

Managing Hyper-Growth - A System Dynamics Analysis of Competitive Dynamics in Business-to-Consumer Electronic Commerce

by

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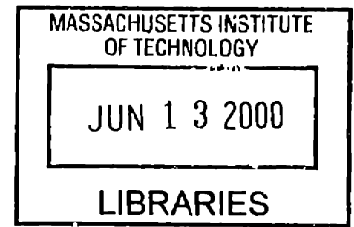
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ABSTRACT

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? The paper addresses this question with the help of a System Dynamics model that reflects two particular online retail markets (books and pet supplies). The Dot Com Model captures 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.

The Dot Com Model is used to identify a typology of winning strategies and failure modes and the range of scenarios and conditions under which each of those strategies applies. Finally, the paper explores 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 net income, discounted cash flow analysis).

Thesis Supervisor: John Sterman
Title: Standish Professor of Management

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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.”¹

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 the business world sees all-time record highs in venture capital (VC) investments and initial public offerings (IPO). In the first quarter of 2000, US-based Internet startups raised \$17.05 billion in venture capital, thereby accounting for over 75 percent of all venture funding raised.² A total of 139 companies went public in the first quarter of 2000.³ As with the disk drive industry, growth, not profit, is the metric for success. The typical Internet retailer⁴ is expected to lose \$43 million in 2000⁵, 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

¹ William A. Sahlmann and Howard H. Stevenson, Capital Market Myopia, *Journal of business Venturing* 1, 7-30 (1985).

² Press release by the National Venture Capital Association and Venture Economics, May 4, 2000.

³ Press release by the National Venture Capital Association, April 10, 2000.

⁴ For 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.

⁵ Forrester Research, *The Demise of Dot Com Retailers*, April 2000.

construction.”⁶ Critics also claim that these companies are “built to flip”⁷ and warnings are issued about the pending burst of the Internet bubble⁸ and about “the demise of dot com retailers”⁹. Warren Buffett compares Internet stocks to a “chain letter”¹⁰ 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 (“the Dot Com Model”) is developed to explore how online retailing might develop in the future. Are the fears of looming collapse justified? Or is the hype and optimism of the market for Internet stocks justified?

For the research discussed in this paper, a system dynamics model was built to allow experimentation that could not be achieved in a real company setting. The simulated companies are exposed to varying scenarios and assumptions. The results of these simulations help identify the assumptions required to justify Internet 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 \$1,366.¹¹ In the late 1990s, online retailers have generated huge interest

⁶ 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>.

⁷ Fast Company issue 32 page 131. See <http://www.fastcompany.com/online/32/builttoflip.html>.

⁸ Anthony Perkins, Michael Perkins, *The Internet Bubble*, Harper Business, New York, 1999.

⁹ Forrester Research, *The Demise of Dot Com Retailers*, April 2000.

¹⁰ Financial Times, May 1 2000, Page A1.

¹¹ Forrester Research, *Metrics for Judging Retail Site Staying Power*, Brief, January 31, 2000.

from investors, and the total market capitalization for publicly listed B2C companies approached \$250 billion in December 1999.¹²

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 earlier¹³. Industry analysts like Forrester Research are already proclaiming “The demise of Dot Com Retailers”¹⁴. Falling valuations have triggered concern over whether online retailers will be able to continue funding their losses (expected to average \$43 million in 2000¹⁵) through the public markets. Stories about likely candidates for bankruptcy abound.¹⁶

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? Or, alternatively, are the hype of and optimism for the market for Internet stocks justified?

This Dot Com 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 Dot Com Model.

¹² Goldman Sachs, Issues & Outlook 2000, e-markets: B2B and B2C, December 1999.

¹³ Forrester Research, The Demise of Dot Com Retailers, April 2000, Table 2.

¹⁴ Forrester Research, The Demise of Dot Com Retailers, April 2000.

¹⁵ Forrester Research, The Demise of Dot Com Retailers, April 2000.

¹⁶ 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>.

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 2000.¹⁷ 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.

Amazon's 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, the market capitalization for barnesandnoble.com stands at \$302.7 million (May 5, 2000).¹⁸ Other players in the book market are significantly smaller than either Amazon or barnesandnoble.com.¹⁹

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

¹⁷ From Amazon, SEC-Filings, S-1 from March 24, 1997.

¹⁸ See also Dickson L.Louie, BarnesandNoble.com (A), Harvard Business School Case N9-898-082, Revised April 7, 1998.

¹⁹ Check www.gomez.com for a performance comparison of online book sites.

approximately \$23 billion (1997) with an annual growth rate of 9%,²⁰ which means the bricks-and-mortar 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.²¹ 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.²² 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 cost or even below cost. Online pet supplies companies are among those online retailers whose further survival is questioned publicly. Pets.com, the only pet supplies company that went public before the March 2000 slump in Internet stocks currently trades at \$ 2 11/16 (May 5 2000), down 75 percent from its February 2000 IPO price of \$11. This translates into a market capitalization of \$79.4M.

²⁰ Pets.com SEC-Filing S-1/A Registration Statement, February 9, 2000.

²¹ K9 Commerce, Business 2.0, August 1999, page 29.

²² 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.

Company	Pets.com. ²³	Petopia ²⁴	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 ²⁵
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. ²⁶
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.

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.²⁷ 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

²³ Pets.com SEC-Filing S-1/A Registration Statement, February 9, 2000.

²⁴ Petopia SEC-Filing S-1 Registration Statement, March 13, 2000.

²⁵ Closure of first funding round.

²⁶ From http://www.petstore.com/about_us/about_us.jhtml.

²⁷ Sterman, Repenning and Kofman, Exploring a Paradox of Organizational Improvement, Management Science/Vol. 43, No.4, April 1997, page 506.

- 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 content 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.²⁸

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.²⁹ Hagel and Armstrong demonstrate that while all four loops are powerful drivers of growth, they are even more powerful when they are combined.³⁰

²⁸ 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.

²⁹ Hagel/Armstrong, *Net Gain, Expanding Markets through Virtual Communities*, 1997, page 49.

³⁰ Hagel/Armstrong, *Net Gain, Expanding Markets through Virtual Communities*, 1997, page 56.

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.³¹

3.3. Goals for the Dot Com Model

A model can never capture every aspect of a system. A good system dynamics model is built with a clear purpose. The Dot Com 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

³¹ Hagel/Armstrong, *Net Gain, Expanding markets through Virtual Communities*, 1997, page 55.

- 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.

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, often network externalities are not significant at the level of an individual online retailer. This is because a buyer does not receive a direct benefit from buying at the most popular site, and because 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 Dot Com Model and Time Frame

4.1. Boundaries

The Dot Com 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 Dot Com Model that would have made the analysis more difficult.

Furthermore, the goals for this model, outlined in Section 3.3, could be achieved by focusing on a single market by itself throughout the simulation. This model does not deal explicitly with bankruptcy; 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 because when the company shrinks into obscurity, the bankruptcy has no impact on the other players.³² Also, no mergers between companies are foreseen in the Dot Com Model. Finally, macroeconomic factors such as changes in gross domestic product and total consumer spending have been excluded.

Though they are part of the model structure, population growth and Internet adoption are exogenous to the dynamics examined in the Dot Com Model. There is no feedback from the

³² 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.

model to these variables. Both were modeled to fit data from industry reports and forecasts from Forrester Research.³³

Endogenous	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 - Dot Com Model Boundary Chart

4.2. Time Frame

The model simulates the period from 1995 to 2015. Widely regarded as the year that Internet retailing began, 1995 is also the year Amazon started. The year 2015 was picked to allow enough time to explore the ramifications of Internet saturation in the US.

³³ Forrester Research, Post-Web Retail (September 1999).

5. Overview of the Dot Com Model

The Dot Com 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 Dot Com 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 Dot Com 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 in the Dot Com Model, because it does not use inputs from other sections of the model. Its sole purpose is to model the diffusion of the Internet, thus generating the number of potential users that is used by other parts of the model. This purpose is achieved by a word-of-mouth adoption process calibrated with data from Forrester Research.³⁴ 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:

- *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

³⁴ Forrester Research, Post-Web Retail (September 1999).

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 the *Financial Accounting Module* and the *Site Operations Module*) and the *number of page views* (used by the *Site Operations Module*).

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, site 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 Module* output, such as *sales revenue* and *expected annual growth in earnings*, and competitive data from the *Relative Performance Module* are used for the investment and spending decisions contained in the *Site Operations Module*.

The *Site Operations 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.³⁵ Consistent with theories of bounded rationality,³⁶ 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 Dot Com 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.

³⁵ See Mark Paich and John Sterman, Boom, Bust, and Failures to Learn in Experimental Markets, Management Science/Vol.39, No.12, (1993).

³⁶ 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. J. Morecroft, 1992. Executive Knowledge, Models and Learning. European Journal of Operations Research 59 (1992), 9-27.

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.

