangerous trend towards "hollow companies, which have limited experience, wisdom, commitment, long-term view, allegiance to the customer, or sense of construction."[7] Critics also claim that these companies are "built to flip"[8] and warnings are issued about the pending burst of the Internet bubble[9] and about "the demise of dot com

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[2] William A. Sahlmann and Howard H. Stevenson, Capital Market Myopia, Journal of business Venturing 1, 7-30 (1985).
[3] Press release by the National Venture Capital Association and Venture Economics, May 4, 2000.
[4] Press release by the National Venture Capital Association, April 10, 2000.
[5] For some inside reports about representative companies, see The fall of a dot-com (On ValueAmerica) in Business Week, May 1, 2000, page 150. Free Money (iVillage) in The New Yorker, October 11, 1999. See also Michael Wolff, Burn Rate, Touchstone, New York, 1999 and Michael Lewis, The New New Thing" W.W. Norton, New York, 1999.
[6] Forrester Research, The Demise of Dot Com Retailers, April 2000.
[7] Hollow.Com, George F. Colony, Chairman of the Board and CEO, Forrester Research. See http://www.forrester.com/ER/Marketing/0,1503,183,FF.html.
[8] Fast Company issue 32 page 131. See http://www.fastcompany.com/online/32/builttoflip.html.
[9] Anthony Perkins, Michael Perkins, The Internet Bubble, Harper Business, New York, 1999.

retailers"[10]. Warren Buffett compares Internet stocks to a "chain letter"[11] arguing that "If you are very early in a chain letter, you can make money, but there's no money created."

This paper examines online retailing, a major segment of Internet companies. A system dynamics model is developed to explore how online retailing might develop in the future. Are the fears of dooming collapse justified? Or is the hype and optimism of the market for Internet stocks justified?

The modeling approach allows experimentation that could not be achieved in a real company setting. The simulated companies are exposed to varying conditions and assumptions in order to identify what assumptions need to hold in order to justify current valuation levels. Winning strategies and failure modes for competitors in this market are explored.

2. Business to Consumer Electronic Commerce

2.1. Online Retailing

Business to Consumer (B2C) electronic commerce has grown rapidly over the past five years. For 2000, Forrester Research predicts a market size of $38 billion with 28 million households spending an average of $1,366.[12] In the late 1990s, online retailers have generated huge interest from investors, and the total market capitalization for publicly listed B2C companies approached $250 billion in December 1999.[13]

However, the continuation of this trend appears doubtful in early 2000. By March 31, 2000 many online retailers were trading 30% to 95% below the peak valuations that they enjoyed only a few weeks or months earlier[14] and industry analysts like Forrester Research are already proclaiming "The demise of Dot Com Retailers"[15]. Falling valuations have triggered concern over whether online retailers will be able to continue funding their losses (expected to average $43 million in 2000[16]) through the public markets. Stories about likely candidates for bankruptcy abound.[17]

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[10] Forrester Research, The Demise of Dot Com Retailers, April 2000.
[11] Financial Times, May 1 2000, Page A1.
[12] Forrester Research, Metrics for Judging Retail Site Staying Power, Brief, January 31, 2000.
[13] Goldman Sachs, Issues & Outlook 2000, e-markets: B2B and B2C, December 1999.
[14] Forrester Research, The Demise of Dot Com Retailers, April 2000, Table 2.
[15] Forrester Research, The Demise of Dot Com Retailers, April 2000.
[16] Forrester Research, The Demise of Dot Com Retailers, April 2000.
[17] Shakeout looming for many Net firms, April 1, 2000 on http://news.cnet.com/news/0-1007-200-1620033.html?tag=st.ne.1002 or Ouch! Barron's story bites Net stocks on http://www.redherring.com/investor/2000/0320/inv-off-zdii032000.html.

This paper will analyze the online retailing market to see where the online retail market is going, based on the underlying dynamics. Are the fears of bankruptcy justified? Is the hype and optimism of the market for Internet stocks justified?

This model focuses on two online retail markets. The first is the online book market, which was one of the first online markets to develop. The second is the online pet supplies market, which started only in 1999, but with several well-funded competitors emerging simultaneously. Publicly available data from these markets, especially the SEC filings of Amazon, Barnesandnoble.com, Pets.com and Petopia.com were used to construct, test and calibrate the model.

2.2. The Online Market for Books

Total U.S. book sales were estimated to be $26 billion in 1996 and estimated to grow to $30 billion in 2000.[18] The book market was one of the first markets for online retailing to develop. A pure-play online retailer, Amazon, started in July 1995 and quickly achieved a dominant market position. Over time, the company added music (June 1998), video and gifts (November 1998), personal electronics and toys to its product selection. Sales revenue grew from $15.7 million in 1996 to $147.8 million in 1997 to $610.0 million in 1998 and to $1,639.8 million in 1999. Amazon commands a market capitalization of $20.4 billion (May 5, 2000), despite losses of $720 million in 1999.

Its largest competitor, barnesandnoble.com, the online division of the leading bricks-and-mortar retailer Barnes&Noble, started selling books in March 1997 and has also expanded its product selection to include software, magazines, music and video products. Its sales grew to $202.6 million in 1999, which means that barnesandnoble.com still trails Amazon by an eight-to-one-ratio. With losses of $48.2 million in 1999, its market capitalization stands at $302.7 million (May 5, 2000).[19] Other players in the book market are significantly smaller than both Amazon and barnesandnoble.com.[20]

2.3. The Online Market for Pet Supplies

The Online Pet Supply Market took off much later than the online book market. According to the Pet Industry Joint Advisory Council, total U.S. consumer spending on pet products was

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[18] From Amazon, SEC-Filings, S-1 from March 24, 1997.
[19] See also Dickson L.Louie, BarnesandNoble.com (A), Harvard Business School Case N9-898-082, Revised April 7, 1998.
[20] Check www.gomez.com for a performance comparison of online book sites.

approximately $23 billion (1997) with an annual growth rate of 9%,[21] which means the market is almost as large as the book market. Traditionally, this demand was filled through store-based retailers, superstores and grocery stores. In late 1998 and early 1999 at least a dozen teams submitted business plans for online Pet supply stores to venture capitalists.[22] These investors then started the first round of consolidation in the nascent marketplace. This reduced the number of players, the most significant of which are Pets.com, Petopia, Petstore and PETsmart.[23] The table below describes the outcome in this industry so far.

Due to the intense competition in this segment, many companies are selling their products at or even below costs and online pet supplies companies are among those online retailers whose chances for survival as a going concern are questioned publicly. Pets.com, the only pet supplies company that went public before the March 2000 slump in Internet stock valuations currently trades at $ 2 11/16 (May 5 2000) after a huge decline from its February 2000 IPO price of $11. This translates into a market capitalization of $79.4M.