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

$$\text{Indicated First-Time User Fraction[company]} = \text{Relative attractiveness of Brand[company]} * \text{Relative Attractiveness of Price[company]} * (1 - \text{"Fraction of Sales Lost Due to Non-Availability of Product"[company]})$$

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 *employee quit rate* 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 Dot Com 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 Approach³⁷.

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 Dot Com Model also distinguishes between engineers and customer support people on the assumption that engineers 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 Dot Com 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 Dot Com 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.

³⁷ James Lyneis, *Corporate Planning and Policy Design – A System Dynamics Approach*, Chapter 13, 1980.

The Dot Com 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 the *Financial Accounting Module*.

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 the *Site Operations Module*), *salary expenses* (from the *Human Resources Module*), *number of transactions and average order size* (from the *User Flows Module*) and *proceeds from the sale of equity* (from the *Fundraising Module*). 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 Dot Com 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 Dot Com 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 the *Financial Accounting Module* is used as input for decisions in the *Human Resources Module* and the *Site Operations Module*. 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 the *Financial Accounting Module* and the *stock price* from the *Financial Markets Module*.

In a simplification from the real world, the Dot Com 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 Dot Com

Model contains a stock valuation model. The model initially incorporated a proven module for a traditional stock market valuation³⁸ 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.³⁹

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

```
Indicated Internet Market Value of the Firm [company]=
  (Internet Value of Growth[company] + Present value of
  Gross Margin[company]) * "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]=
  MAX(0,Expected Annual Gross Margin[company]/Discount
  rate)
```

Units: dollar

```
Internet Value of Growth[company]=
  MAX(0,Predicted Steady State Gross Margin[company] *
  Effective Internet Growth Value(Perceived Growth in
  Revenue[company]))/Discount rate
```

Units: dollar

³⁸ Based on Repenning/Sterman, Unanticipated Side Effects of Successful Quality Programs: Technical Documentation, August 1994, Page 156ff.

³⁹ 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>.

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 Dot Com Model to changes in the *time to adjust worst case expectations* is explored in section 8.4.

The Dot Com 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 Dot Com Model can simulate the effect of a burst of the Internet-valuation bubble.⁴⁰ The impact of this structure is explored further in section 9.4.

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 *Financial Market Module* exports the *stock price* to the *Fundraising Module* and the *Human Resources Module*.

⁴⁰Anthony Perkins, Michael Perkins, *The Internet Bubble*, Harper Business, New York, 1999.

6. Limits of the Dot Com Model and Level of Aggregation

6.1. Limits

It should be noted that the availability of data to test and calibrate the Dot Com Model was very limited. The main sources of numerical data to test and calibrate the model were industry reports from Forrester Research⁴¹, Goldman Sachs⁴², Donaldson, Lufkin & Jenrette⁴³ as well as Company Reports and SEC filings of Amazon, barnesandnoble.com, pets.com, Petopia and other online retailers. However, the Dot Com 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 Dot Com 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 were 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

⁴¹ 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).

⁴² Goldman Sachs, Issues & Outlook 2000, e-markets: B2B and B2C, December 1999.

⁴³ DLJ Report used: Traditional Retailing Meets the Internet, (May 15, 1999).

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 is 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.

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 Dot Com 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. Second, 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 stock-keeping units (SKU) 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 Dot Com 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.⁴⁴

7. Testing the Dot Com Model

7.1. Physical and Decision-Making Structure

The Dot Com 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 *perceived growth rate*. It is assumed that the recruiters receive feedback from the engineering department how well or poorly the current staffing fills the current needs. It is also assumed 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 Dot Com Model through reliance on revenue growth as an indicator. The model contains two further delays, a human resource department *processing delay* of one month

⁴⁴ 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>.

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 Dot Com 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 Dot Com Model is potentially 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 campaign.

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.⁴⁵ They hoped that including the URL of the online business in the marketing for the bricks-and-mortar company

⁴⁵ Dickson L. Louie, BarnesandNoble.com (A), Harvard Business School Case N9-898-082, revised April 7, 1998.

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 Company 3 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 Dot Com Model has not yet been reviewed or criticized by independent third parties. The author invites comments and feedback.⁴⁶ The documented Dot Com Model is found in the

⁴⁶ Please email the author at martin.giese@alum.mit.edu.

appendix to this paper. It can also be downloaded over the Internet.⁴⁷ The author has secured access to an online retailer for interviews that will happen after the completion of this thesis.

8. Running the Dot Com 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.

8.2. Important Findings

The Dot Com Model produces an outcome with characteristics that resemble the online book market in the United States (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).

⁴⁷ [Http://www.people.hbs.edu/roliva/research/dotcom](http://www.people.hbs.edu/roliva/research/dotcom).

Base Case 1 (Books)	Company 1	Company 2	Company 3
Summary	Amazon-like online-only retailer. Aggressive marketing, high-service, miedium price strategy	Online-only retailer. Low price, low service strategy	Barnes&Noble-like online subsidiary of Bricks and Mortar--company. Late start with significant assets
Initial Conditions			
Starting Date	1995.5	1995.5	1997.5
Initial Cash	\$10 Million	\$10 Million	\$100 Million
Initial Brand Equity	\$50,000	\$50,000	\$2,500,000
Initial Product Selection	1,000,000 SKU	1,000,000 SKU	3,000,000 SKU
Initial Warehouse Space	50,000 SQF	50,000 SQF	150,000 SQF
Initial Experienced Employees	5 engineers, 5 customer support	5 engineers, 5 customer support	5 engineers, 5 customer support
Initial Server Infrastructure	\$50,000	\$50,000	\$50,000
IPO date	1997.5	1997.5	1999
Initial # of shares outstanding	10 million	10 million	10 million
Initial % of Founder Ownership	40%	40%	40%
% reserved for employees	20%	20%	20%
Stock Market Valuation Model	100% Internet-Style	100% Internet-Style	100% Internet-Style
Other Conditions			
	Bricks-And-Mortar margins are assumed constant at 30%.		
	Early Internet users are assumed 50% likely to buy books, late adopters only 20%.		
	The book market is assumed to have 5 million SKUs.		
Company Strategy			
Minimum Marketing Spending	\$1 million/year	\$1 million/year	\$1 million/year
Target Marketing Spending as % of revenue	40% until 1999, declining to 10% in 2003 and 5% in 2010	15% until 2000 declining to 5% in 2005	60% until 1999, declining to 20% in 2003 and 10% in 2010
Desired Product Selection	5 million SKU	3 million SKU	5 million SKU
Desired Time for Fulfillment	2.5 days	4 days	3 days
Target Gross Margin	20%	15%	20%
Editorial budget	\$1 million/year	\$1 million/year	\$2 million/year
User-Generated Content	Enabled	Enabled	Enabled
Hiring Policy	Automated	Automated	Automated
Fundraising Policy	Automated	Automated	Automated
Server Purchasing	Automated	Automated	Automated
Warehousing Policy	Automated	Automated	Automated

Table 7 - Parameters for Base Case (Books)

Base Case 2 (Pet Supplies)	Company 1	Company 2	Company 3
Summary	Online-only retailer. Aggressive marketing, high-service, medium price strategy	Online-only retailer. Low price, low service strategy	Online subsidiary of Bricks and Mortar--company. Starts with significant assets.
Initial Conditions			
Starting Date	1999	1999	1999.5
Initial Cash	\$10 Million	\$10 Million	\$100 Million
Initial Brand Equity	\$50,000	\$50,000	\$2,500,000
Initial Product Selection	10,000 SKUs	10,000 SKUs	15,000 SKU
Initial Warehouse Space	50,000 SQF	50,000 SQF	150,000 SQF
Initial Experienced Employees	5 engineers, 5 customer support	5 engineers, 5 customer support	5 engineers, 5 customer support
Initial Server Infrastructure	\$50,000	\$50,000	\$50,000
IP O date	2000.125	2000.5	2001
Initial # of shares outstanding	10 million	10 million	10 million
Initial % of Founder Ownership	40%	40%	40%
% reserved for employees	20%	20%	20%
Stock Market Valuation Model	100% Internet-Style	100% Internet-Style	100% Internet-Style
Other Conditions			
	Bricks-And-Mortar margins are assumed constant at 30%.		
	Early Internet users are assumed 20% likely to buy pet supplies online, so are late adopters also.		
	The book market is assumed to have 40000 SKUs.		
Company Strategy			
Minimum Marketing Spending	\$1 million/year	\$1 million/year	\$1 million/year
Target Marketing Spending as a percentage of revenue	60% in the beginning, declining by 6% per year until 2008	50% in the beginning, declining by 5% per year until 2008	75% at start, declining by 7.5 % until 2008
Desired Product Selection	40000	25000	40000
Desired Time for Fulfillment	2.5 days	4 days	3 days
Target Gross Margin	-10% until 2001, increasing to 10% by 2011	5% below lowest competition	5% until 2001, increasing to 15% by 2011
Editorial budget	\$1 million/year	\$1 million/year	\$2 million/year
User-Generated Content	Enabled	Enabled	Enabled
Hiring Policy	Automated	Automated	Automated
Fundraising Policy	Automated	Automated	Automated
Server Purchasing	Automated	Automated	Automated
Warehousing Policy	Automated	Automated	Automated

Table 8 - Parameters for Base Case (Pet Supplies)

This outcome can be understood by analyzing the underlying structure of the market. Most importantly, the Dot Com 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 Figure 13). 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 Dot Com 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.

Com 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 Dot Com 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 a medium-to-high price. This has a positive impact on revenue, valuation and fund-raising ability, offsetting 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 latecomer 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 improves its *market share* by a factor of four if it either starts a year earlier, or spends an extra \$100 million for marketing. Both changes made jointly would increase the *market share* by a factor of about 25, making Company 3 the leader in *market share*. Although no one today can start a company in the past, this finding demonstrates the importance of time-to-market. Immense resources are required 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 to 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 good site performance or it fails to build adequate warehouse infrastructure to deliver the 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 of new customers 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 its 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: *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. Conversely, during periods of limited hiring, 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 is 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 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

Online retailers face a high risk of price wars as they focus on growth, not profitability. A price war is an interesting behavior as it can happen through a series of seemingly rational steps by actors who take a partial view of the system. Taking a partial view of the system, a manager may understand that a price below the competition increases sales. And indeed, for a certain range of parameters, lowering the price increases the company valuation in the short run and grows the customer base. However, lowering the price simultaneously increases the losses incurred and reduces gross margin, both with adverse effect on the valuation. Even worse, if the competitor applies the same reasoning, he will react by setting even lower prices, thus taking away the advantages of the lower price from the first company, while the negative impact in terms of bigger losses remain. Not to be outdone, the first company may well further reduce its price, starting a price war.

All it takes to start a price war are two or more companies 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, resulting in a mass exodus of employees, leading to a drop in average productivity.

9.4. Modeling the Burst of the Bubble

To model the 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, net income replaces margin as the core driver of valuation. Hence 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 Dot Com Model succeeds in replicating many outcomes seen in the real world, such as rapid growth and market dominance (Amazon), difficulties in catching up 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 Dot Com 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 Dot Com 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 paper showed that a “Get Big Fast” strategy can work, but only if all of the following assumptions hold. First of all, the company needs to be able to sustain its growth rate for several years in order to grow into its valuation and to benefit from economies of scale. Second, financial markets need to remain supportive during the growth years to support ongoing losses. Third, the economies of scale and growth loops favoring the market leader need to be strong enough to allow the company to become profitable. Fourth, users must remain loyal enough to allow reduction of marketing spending while keeping user retention high through high service quality.

Following the “Get Big Fast”-strategy is a delicate balancing act as the company has 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. This makes the “Get Big Fast”-strategy particularly risky, as some failure modes can initially look very similar to the winning trajectory aimed at.

The Dot Com Model also examined the challenge faced by a latecomer trying to catch up with an early mover. The analysis showed that the powerful growth loops in online retailing make it extremely difficult to ever catch up if one starts two years late as Barnesandnoble.com did in the book market. The increase in market share from an assumed start one year earlier equaled the impact of a \$100 million marketing campaign.

Examining the pet supply market, the Dot Com Model also showed that multiple players of roughly equal strength make it more difficult for each other to turn profitable as none of them

fully benefits from the assumed economies of scale while competition increases marketing spending and margins come under pressure. This makes the industry a likely candidate for consolidation, a process not modeled in the present paper.

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.

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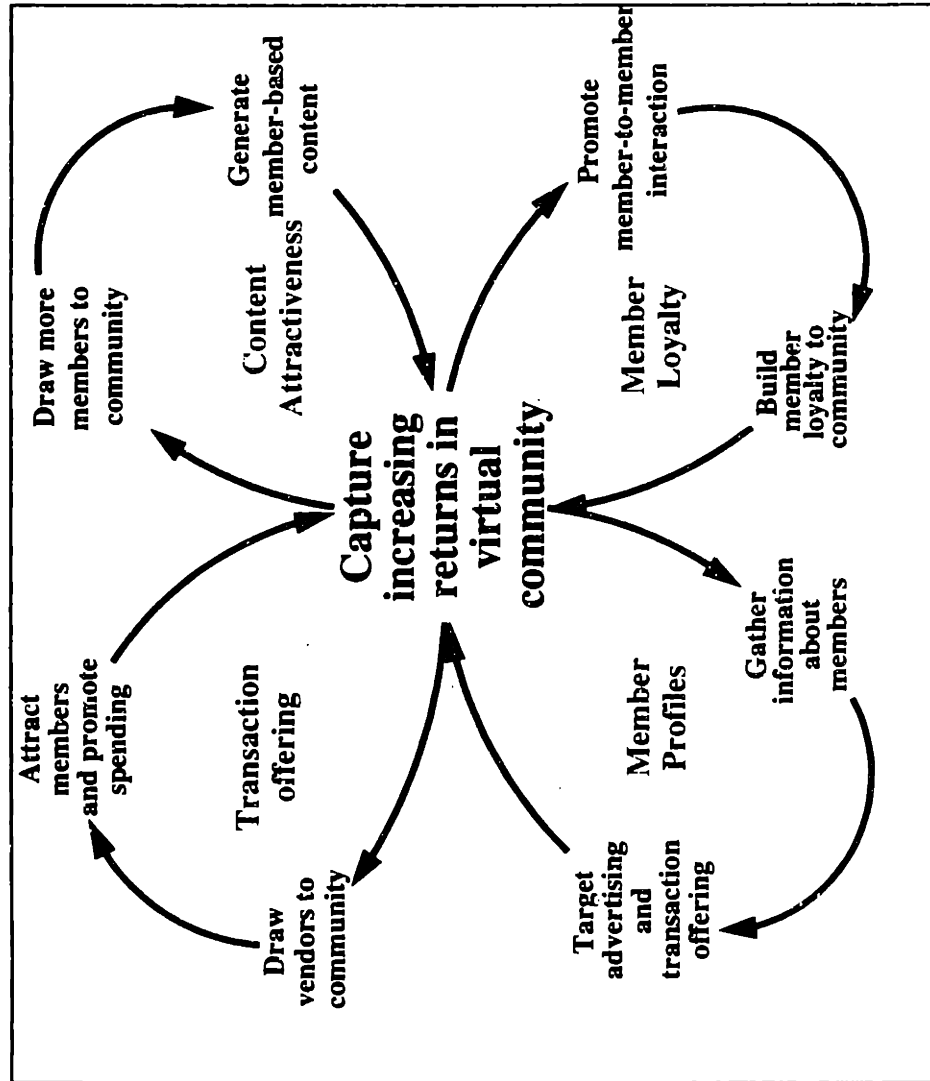
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Figure 1 - Hagel & Armstrong's Model on Online Communities



From Hagel/Armstrong, Net Gain, Expanding Markets through Virtual Communities, 1997, page 56.