Company	Pets.com.[24]	Petopia[25]	Petsmart.com	Petstore
Notable Partners	Amazon	PETCO (leading specialty retailer	PETsMART (49.9%), Idealab!, Global Retail Partners	Battery Ventures, Advanced Technology Ventures, Discovery Communications
Founded	02/1999	10/1999	05/1999	03/1999[26]
Status	IPO in 02/99	Filed for IPO on March 13, 2000	Private Company	Private Company
Money Raised	$73.7 million (Pre-IPO) plus $82.5 million (IPO)	$84.7 million	N/A	More than $150 million.[27]
Revenue (1999)	$5.8 million	$3.5 million	N/A	N/A
Net Losses (1999)	$61.8 million	$41.6 million	N/A	N/A
Market Capitalization (May 2, 2000)	$79.4 million	N/A	N/A	N/A

Table 1 – Overview of Leading Online Retailers for Pet Supplies.

[21] Pets.com SEC-Filing S-1/A Registration Statement, February 9, 2000.
[22] K9 Commerce, Business 2.0, August 1999, page 29.
[23] Check www.gomez.com at http://www.gomez.com/channels/index.cfm?topcat_id=35 for a listing/ranking of 15 online pet supply sites.
[24] Pets.com SEC-Filing S-1/A Registration Statement, February 9, 2000.
[25] Petopia SEC-Filing S-1 Registration Statement, March 13, 2000.
[26] Closure of first funding round.
[27] From http://www.petstore.com/about_us/about_us.jhtml.

3. System Dynamics at Work

3.1. System Dynamics and Corporate Growth

It is difficult to test hypotheses to explain the powerful dynamics demonstrated in online retailing because it is not possible to conduct experiments with real organizations. Models allow researchers to explore the consequences of different policies and environmental settings.[28] To be useful for a model of online retailing, a methodology needs to fulfill the following criteria:

- It must be able to represent the physical and organizational structure of the companies and the market
- It must be able to map decision processes of key actors in the system
- It must be able to capture soft variables such as the impact of overtime on employee retention or the impact of user-generated contact on spending volumes
- It must be able to deal with multiple levels of analysis to capture the dynamics within a company, the competitive dynamics between companies and also the interactions of these companies with the financial markets.

System dynamics fulfills those criteria and has been used successfully to model corporate dynamics. The earliest system dynamics models of high-tech growth companies date back to the 1960s and to Jay Forrester himself.[29]

3.2. System Dynamics and the Internet

The first published system dynamics model examining the Internet space appeared 1997 in the best-selling book "Net Gain" by McKinsey & Company consultants Hagel and Armstrong. Their model (see Figure 1) employs system dynamics to draw a causal-loop diagram that displays four reinforcing growth loops for online communities: Content Attractiveness, Member Loyalty, Member Profiles and Transaction Offering.[30] Hagel and Armstrong demonstrate that while all

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[28] Sterman, Repenning and Kofman, Exploring a Paradox of Organizational Improvement, Management Science/Vol. 43, No.4, April 1997, page 506.

[29] Jay W. Forrester, Collected papers of Jay W. Forrester, 1975; O. Nord, Growth of a New Product: Effects of Capacity Acquisition Policies (1963), D. Packer, Resource Acquisition in Corporate Growth (1964). See also Mark Paich and John Sterman, Boom, Bust, and Failures to Learn in Experimental Markets, Management Science/Vol.39, No.12, (1993) and John Sterman, Business Dynamics – Systems Thinking and Modeling for a Complex World, 2000, page 605.

[30] Hagel/Armstrong, Net Gain, Expanding Markets through Virtual Communities, 1997, page 49.

four loops are powerful drivers of growth, they are even more powerful when they are combined.[31]

The Hagel/Armstrong model has multiple shortcomings. There is significant redundancy between the Content Attractiveness and the Member Loyalty loops as the member-generated content is a key form of member-to-member interaction. The model also ignores important other sources of growth for an online community such as word-of-mouth and the (extraneous) growth of the Internet. Even more importantly, in a finite world, no growth loop can continue perpetually. These limits (or, in System Dynamics terms, "balancing loops") are constituted by a variety of factors, such as the limits as to how many Internet users can be converted to members and technical hurdles in adjusting the server and fulfillment infrastructure to the increased traffic. Also competition (which can use the same growth loops as a driver) can limit the growth of any one community. These concerns make it unadvisable to extrapolate these growth loops for ten years as Hagel and Armstrong do within their example of an online travel community.[32]

3.3. Goals for this Model

A model can never capture every aspect of a system. A good system dynamics model is built with a clear purpose. The model presented in the paper was built with the following goals:

- Explore the strength and interaction of reinforcing loops driving the rapid growth demonstrated by successful online retailers
- Identify internal limits to growth relating to the organizational capability to adjust to rapid growth
- Identify external limits to growth such as market saturation
- Test what assumptions need to hold in order to justify current valuation levels
- Explore some of the competitive dynamics between multiple online retailers or between online retailers and online divisions of bricks-and-mortar companies
- Identify winning strategies and failure modes for online retailers
- Speculate on the impact of an external shock such as a change in the way in which Internet stocks are valued.

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[31] Hagel/Armstrong, Net Gain, Expanding Markets through Virtual Communities, 1997, page 56.
[32] Hagel/Armstrong, Net Gain, Expanding markets through Virtual Communities, 1997, page 55.

It is important to point out how online retailing is different from some other dynamics that have been explored using system dynamics. Most notably, the well-researched boom-and-bust cycle in product diffusion does not apply here. In that phenomenon, companies fail to realize that they have two different types of sales: new products sales and replacement sales. New product sales often peak and then decline after the market saturates whereas replacement sales reach a constant level. Many companies go bust because they built excess capacity during the peak of new product sales that is not needed once the market stabilizes at replacement levels. By contrast, both the online markets for books and pet supplies only present a small fraction of the larger and growing total market. Different from the product diffusion situation, there is no compelling structural reason why online sales volumes need to decline. Of course, online retailers may still build significant excess capacity and fail, but typically the cause is different – for example, overestimation of future growth rates.

Network externalities that were demonstrated to be significant in battles between conflicting standards (Betamax vs. VHS or Wintel vs. Macintosh) are an important driver in the growth of the Internet itself, however they are not significant at the level of an individual online retailer. A buyer does not receive a direct benefit from buying at the most popular site and switching costs are relatively low. Only secondary benefits such as user-generated content or cost benefits due to economies of scale may drive people to the largest player.