Figure 2

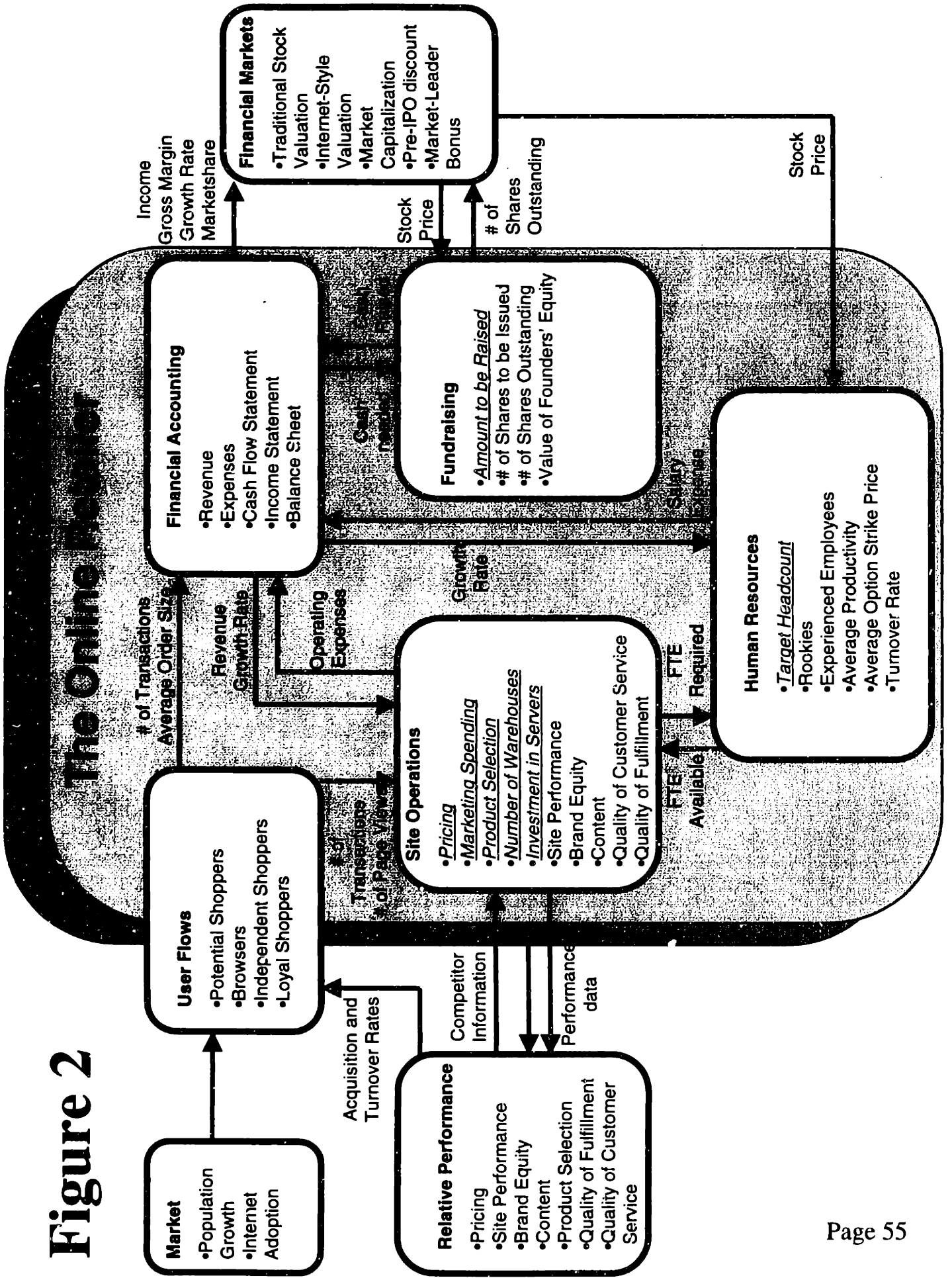
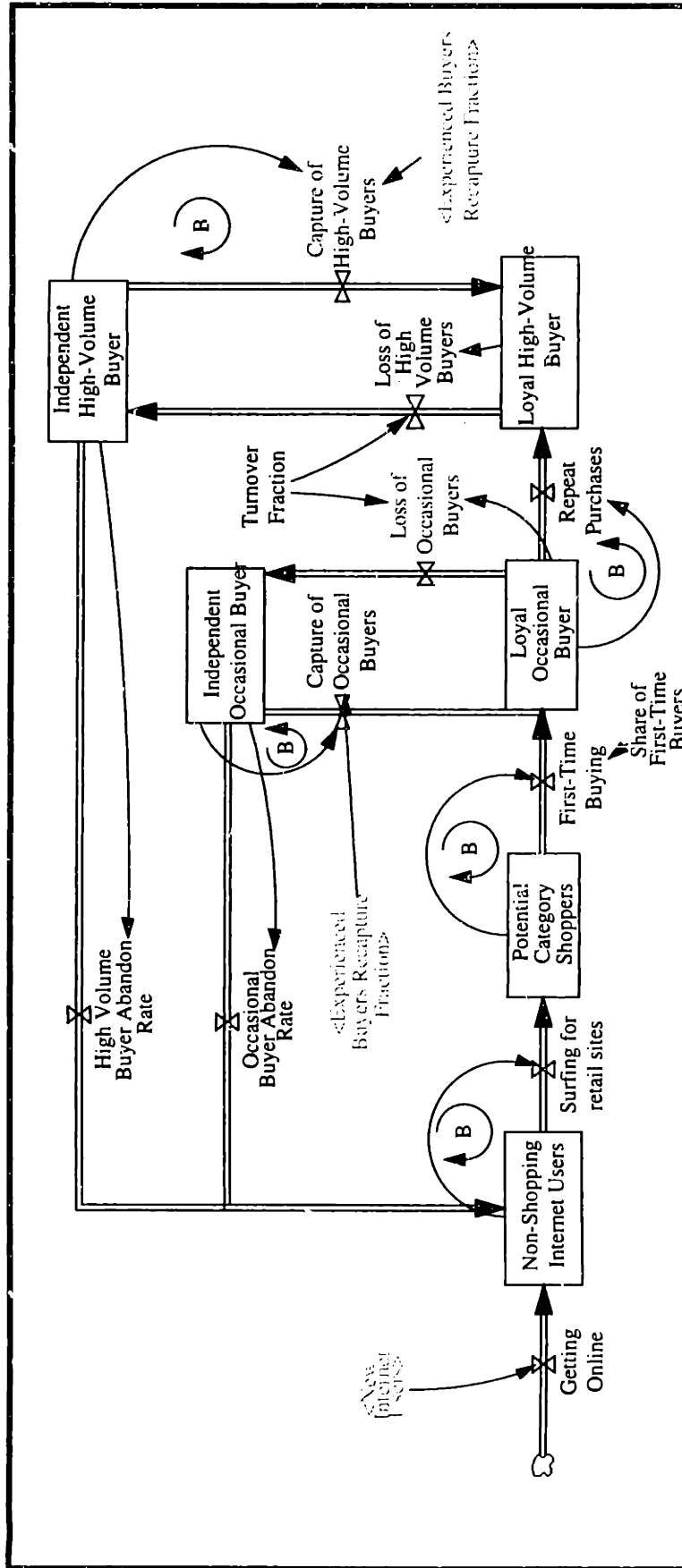
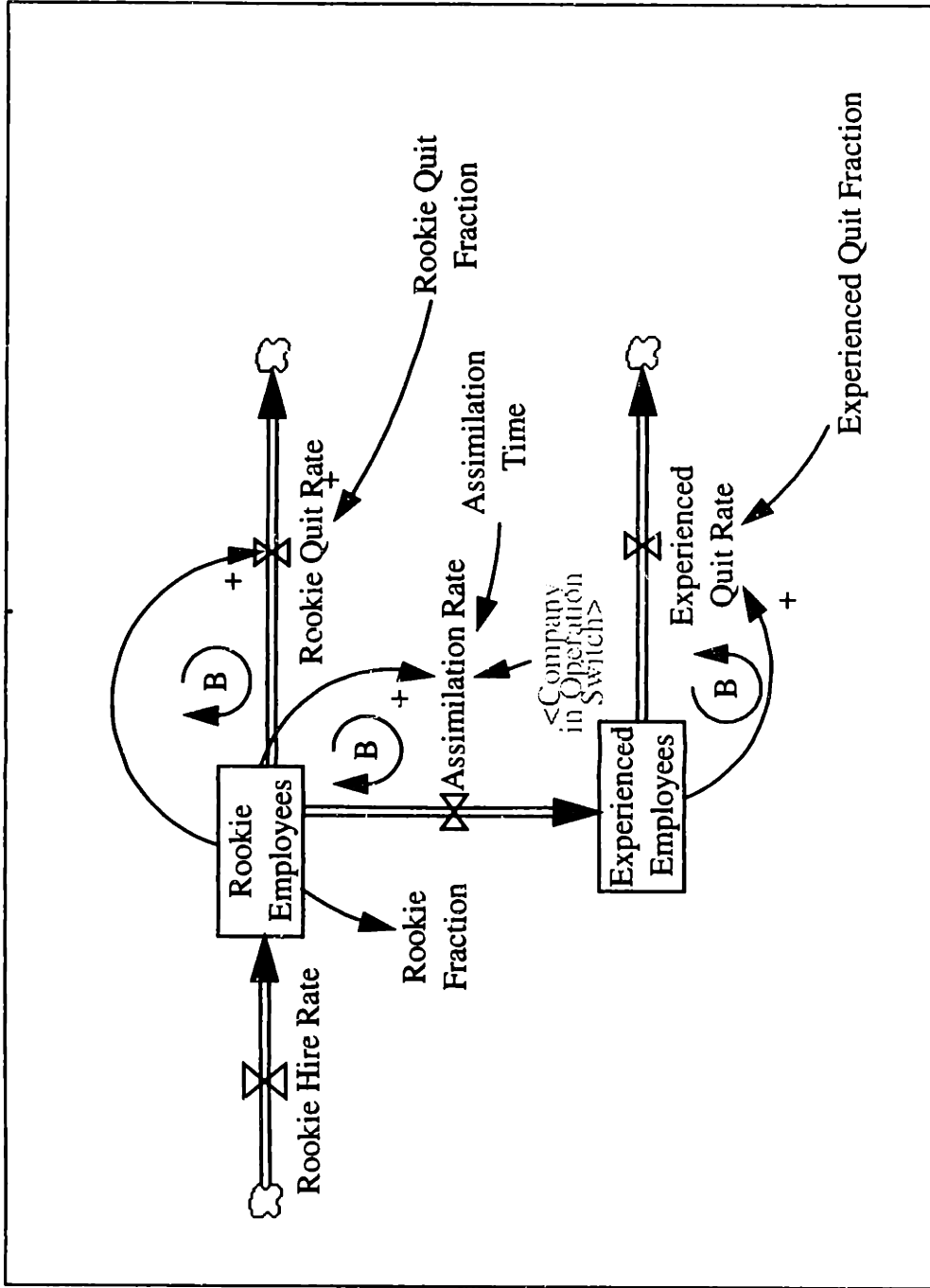


Figure 3 - User Flows



This stock-and flow structure describes the acquisition and retention of users by the different companies in the market. Note that the Loyal Buyer Stocks exist separately for each company.

Figure 4 - The Hiring and Training Cycle



Source: Inspired by Figure 12-11 in Sterman, Business Dynamics, Systems Thinking and Modeling for a Complex World, page 491. See also James Lyeins, Corporate Planning and Policy Design A System Dynamics Approach, Chapter 13, 1980.

Figure 5 - Tracking Option Strike Price relative to Stock Price

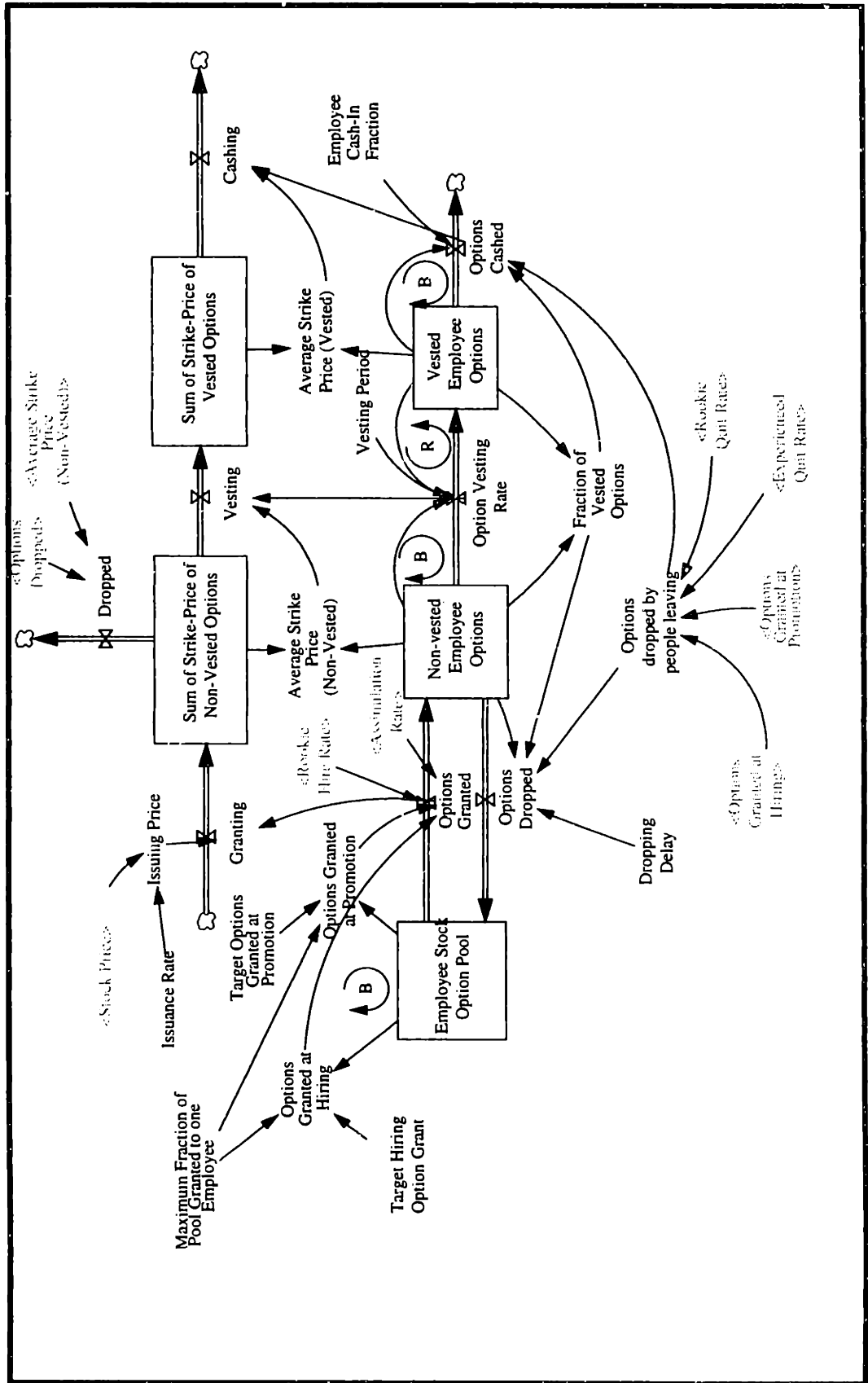


Figure 6 - Two Modes of Stock Valuation

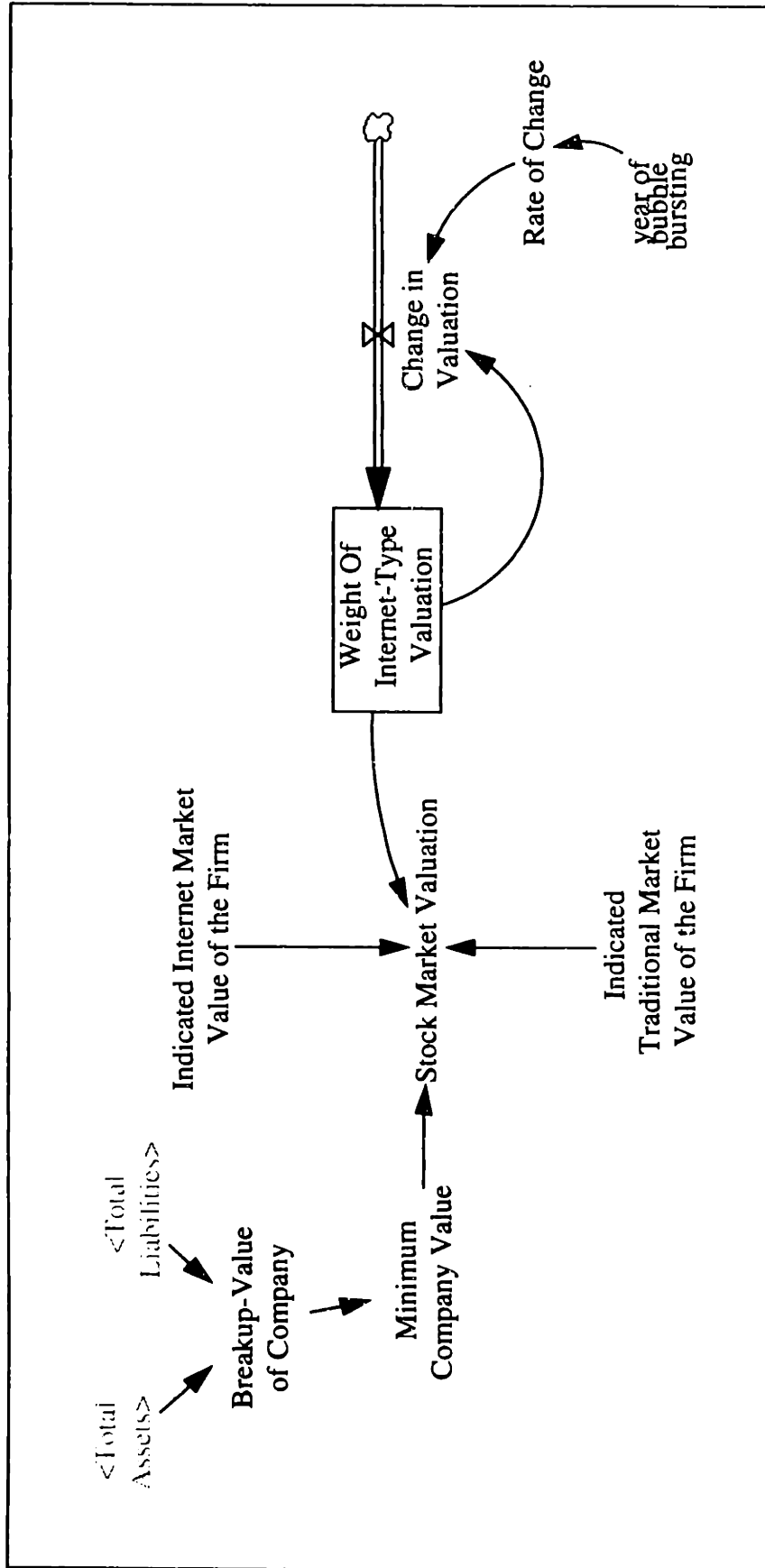