4. Boundaries of the Model and Time Frame

4.1. Boundaries

The model presented here has important boundaries. Most importantly, it neither models entry into new and complementary markets (such as Amazon's move from books into CDs and consumer electronics), nor does it model international expansion. Both decisions may be significant to determine whether or not companies can ever reach profitability or even profits justifying today's valuations. However, modeling these dynamics would have introduced significant discontinuities into the model that would have made the analysis more difficult. Furthermore, the goals outlined above could be achieved by focusing on one market such as books or pets throughout the simulation. The model does not deal explicitly with bankruptcy as loss-making companies are not "removed" from the playing field even if the financial markets stop to support their losses. This is non-consequential in most failure scenarios when the

company shrinks into obscurity such that the bankruptcy has no impact on the other players.[33] Also no mergers between companies are foreseen in the model. Also factors such as changes in Gross Domestic Product and Consumer Spending have been excluded.

Though part of the model structure, population growth and Internet adoption are exogenous to the dynamics examined in the model as there is no feedback from the model to these variables. Both were modeled to fit data from Industry reports and forecasts from Forrester Research.[34]

Endogeneous	Exogenous	Excluded
User Acquisition and Retention	Population Growth	Expansion into new product categories
Marketing Spending	Internet Adoption	International Expansion
Product Selection	Size of Total Market	Mergers and Acquisition
Pricing		Bankruptcy
Server Infrastructure		GDP
Warehouse Infrastructure		Trends in Total Consumer Spending
Site Content		
Hiring		
Workweek		
Employee Turnover		
Employee Stock Options		
Customer Support Quality		
Site Performance		
Cash Flows		
Revenue		
Net Income		
Market Share		
Fund-Raising & IPO		
Stock Valuation		

Table 2 - Model Boundary Chart

4.2. Time Frame

The model simulates the period from 1995 to 2015. 1995 is the year Amazon started and can be identified as the first year of significant online retailing efforts. The year 2015 was picked to allow significant time after the point at which Internet penetration reaches the saturation point in the US.

[33] The only case in which this limit becomes relevant occurs when a market share leader goes bankrupt. In this case, the model run should be treated with caution after the bankruptcy.
[34] Forrester Research, Post-Web Retail (September 1999).

5. Model Overview

The model used in this paper consists of eight key modules (see Figure 2). Five of these (*User flows, Site Operations, Human Resources, Financial Accounting* and *Fundraising*) are internal to the company. Three others, *Market, Financial Market* and *Relative Performance* are external to the company. The model allows the creation of multiple scenarios by changing the size of the potential market and the number of companies. For each simulated company, the following parameters can differ: *Starting Date, Initial Cash, Initial Brand Equity, Initial Product Selection, Initial Warehouse Space, Initial Experienced Employees, Initial Server Infrastructure, IPO date, Initial Number of Shares Outstanding, Initial Fraction of Founder Ownership* and *Fraction Reserved for Employees*.

The model assumes disequilibrium dynamics throughout as it models rapid corporate growth (or decline) in a changing market environment. However, companies can reach two states of "equilibrium" – bankruptcy or generating a stable stream of profits.

5.1. Market Module

The *Market Module* is the simplest module as it does not use inputs from other sections of the model. Its sole purpose is to model the diffusion of the Internet to generate the number of potential users that is used by other parts of the model. This purpose is achieved by use of a Word-of-Mouth adoption process calibrated with data from Forrester Research.[35] The base of *total Internet users* follows an s-shaped pattern, while the rate of *new Internet users* rises exponentially, then peaks and declines to the small rate that accounts for population growth.

5.2. User Flow Module

The *User Flows Module* models how US citizens start to browse retail web-sites, make transactions, develop loyalty to a online retailer, change their preference among retailers, increase their spending volumes or abandon online shopping altogether (see Figure 3).

The module imports data on *new Internet users* (from the *Market Module*) and data on acquisition and turnover rates (from the *Relative Performance Module*).

At the core of the *User Flows Module* is a stock-and-flow structure that tracks the behavior of Internet users through various types of online shopping behavior. Users are classified into the following categories:

[35] Forrester Research, Post-Web Retail (September 1999).

- *Non-Internet Shopper*: Someone who does not shop on the Internet for the Product category examined.
- *Potential Category shopper*: Someone likely to shop online for the products, but who has not yet made a transaction.
- *A loyal occasional shopper*: Someone who has a shopped online and shows a clear preference for one online retailer.
- *A loyal high-volume shopper*: Same as above, except with higher spending volume.
- *An independent occasional shopper*: Someone who shops online, but who distributes his purchases over various retailers without a demonstrable preference.
- *An independent high-volume shopper*: Same as above, except with higher spending volume.

Table 3 – Different types of user-company relationships.

The movements among these categories are driven by the first-time acquisition fraction, experienced-acquisition fraction and turnover-fraction imported from the Relative Performance Module.

The module makes important assumptions as to how quickly Internet users will become shoppers, what percentage of online users is likely to shop online for the product category and what percentage of those shopping is likely to become high-volume buyers. These assumptions largely determine the size of the online market for the product category. For all simulations shown in this paper, a growing of the overall market for online sales is assumed. The outputs of this section are the number of transactions (used by Financial Accounting and Site Operations) and the number of page views (used by Site Operations).

5.3. Site Operations Module

The *Site Operations Module* describes the core operations of an online retailer. It deals with the performance of the company along the parameters of *price*, s*ite performance*, *brand equity, site content, product selection, quality of fulfillment* and *quality of customer support*. The module imports the *number of transactions* and *page views* (from the *User Flow Module*) and the Full Time Equivalent (FTE) employees available for work (from the *Human Resources Module*). *Financial Accounting* data such as *sales revenue* and *expected annual growth in earnings* and competitive data from the *Relative Performance Module* are used as an input for some of the investment and spending decisions contained in the module.

The module also contains important policy decisions for the company:

Pricing is modeled as a decision about a *target gross margin*. The *target gross margin* is then added to the procurement costs of the products sold. For all runs presented in this paper, procurement costs are assumed equal for all companies and not affected by volume. Pricing can

also be set in relation to other companies, e.g. five percent lower than the lowest offered by any competitor. The margin can be set below zero, however, the company valuation in the stock valuation module is affected by negative margins (see section 5.8. for details).

Investment in Server Infrastructure is modeled as a decision process in a manner that is extensively used in simulation models and is well supported empirically and experimentally.[36] Consistent with theories of bounded rationality,[37] the company relies on locally available information by comparing the current infrastructure with the infrastructure required for smooth operation of the site. Management is assumed to adjust its investment based on the expected growth during the procurement delay of four months and on the expected depreciation during the procurement delay.