Figure 7 - The Internet-Style Valuation

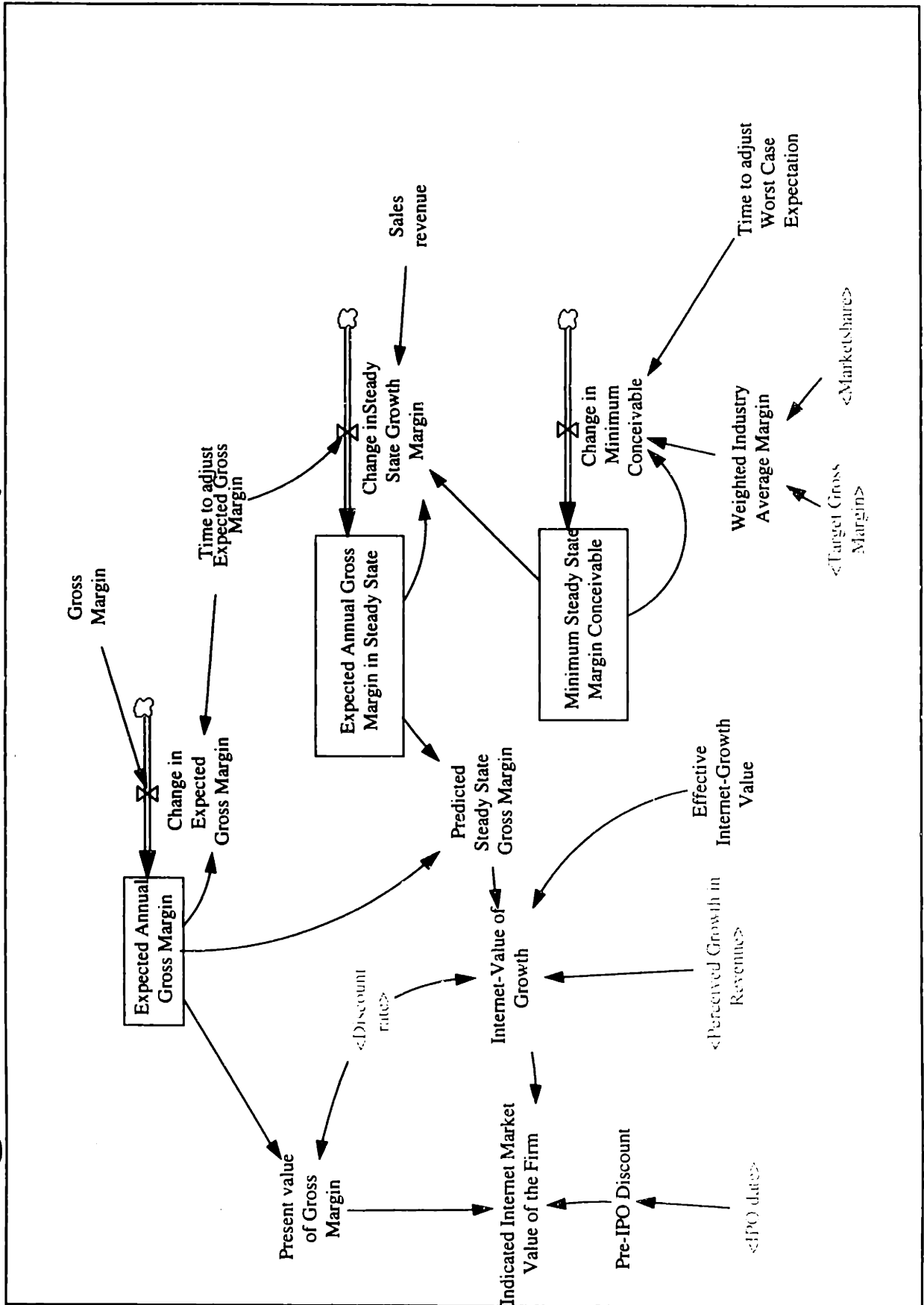
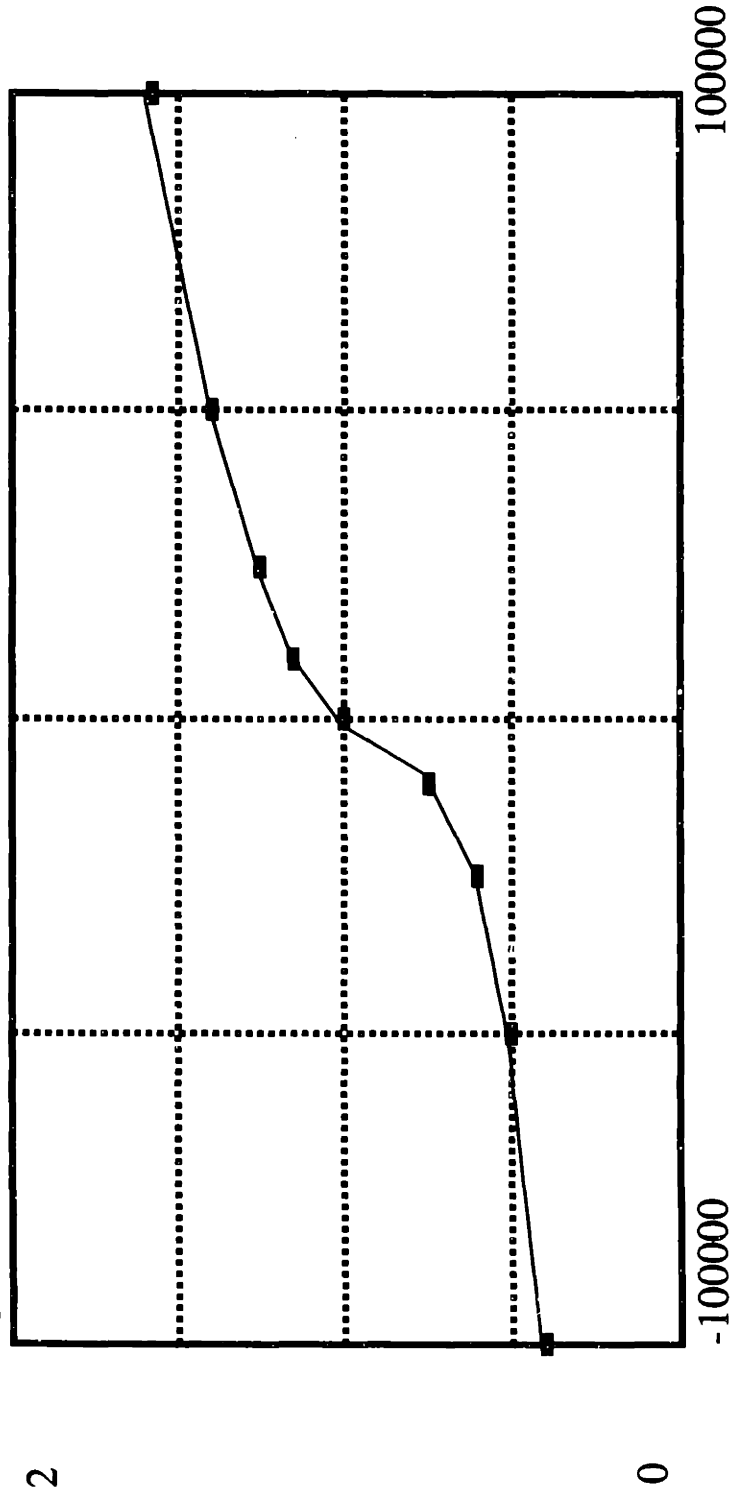


Figure 8 - Testing Robustness

Graph Lookup - Effect of Option Performance on Financial Attractiveness of the Job



This graph describes the impact of the current difference between option strike price and stock price on Financial Attractiveness of the Job. A positive value increases attractiveness, a negative value decreases attractiveness