Desired Product selection is a target variable set by the company. It is assumed to take about 18 months for the company to achieve its goal in product selection.

Warehouse infrastructure is driven by a decision variable called *desired time for fulfillment*. The module assumes that time to fulfillment is a function of the *product selection* and the *number of transactions* relative to the *warehouse space*. The model adjusts *warehouse space* automatically towards the fulfillment goal set by management. However, a two-year construction delay is assumed in the process.

Marketing Spending is determined by setting a minimum amount and by setting a *target percentage of revenue* for marketing spending.

Site content is created in two ways, either through a paid editorial staff or –if the company decides to facilitate this option - through user-generated content.

The site operations module contains two important assumptions that favor larger companies over smaller competitors. Both the *required infrastructure for site operations* and *required manpower for site operations and customer support* are subject to significant economies of scale up to the order of a ten-fold decline in manpower needs. Also, users are more likely to contribute content if other users have already contributed content.

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[36] See Mark Paich and John Sterman, Boom, Bust, and Failures to Learn in Experimental Markets, Management Science/Vol.39, No.12, (1993).
[37] H.A. Simon, Models of Bounded Rationality, The MIT Press, Cambridge, MA, 1982. J. Morecroft, Rationality in the Analysis of Behavioral Simulation Models, Management Science, Vol.31, No.7 (1985), 900-916.

The module exports company performance data (to *Relative Performance Module*). Manpower needs (to *Human Resources Module*) and *operating costs* (to *Financial Accounting Module*).

5.4. Relative Performance Section

The **Relative Performance** module compares performance data from the company and its competitors and translates this into customer acquisition and retention rates.

It imports data on *price, product selection, time for fulfillment, brand equity, perceived site performance, content* and *perceived quality of customer support* from the *Site Operations Module*. In order to calculate the rates of acquisition and retention, we needed to estimate which factors were relevant for first-time users and for experienced users, and which factors could potentially drive a loyal user away. The table below represents the reasoning by the model builder. The following table gives and overview which factors influence the different fractions.

Competitive Performance	Driven by:
First-Time Acquisition Fraction	Relative Brand Equity Relative Price Availability of Product
Turnover Fraction	Site Performance Quality of Fulfillment Quality of Customer Support Relative Price
Experienced User Acquisition Fraction	Relative Price Availability of Product Quality of Customer Support Quality of Fulfillment
Average Order Size	Relative Attractiveness of Content

Table 4 – Factors Affecting Competitive Performance.

In the absence of numerical data on the relative importance of these factors, the relative importance was estimated on the assumption that all factors are relevant and none is dominant. For example the *indicated first-time user fraction* for a company is formulated as

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   Indicated First-Time User Fraction[company]=
   Relative attractiveness of Brand[company]*Relative Attractiveness of
Price[company]*(1-"Fraction of Sales Lost Due to Non-Availability of
Product"[company])
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The variables impacting the *first-time user fraction* fluctuate in the following range:

Variable	Maximum Range
Relative Attractiveness of Brand	0-1
Relative Attractiveness of Price	0-2
Fraction of Sales Lost Due to Non-Availability of Product	0-1

Table 5 – Ranges for Variables Impacting Indicated First-Time Acquisition Fraction.

The resulting *indicated first-time acquisition fraction* is then standardized to assure that the sum of all acquisition fractions is one before being exported to the *User Flow Module*. The outputs of the *Relative Performance Module* are used by the *User Flow Module* to drive user acquisition and retention and to model *average order size*.

5.5. Human Resources Module

The *Human Resources Module* deals with the hiring and training of engineers and customer support people. The quit rate of employees is driven by workload and by the performance of their stock options relative to the stock price. This module imports the manpower needs from the *Site Operations Module* and the current growth rate from *Financial Accounting*. The *stock price* is imported from the *Fundraising Module*.

The dynamics around the acquisition and retention of employees are one of the most interesting parts of the model. The basic structure for hiring and training employees distinguishes between rookies and experienced employees and assumes that – for an emerging new industry such as online retailing- only rookies are available (see Figure 4). This basic distinction serves to capture core dynamics of hiring and learning in professional services organizations that have been repeatedly modeled using the System Dynamics Approach[38]. One important consequence of the structure chosen is the lowering of *average productivity* during periods of rapid growth. This reduction of *average productivity* is both due to the lower productivity of rookies but also due to the time that experienced employees spend interviewing and coaching. The model also distinguishes between engineers and customer support people on the assumption that engineers

[38] James Lyneis, Corporate Planning and Policy Design – A System Dynamics Approach, Chapter 13, 1980.

are more difficult to hire in today's job market and require a longer training before they achieve full productivity.

To model the new phenomenon of an online retailer who compensates his employees through generous stock-option grants, the model also tracks the performance of the stock options issued to employees relative to the *stock price* by using a combination of co-flows (see Figure 5). The model assumes a standard stock option plan in which options are granted on hiring and on promotion and are always issued at the current stock price. Options vest continuously over four years.

The model tracks the development of options, i.e. the vesting and cashing in of vested options as well as the dropping of options by employees who leave before the end of their vesting schedule. To calculate the *average strike price*, the model also keeps track of the *sum of strike prices of non-vested options*, i.e. the amount of money that would need to be paid to purchase all non-vested options outstanding. This sum is adjusted every time new options are issued, but also when existing options vest or are dropped. The *average strike price of non-vested options* is calculated by dividing the *sum of strike-prices of non-vested options* by the *number of non-vested options* issued to employees.

It is assumed that only the number and performance of non-vested options affect employee loyalty, as their ownership of options that have already vested is no longer impacted by their decision to stay or to quit.

The relationship between option value (*number of options* times *difference between strike-price and stock price*) and *financial attractiveness* is captured by Figure 8.

If the option value is zero ("options are at par"), employees are assumed neutral, resulting in a financial attractiveness of one. If the option value is positive ("options are in the money"),

financial attractiveness increases gradually. If the option value is negative ("options are out of the money"), financial attractiveness declines gradually, as it becomes increasingly unlikely that the stock might recover and exceed the option strike price at a future date.

The *financial attractiveness* is combined with information on *lifestyle attractiveness* (driven by *average workweek*) to determine the *employee quit rate*.

The *Human Resources Module* provides information about the available manpower to *the Site Operation Module* and information about the *salary expenses* to *Financial Accounting*.

5.6. Financial Accounting Module

The *Financial Accounting Module* translates the costs and revenues from the other sections into standard accounting measures. Its inputs are the *operational expenses* (from *Site Operations*), *salary expenses* (from *Human Resources*), *number of transactions and average order size* (from *User Flows*) and *proceeds from the sale of equity* (from *Fundraising*). These inputs are used to calculate *operating income* and *net income after taxes* (which includes accounting for the carry-forward of tax-credits from prior losses). The module also calculates a standard balance sheet and accounts for cash flows in the business. Finally, the module also keeps track of the *percentage ownership by the founder* and the value of these stock holdings.