Figure 9 - Testing Robustness

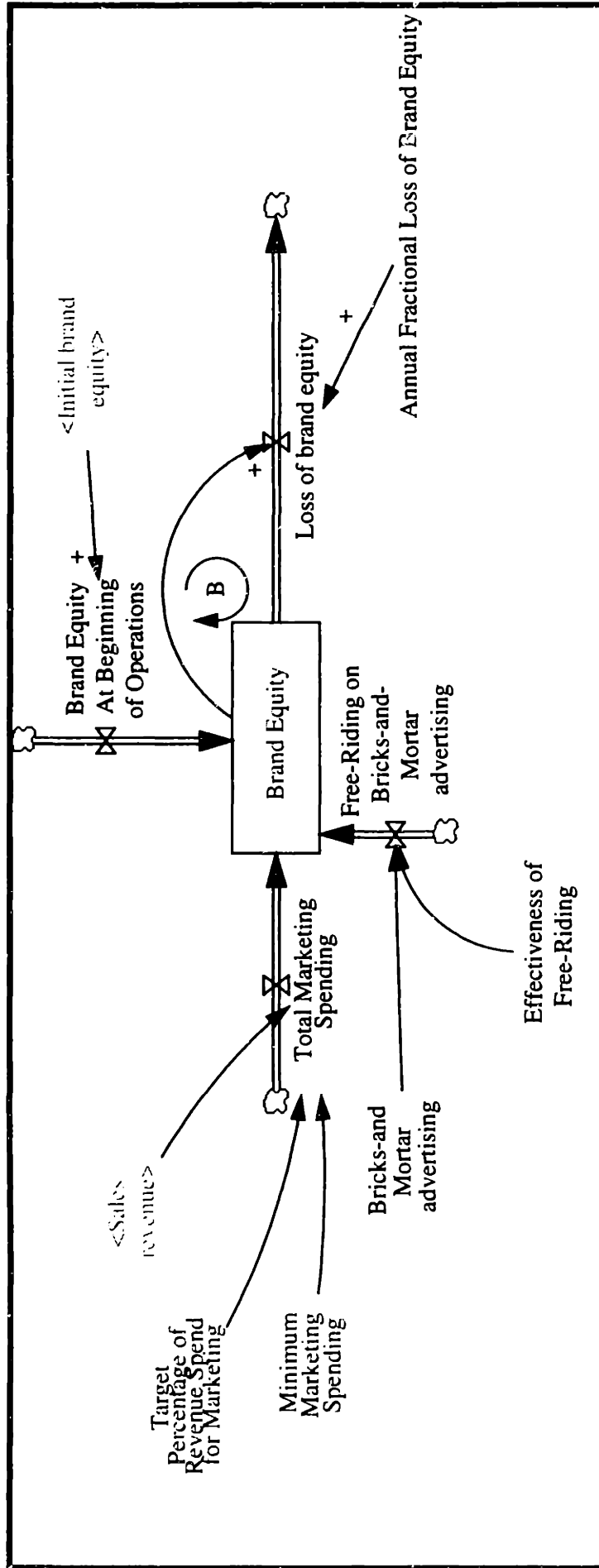
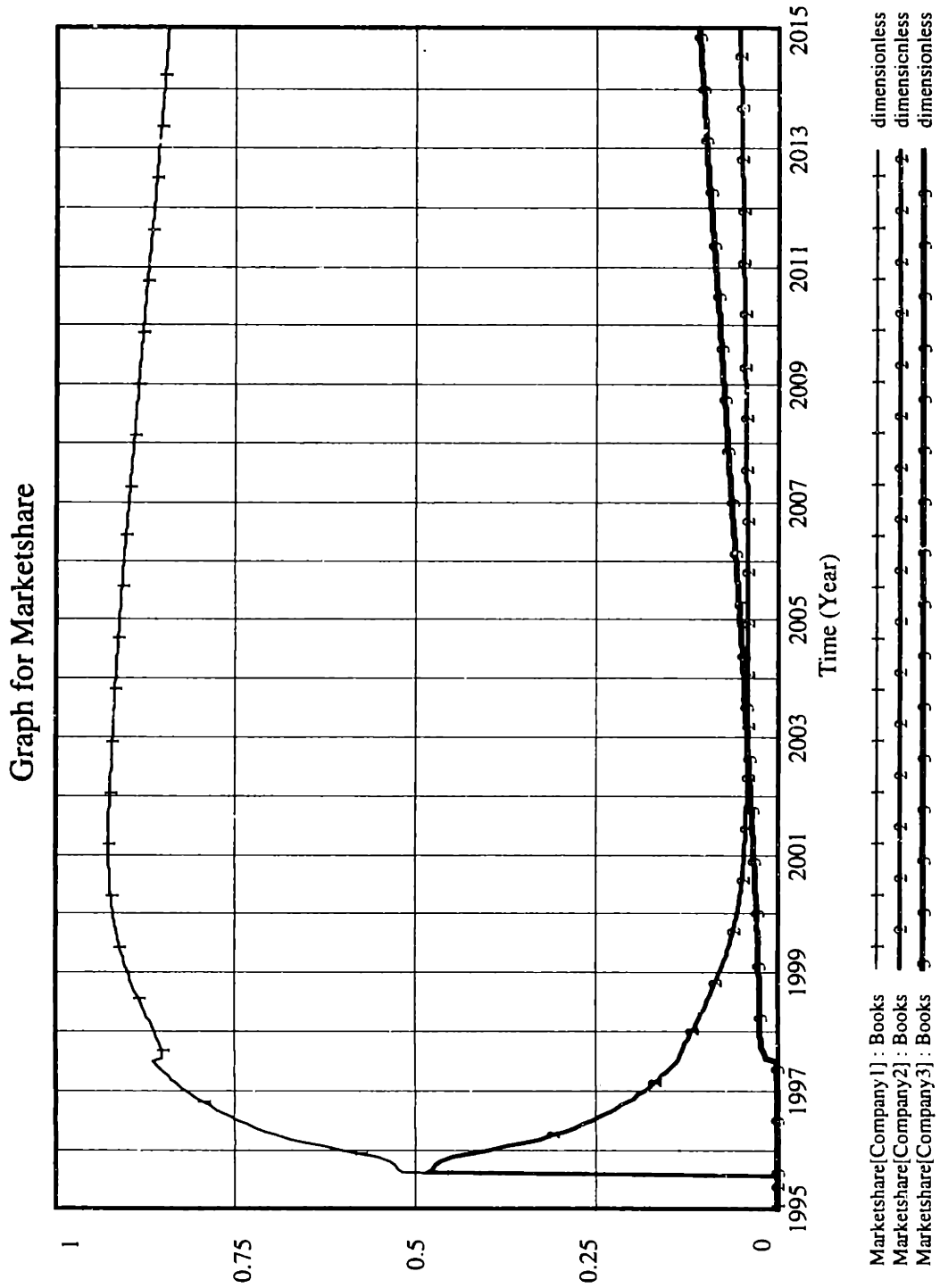
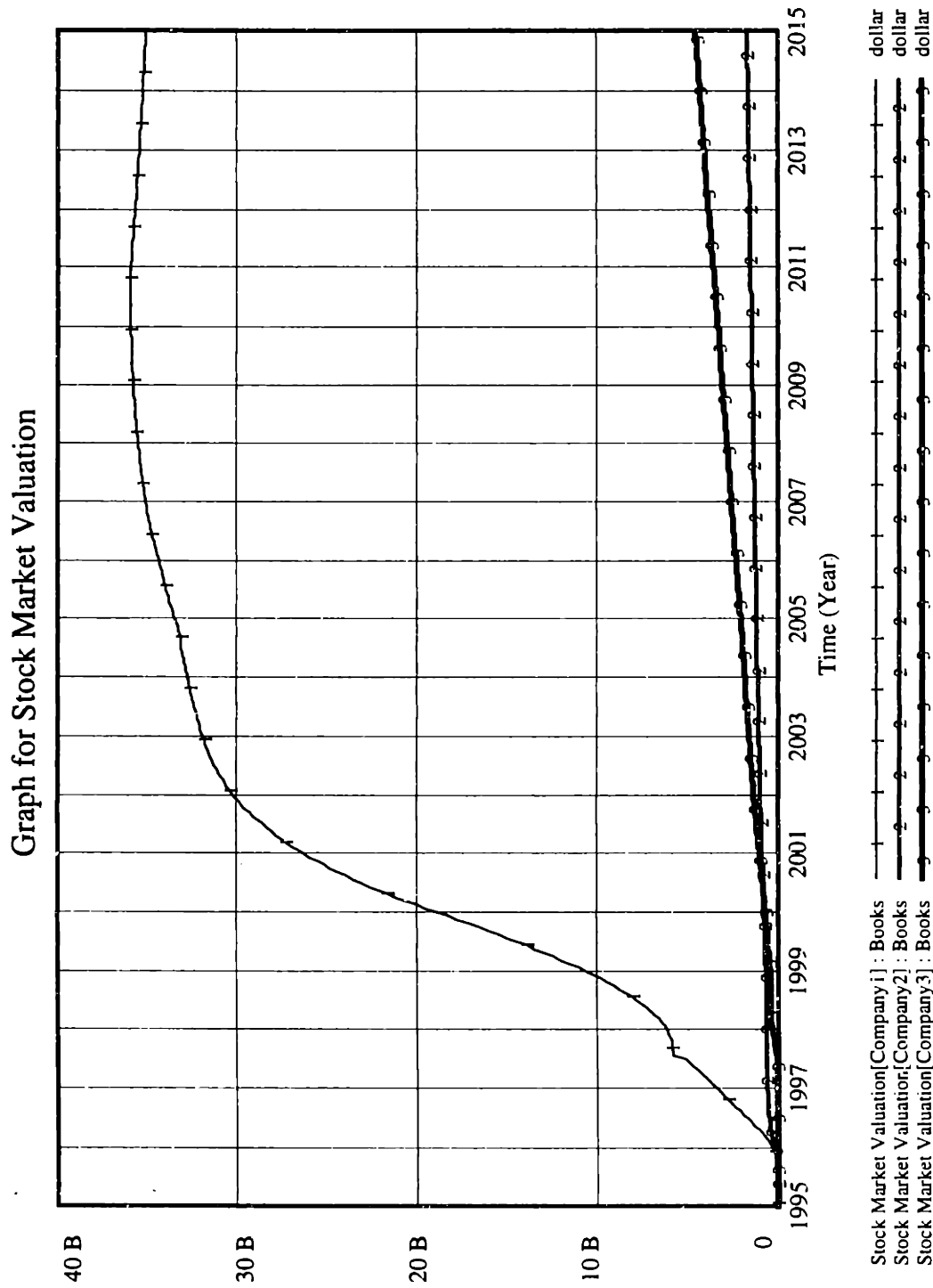