The model uses several simplifications: First of all, the company is not carrying inventory, which is true for some online retailers like Amazon who only pay the wholesaler or distributor after they receive payment from the customer. The company also does not use long-term debt. The model assumes that all revenue is received instantly and that all accounts payable are paid within three months.

Net income, gross margin, growth rate and *market share* from the *Financial Accounting Module* are used by the *Financial Markets Module* to calculate the *market value* for the company. The *revenue growth rate* from *Financial Accounting* is used as input for decisions in *Human Resources* and *Site Operations*. The *Site Operations Module* also uses the current revenue figure. The current burn rate is an input to the *Fundraising Module*.

5.7. Fundraising Module

The *Fundraising Module* allows the company to raise the required capital by selling stock to the public at the current valuation. It uses the burn rate from *Financial Accounting* and *the stock price* from the *Financial Markets Module*.

In a simplification from the real world, the model allows the company to raise money continuously instead of modeling distinct round of funding. Based on the *desired cash coverage*, the current losses (*Net Change in Cash except Fundraising*) and the *projected growth rates*, this module calculates the *amount to be raised* and sells the required number of stocks at the current valuation. An IPO is modeled as a discontinuous event during which a significant fraction of the company is sold at once. The module assures that during the IPO at least 10 percent of the company are made available to the public and that a least $50 million in proceeds are achieved. The *Fundraising Module* reports the *proceeds from fundraising* back to the *Financial Accounting Module* and the *number of shares outstanding* to the *Financial Market Module*.

5.8. The Financial Market Module

The *Financial Market Module* translates the financial performance of the company into a *stock price*. It uses *net income, gross margin, growth rate* and *market share* from the *Financial Accounting Module* and the *number of shares outstanding* from the *Fundraising Module*. In order to portray the interaction of an online retailer with the financial market, the model contains a stock valuation model. The model initially incorporated a proven module for a traditional stock market valuation[39] that focuses on profits and growth rates.

Not surprisingly, this module produces a valuation of the liquidation value of the firm's assets when applied to the income statements of loss-making online retailers. An adjusted Internet-Style version relies on *gross margin* instead of profits, thereby looking for the companies profit-making potential while disregarding current expenses such as heavy marketing. This approach is supported by a recent paper from Trueman, Wong and Zhang , who find "gross profits to be positively and significantly associated with prices" as far as online retailers are concerned, while they are unable to detect a positive relation between prices and net income.[40]

The key equations of the Internet-style stock valuation module (see Figure 6) are as follows:

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[39] Based on Repenning/Sterman, Unanticipated Side Effects of Successful Quality Programs: Technical Documentation, August 1994, Page 156ff.

[40] Brett Trueman, M.H. Franco Wong, Xiao-Jun Zhang, The Eyeballs Have It: Searching for the Value in Internet Stocks". Working Paper at http://www.haas.berkeley.edu/~trueman/valuation48.pdf.

```
Indicated Internet Market Value of the Firm [company]=(Internet Value of
Growth[company] + Present value of Gross Margin[company],0)*"Pre-IPO
Discount"[company]
Units: dollar

"Pre-IPO Discount"[company]=
      IF THEN ELSE( Time<=IPO date[company] , 0.75 , 1)
Units: dimensionless

Present value of Gross Margin[company]=
      Expected Annual Gross Margin[company]/Discount rate
Units: dollar

Internet Value of Growth[company]=
      (Predicted Steady State Gross Margin[company]* Effective Internet Growth
Value
(Perceived Growth in Revenue[company]))/Discount rate
Units: dollar
```

A further adjustment has been made to model the phenomenon of stocks operating with a negative gross margin as is currently happening in the pet supplies space. As observed in the pet supplies space, companies can at least temporarily operate with a negative gross margin and still receive a significant valuation, presumably because investors expect the company to improve its margins over time. As the valuation is based on future expectations of profitability, the structure introduces the notion of an expected minimum margin in the mature state, which starts at 10 percent. This expectation adjusts gradually to the actual margin based on the *time to adjust worst case expectations.* If the actual gross margin falls below the minimum expectation, the minimum expectation is used in modeling investor expectation of future returns. This structure allows companies to temporarily operating with negative gross margins without turning their stock worthless. However, if the negative gross margin continues for extended periods, investors are assumed to adjust their expectations of future returns downwards. The sensitivity of the model to changes in the *time to adjust worst case expectations* is explored in section 8.4.

The model calculates both the Internet-style market-valuation and the traditional market valuation and contains a switch that allows to make the stock valuation applied a weighted average of the two valuations (see Figure 7).By changing the weights given to the two different valuation methods, the model can simulate the effect of a burst of the Internet-valuation bubble.[41]

The Internet valuation incorporates a 25%-discount on the stock value prior to an initial public offering (IPO) to compensate for the reduced liquidity of these stocks prior to the IPO.

The model also contains a structure that allows giving a valuation bonus to the leader in market share. It was disabled for all runs shown in this paper. The *Financial Market Module* exports the *stock price* to the *Fundraising* and *Human Resources Modules*.

6. Limits of the model and level of aggregation

6.1. Limits

It should be noted that the availability of data to test and calibrate the model was very limited. The main sources of numerical data to test and calibrate the model were industry reports from Forrester Research[42], Goldman Sachs[43], Donaldson, Lufkin & Jenrette[44] as well as Company Reports and SEC filings of Amazon, barnesandnoble.com, pets.com, Petopia and other online retailers. However, the model relies to a significant extent on variables and assumptions for which no numerical data was available. In these cases, best judgment and sensitivity testing (see below) were used to estimate the required parameters. No interviews or field research have yet been conducted for this model.

6.2. Level of Aggregation

The level of aggregation was chosen with the goals of the model in mind. For example, the model does not differentiate between different forms of marketing such as offline marketing, online marketing, portal deals and affiliate marketing. No hard data was found to distinguish the impact of these different forms of advertising. Modeling these would have increased the detail complexity of the model, but would not necessarily have introduced new interesting loops. The added new complexity would make the analysis of model behavior more difficult as differences in outcome might be interpreted as the result of good or poor management decisions in allocating the marketing money. Weighing these factors, it was concluded that aggregating all marketing spending in one variable can be justified for the purposes of this model. For similar reasons, details such as site personalization, data-mining with user data and shipping costs have not been modeled.

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[41] Anthony Perkins, Michael Perkins, The Internet Bubble, Harper Business, New York, 1999.

[42] Forrester Reports used: Syndicated Selling (December 1997), The Look-To-Buy-Imperative (April 1998), The Content-Commerce Collision (March 1999), Driving Site traffic (April 1999), Making Net Shoppers Loyal (June 1999), Smart Personalization (July 1999), Ringing Up web Store Costs (August 1999), Internet-Advertising Skyrockets (August 1999), Cashing In On Community (September 1999), Post-Web Retail (September 1999).

[43] Goldman Sachs, Issues & Outlook 2000, e-markets: B2B and B2C, December 1999.

[44] DLJ Report used: Traditional Retailing Meets the Internet, (May 15,1999).

Volume discounts in product procurement have not been modeled either. It was assumed that they are of lesser relevance for the dynamics under observation. This assumption is based on two factors: First, The model already contains multiple assumptions that strengthen the volume leader, most notably through assumed economies-of-scale in site operations and customer support and through the impact of user-generated content. Secondly, volume discounts received by the market leader might be offset if that player also offers the largest product selection that includes rare titles or low turnover SKUs that may increase procurement costs.

The acquisition of users to individual companies through word-of-mouth has not been modeled. In this case, it was assumed that the impact of word-of-mouth is partly captured by another mechanism through which a company benefits from a large user base, namely the impact of user-generated content as a driver of average purchase volumes.

The model does not include events such as bankruptcy, mergers and acquisitions, expansion into new product categories or into international markets. Because of their discontinuous nature, these events have the potential to distract considerably from the dynamics under observation. The only discontinuous event modeled is the initial public offering, which was assumed relevant because of the impact that the change of stock valuation at the IPO has on the ability to hire and retain employees. Many companies report significant difficulties to attract top talent after the IPO.[45]

7. Model-Testing

7.1. Physical and Decision-Making Structure

The model preserves physical laws such as the conservation of matter and there are no unit inconsistencies. The Stock and Flow Structure is made explicit. Appropriate time delays, constraints and bottlenecks are taken into account. More specifically, decision makers in the model are assumed to act rationally within their cognitive limitations. Decisions are based on measurable data that is available to the decision-maker.

One example is the hiring process for engineers in the human resource module. The decision is based on three key inputs: Required Manpower for Site Operation, Perceived Average Productivity and Current Growth rate. It is assumed that the recruiters receive feedback from the engineering department how well or poorly the current staffing fills the needs. It is also assumed

[45] See Jenn Shreve, The Paper padlock in The Standard, March 20, 2000. Online at http://www.thestandard.com/article/display/0,1151,12994-0,00.html.

that the company has an expectation about the level of productivity to expect from an average employee. It is assumed that these expectations adjust to real performance with a perception delay of six months.

Finally, it is assumed that the company adjusts its hiring for expected levels of growth, represented in the model through reliance on revenue growth as an indicator. The model contains two further delays, a human resource department processing delay of one month for the adjustment of staffing targets and a hiring delay (three months for engineers and two months for customer support employees) before open positions are filled.

7.2. Robustness and Sensitivity to Alternative Assumptions

The model has been tested with a variety of extreme input conditions and policies and appears to be robust. When tested with various spending policies under Internet-style valuations, the model makes it almost impossible to fail through overspending on marketing, as the positive impact on stock valuation and additional fundraising ability outweighs the additional expenses over a wide range of values. Thereby the model is potentially to forgiving on aggressive spenders. This problem could be addressed by introducing a longer delay before increased revenues affect valuations. Further research could be helpful on this point.

It is also important to note that the boundaries chosen can affect the policy recommendations developed below. Most importantly the exclusion of international markets and of expansion into new products are constraints that make it more difficult for the simulated companies to break even or to generate profits. Also, the aggregation of various forms of marketing spending into one variable make it harder for a latecomer to catch up with the dominant player as it practically excludes the option to conduct a smarter, more innovative spending.

One robustness test examined the impact of marketing spending for a bricks-and-mortar parent company. Barnes & Noble managers assumed a significant impact of the fact that they already spend about $15 million annually to promote their retail outlets.[46] They hoped that including the URL of the online business in the marketing for the bricks-and-mortar company would allow them to catch up with Amazon quickly. To test the impact of this spending, the following structure was added in the Site Operations module (see Figure 9).

The structure allows a company to take credit for marketing spending that does not impact its balance sheet, such as marketing spending conducted by a bricks-and-mortar parent company.

Experiments show that the advertising spending does indeed increase the share of B&N (company 3), though the impact is too small to challenge the market dominance of the first mover. The table below shows the difference if the spending is assumed to have no effect, to have half the effectiveness of targeted advertising or to have an effect equal to targeted advertising.

Effectiveness of Offline-Parent spending	Market share Company3 in 2000
0%	2.68%
50%	3.15%
100%	3.62%

Table 6 – The Impact of Free-riding on Advertising by a Bricks-and-Mortar Parent Company.

The limited impact of the additional $15 million per year is mainly caused by the size of marketing spending under way as Company 1 is already spending at an annualized rate of $282.5 million per year.

7.3. Further Testing

The model has not been reviewed or criticized by independent third parties. The author invites comments and feedback.[47] See documented model is found in the appendix to this paper. It can also be downloaded of the Internet.[48] The author has secured access to a online retailer for interviews that will happen after the completion of this thesis.

8. Running the Model

8.1. Base Case: Book Market

The Base Case for this model involves the competition between three Companies. Company 1 is an Amazon-like online only retailer with aggressive marketing, excellent customer service, and moderate pricing. Company 2 is also an online-only retailer, but with a low price, low service strategy. Company 3 is a Barnes&Noble-like online division of a bricks-and-mortar retailer that starts with a two year delay, but with significant resources in terms of product selection, brand equity, cash and warehousing infrastructure.

Please refer to Table 7 for a detailed description of the parameters used in the base case.

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[46] Dickson L. Louie, BarnesandNoble.com (A), Harvard Business School Case N9-898-082, revised April 7, 1998.
[47] Please email the author at martin.giese@alum.mit.edu.
[48] Http://www.people.hbs.edu/roliva/research/dotcom.

8.2. Important Findings

The model produces an outcome with characteristics that resemble the online book market in the US (see Figures 10,11). Notably, the market has evolved to produce one dominant player (Company 1 or "Amazon"), one struggling player (Company 3 or "barnesandnoble.com") and an insignificant player (Company 2). When projected into the future, only the dominant player eventually turns profitable because of the significant economies of scale (see Figure 12).

This outcome can be understood by analyzing the underlying structure of the market. Most importantly, the model shows us that there are a number of powerful growth loops that help the original market leader to extend its lead even further (see Figure13). These are:

- **Marketing-Muscle**: Based on the decision rules used in the model, higher revenue leads to higher marketing spending which impacts user acquisition. This increases the number of users and thus further increases revenue.
- **Stock-Market-Turbo-Booster-Loop**: Higher Revenue with a constant margin also increases Gross Margin, the key driver of stock valuations. The higher stock valuation increases the fundraising ability of the company. This allows increased spending which leads to better performance, higher user acquisition and thus a further increase in revenue.
- **User-Generated Content-Loop**: More users generate more content. This content helps the company to increase sales revenue through upselling, i.e. it is assumed that additional content such as user-generated product reviews help to increase the average order size. This impacts both marketing spending and fundraising ability and facilitates future user acquisition, which closes the loop.
- **Wealthy Employees Work Better-Loop:** The higher user base leads to a higher stock price, which increases the value of the non-vested employee stock options. Employee turnover is reduced which improves average productivity, which in turn leads better performance and even more customers.

However, it is important to note that in a world of finite resources, the growth loops indicated above will encounter some limits. Some of these are depicted in Figure 14:

- **Server Overload-Loop**: Rapid growth increases the number of page views and transactions that the server infrastructure needs to support. If the company does not build its infrastructure fast enough, this will reduce site performance and thereby limit the growth of the user base (see Figure 15).

- **Customer on Hold-Loop:** More users mean more transaction which will result in additional demands on the customer support staff which will reduce the quality of customer support (see Figure 16). The reduced quality will drive some users away, thereby removing some of the pressure.
- **Fulfillment-Bottleneck-Loop**: More users make more transaction that require fulfillment. All else being equal, these additional packages will slow down fulfillment. The fulfillment delays make the site less attractive, thereby limiting future growth.
- **Employee Churn-Loop**: More users increase the workload for engineers and customer support staff (see Figure 17). The overtime work decreases job attractiveness. The employee churn rate increases which leads to a decline of employee productivity as experienced employees are replaced by rookies. This loop is counteracted by the Wealthy-Employees-Work-Harder-Loop. Often, the rapid growth will be accompanied by an increase in stock valuation that will increase the attractiveness of the job (see Figures 18, 19).

8.3. Base Case 2: Pet Supplies

The second base case shows how the model can be calibrated for the pet supply industry with three well-funded players starting within half a year. Please refer to Table 7 for the parameters used in this run.

8.4. Findings for Pet Supplies

With multiple players starting simultaneously, all of them struggle to achieve the necessary economies of scale to turn profitable. Please refer to Figures 20 and 21 for the outcome in terms of market share and stock valuations. It turns out that the overall outcome is highly sensitive to the assumptions made whether and how fast these companies can achieve positive margins and how long financial markets value companies operating at negative margins. With the assumptions in the base case, the industry as a whole will over time achieve a positive gross margin (see Figure 22), though not necessarily profits as operating costs still outweigh the gross margin (see Figure 23). For testing purposes, we varied the time that the financial markets will take to adjust expectations about future gross margins in the industry. The resulting assumptions of the financial market about margins in the mature state are displayed in Figure 23. The outcome shows that a short adjustment delays of 3 years or less leads to failure for the company

under observation (Company 1) as its stock price falls to zero, thus depriving it of its ability to fund continued losses through the public market. It is bankrupt.

8.5. Differences between the Markets for Books and Pet Supplies

There are three key differences between the online markets for books and pet supplies. First, The book market started earlier, at a time when the overall Internet adoption was much smaller whereas pet supplies started in a relatively mature market. Accordingly, some of the key dynamics around division of the market play out faster and the pet supply companies face even higher growth rates during ramp up. Second, the book market produce a dominant player whereas the pet supply market produced a stalemate among multiple competitors that prevents any individual company from benefiting from the powerful economies of scale built into the model. Accordingly, none of the pet supply companies is able to achieve future profits comparable to the dominant bookseller. Finally, the pet supply companies operate at negative gross margins which makes them even more dependent on the expectations of financial investors.

9. Strategies for Online Retailing

9.1. How to Succeed as a First-moving Online Pureplay-Retailer

The highest outcomes are achieved with a "get big fast then consolidate" strategy such as the strategy applied by Company 1 in the base case. As margins are slim, this requires growing the company extremely fast to benefit from economies of scale that are built into the model. Elements of such a strategy are:

- Spend aggressively on Marketing at first (at least 50 percent of revenue), and then reduce it to less than 10 percent of revenue around 2000 to turn profitable.
- Allow user-generated content to leverage early lead in user base.
- Invest heavily in *warehousing infrastructure* to achieve superior *time for fulfillment* to increase retention.
- Offer a wide *product selection*.
- Set medium to high price as the positive impact on revenue, valuation and fund-raising ability offsets the impact on user acquisition.
- Hire early to anticipate future growth, slow down hiring during periods of consolidation.

These recommendations are risky as they imply significant spending before profits are achieved. Therefore, the company needs to carefully assess whether it is on the right trajectory.

Early indicators for a company on this trajectory are a sustained *market share* lead (larger 50% for both user base and for acquisition of new users). The company needs to focus attention on its *turnover rate* and *relative site experience* can be temporarily worse than the competition (see Figures 15 and 16) as the companies systems adjust to rapid growth and the competitors face a lesser management challenge due to slower growth. However, this problem should be linked only to rapid growth and should be solved within 1-2 years as growth rates stabilize. If it does not stabilize, the company is on the path to failure as described in section 9.3.1.

9.2. How to Succeed as a Bricks-and Mortar Player Starting Late

Because of the powerful growth loops helping the first mover in any given online retail market, it is difficult for a late starter to catch up. The following section examines how a late comer can increase its market share by looking at Company 3 in the base case. All parameters except those varied are identical to the base case described in Table 7. In the base case, Company 3 started two years late and achieved a *market share* of only 2.68% in 2000, despite starting with significantly larger resources.

The table below shows the impact of changes in some of the starting parameters and their impact on the *market share* of the Bricks-and Mortar Player.

Scenario	Market Share for Company 3 (Bricks-and-Mortar Player) in 2000
Base Case	2.68%
Base Case plus extra $100 M marketing at start	10.46%
Base Case, but Company 3 starts one year earlier	11.43%
Base Case, but Company 3 starts one year earlier plus extra $100 M in marketing	64.19%

Table 9 – Impact of Different Strategies by Bricks-and-Mortar Player.

The table and the runs presented in Figures 26 and 27 show that the bricks-and-mortar player could improve its *market share* by a factor of four if it either would start a year earlier or would spend an extra $100 million for marketing. Both changes done jointly would increase the *market share* by a factor of about 25, making Company 3 the leader in *market share*. This analysis

shows that it requires immense resources to overcome a two-year delay as experienced by barnesandnoble.com relative to Amazon.

9.3. Failure Modes

9.3.1. Huge Marketing Effort, Low Performance

This is a dangerous failure mode, as it bears a lot of resemblance like the winning strategy in section 9.1. In this failure mode, the player spends a lot on marketing, but fails to serve the acquired customers well enough to leverage this user base. The company either fails to acquire enough engineers and servers to achieve a good site performance or it fails to build an adequate warehouse infrastructure to deliver the ordered goods. In both scenarios, an early lead in market share does not result in long-term profitability due to poor customer retention. The company then faces a dilemma, as either it continues making losses due to the high acquisition costs or it reduces marketing and quickly loses its customer base.

An early indicator of this scenario is a good first-time acquisition rate in excess of 50 percent, but consistently poor marks for *relative site experience* and the highest *turnover-rate* of customers among all companies. As explained above, the winning scenario can also have temporarily low marks on these parameters as the system struggles to adjust to rapid growth.

An example can be constructed by changing the fulfillment goals of Company 1 and Company 2 in our base case. Instead of providing the best fulfillment (within 2.5 days), Company 2 now takes four days for fulfillment, whereas Company 2 improves is performance. Figures 28 and 29 show how this one parameter change affects *market share* and *net income*.

9.3.2. Limited Marketing Spending, Huge Infrastructure Investment

In this scenario, the player builds the perfect website, but forgets to tell the world. To simulate this behavior, we will again adjust the winning strategy from above in just one parameter: marketing spending is reduced by a factor of four. The result is presented in Figures 30 to 32: the *market share* is cut in half and the *stock valuation* drops by a factor of ten. However, in terms of *retained earnings*, it takes quite a long time for the winning strategy to overtake this strategy as it avoids the deep funding pit (see Figure 32).

9.3.3. Mismanaging Human Resources

Managing the hiring process is a difficult challenge in this simulation. To optimize the hiring, players need to understand the impact of hiring on *average productivity per employee*. Massive

hiring leads to significantly reduced productivity as the percentage of rookies increases and experienced employees spend a lot of their time with recruiting and training. Inversely, during periods of limited hiring, the average productivity may increase significantly as rookies gain experience and experienced employees spend less of their time with hiring and training. These gains may be sufficient to allow a company to grow for 2-3 years without hiring. To demonstrate the impact of understaffing, the hiring policy of the market leader from the base case (Company 1) was changed to set its Staffing targets at only half the staffing level achieved by the process explained in section 5.5. The impact –as shown in Figures 33 to 38– is significant. Company 1 again manages to clinch early dominance of the market, but it loses its market share lead over time (see Figure 33). Further examination shows that Company 1's decline it the sum of many dynamics triggered by this one change. The more obvious changes are:

- Less manpower for site support and customer support leads to weaker performance in these parameters. Attraction of new customers stays high due to huge marketing spending, but retention becomes a big issue (see Figures 34 to 36).
- Lower headcount reduces costs in the short term (see Figure 32).

Some of the more subtle impacts are:

- The employee quit rate increases as employees are suffering from a longer workweek and less attractive stock options. The higher turnover of employees leads to a lower average productivity as the company employs more rookies and experienced staff members spend their time with hiring and training, further aggravating the manpower shortage (see Figure 38).

In the long run, the reduced hiring alone prevents the company from recovering the original investment – retained earnings stay negative (see Figure 32).

By comparison, the opposite failure, excessive hiring has less of an impact of the overall system as performance measures stay high. The main impact is on the operating expenses, thereby impacting retained earnings and – if losses need to be financed through additional stock sales – on the ownership of the founders.

9.3.4. Price Wars (*** UNDER CONSTRUCTION ***)

Online retailer face a high risk of price wars as they focus on growth, not profitability. However, in a price war everybody loses. All its takes to trigger a price war are two or more players who reference each other in pricing with a desire to underbid the opponent. Figure 39

shows what happens in pricing if this decision rule is introduced (all other parameters equal the base case in the book market).

The price war impacts valuations as it reduces *gross margin,* which is a key factor in the Internet-style valuation introduced in this model. The falling stock price has negative repercussions in terms of employee retention as shown in Figures 41 and 42. When the stock price rose from 1995 to mid-2000, the average option strike price trailed the stock price, making the employees happy. When the stock starts to fall, this gap narrows. In early 2002, the stock price finally falls below the option strike price with a huge impact on financial attractiveness of the job.

9.4. Modeling the Burst of the Bubble

To model a impact of a burst of the Internet Bubble, the method of valuing Internet stocks was switched from the Internet style to more traditional valuations at different point in time. Put simply, with the change, income replaces margin as the core driver of valuation. Hence now marketing costs and operating costs reduce the valuation. Figure 43 shows how the stock price falls after the switch. This change reduces the fundraising ability of the company and could lead to bankruptcy if the company is not able to turn profitable in time. Figure 44 shows how Company 1 turns profitable "just in time" in mid-2002. However, the mature state valuation in the traditional valuation is only about half the valuation in the Internet-style method. Figure 45 shows another interesting aspect of this problem: The differences in stock valuation affect the dilution of the company. With an early switch to traditional methods of valuation, the founders will hold on to a significantly smaller share of their business.

10. Discussion

The model succeeds to replicate many outcomes seen in the real world, such as rapid growth and market dominance (Amazon), difficulties in catching up experienced by an incumbent entering late (Barnesandnoble.com) and problems experienced by multiple competitors of equal strength (pet supplies). These finding indicate that system dynamics is indeed a suitable tool to analyze online retailing.

The model helped to describe some of the powerful loops that can drive rapid growth of an online retailer. Those are the Marketing-Muscle-Loop, the Stock-Market-Turbo Booster-Loop, the User-Generated Content-Loop and the Wealthy Employees Work Hard-loop.

The model also helped to show some of the limits to growth relating to human resources (Employee Churn-Loop and Customer on Hold-Loop), Site Operations (Server Overload-Loop), Warehousing (Fulfillment-Bottleneck-Loop).

The model also showed that current valuations can be justified only if the following assumptions hold: growth rates can be sustained for many years in the future, financial markets are willing to support ongoing losses until breakeven and powerful economies of scale favor the early market leader.

The paper identified only one winning strategies: Get Big Fast and Consolidate. In order to ride the powerful growth loops, the company must be able to balance aggressive marketing with building the infrastructure to support the masses of customers attracted. If one of the two elements is neglected, overall outcome deteriorates significantly.

These outcomes, of course, are only valid within the assumptions and limits of this particular model as described in this paper and documented in the appendix.