Figure 10 - Base Case 1 (Books)



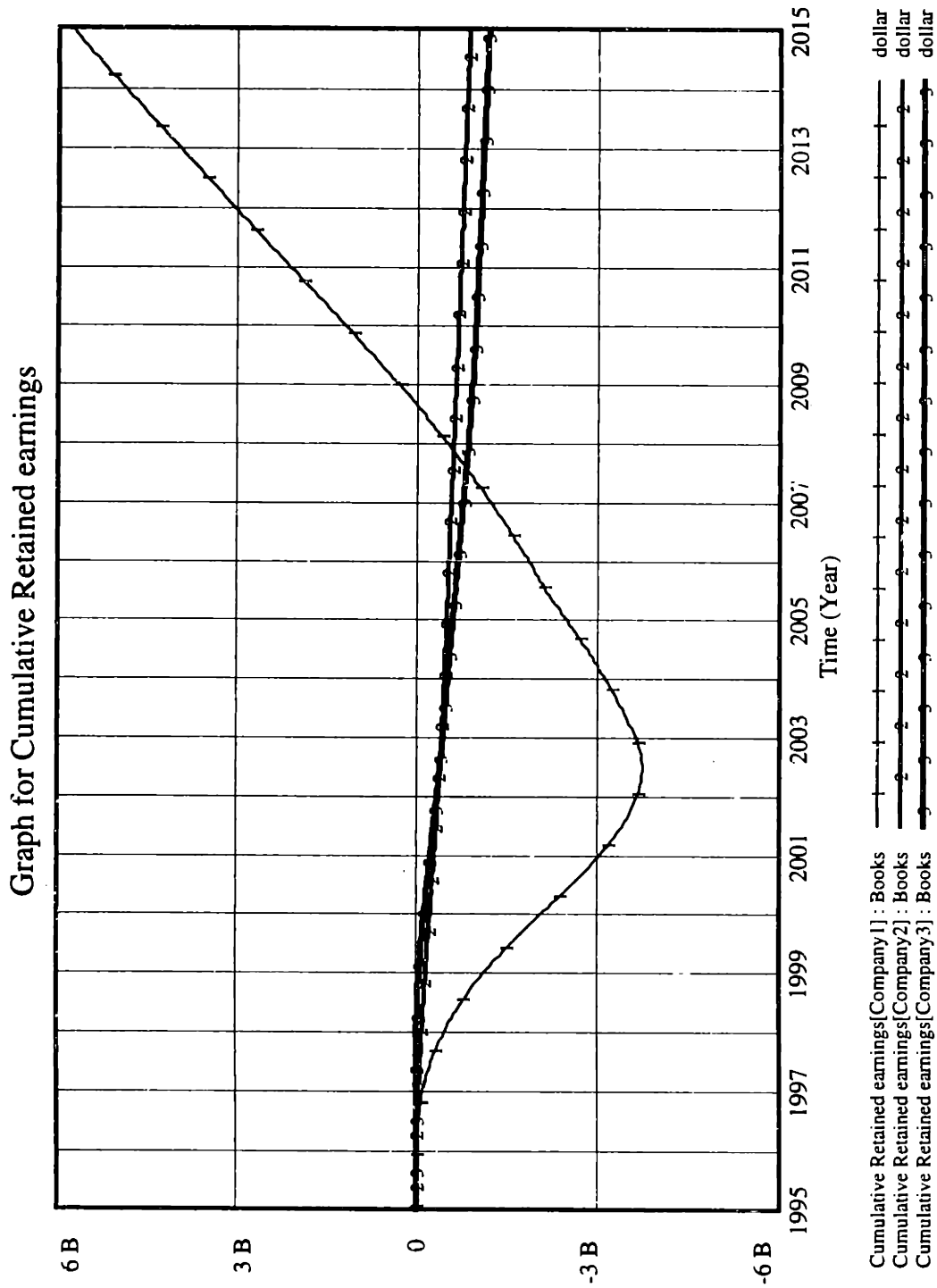
The base case produces a familiar result: the aggressive early-mover (Company 1) dominates, the bricks-and-mortar player (company 3) and others struggle to catch up.

Figure 11 - Base Case 1 (Books)



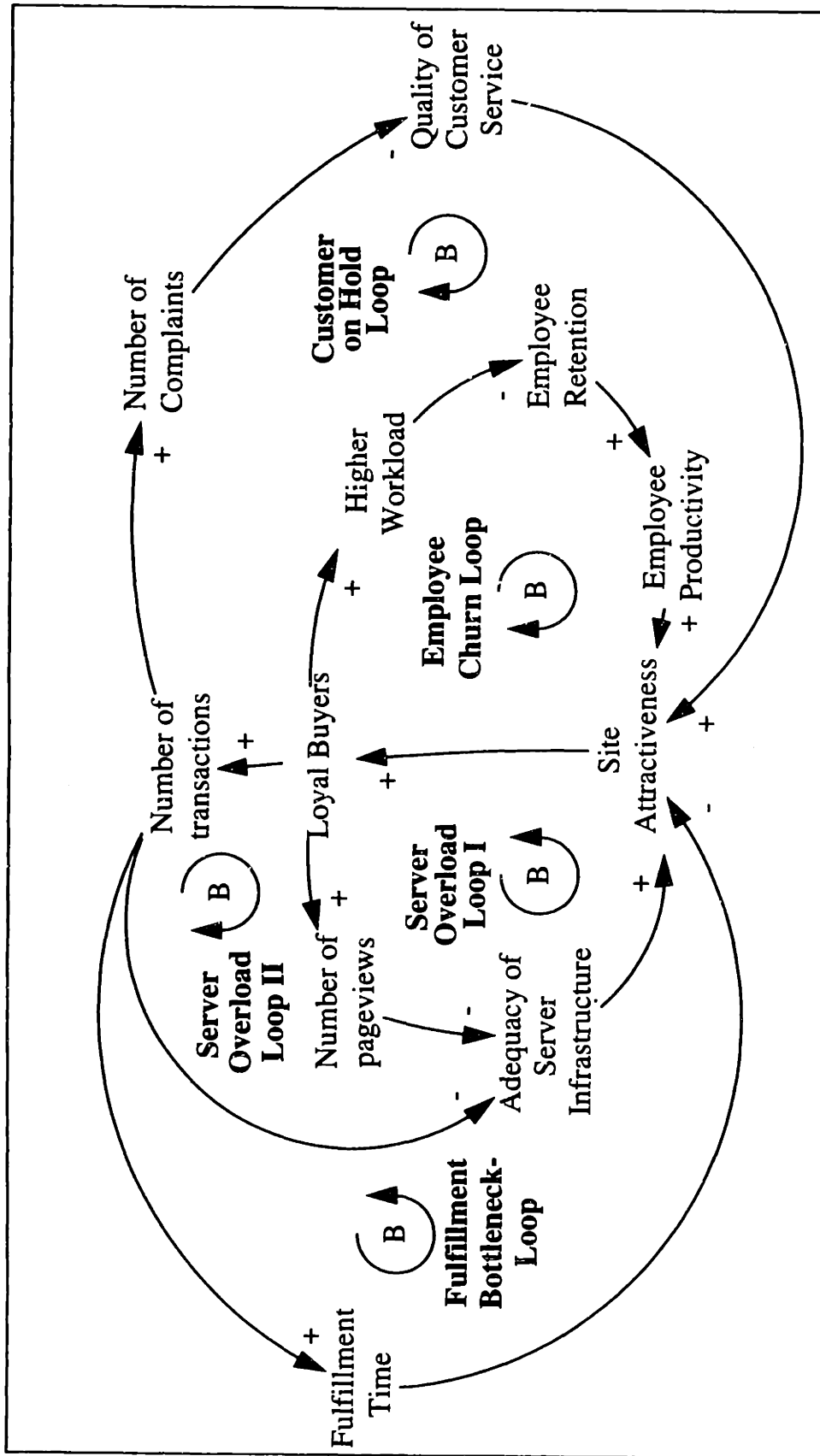
The base case produces a familiar result: the aggressive early-mover dominates, other players, including the bricks-and-mortar player struggle to catch up.

Figure 12 - Base Case 1 (Books)



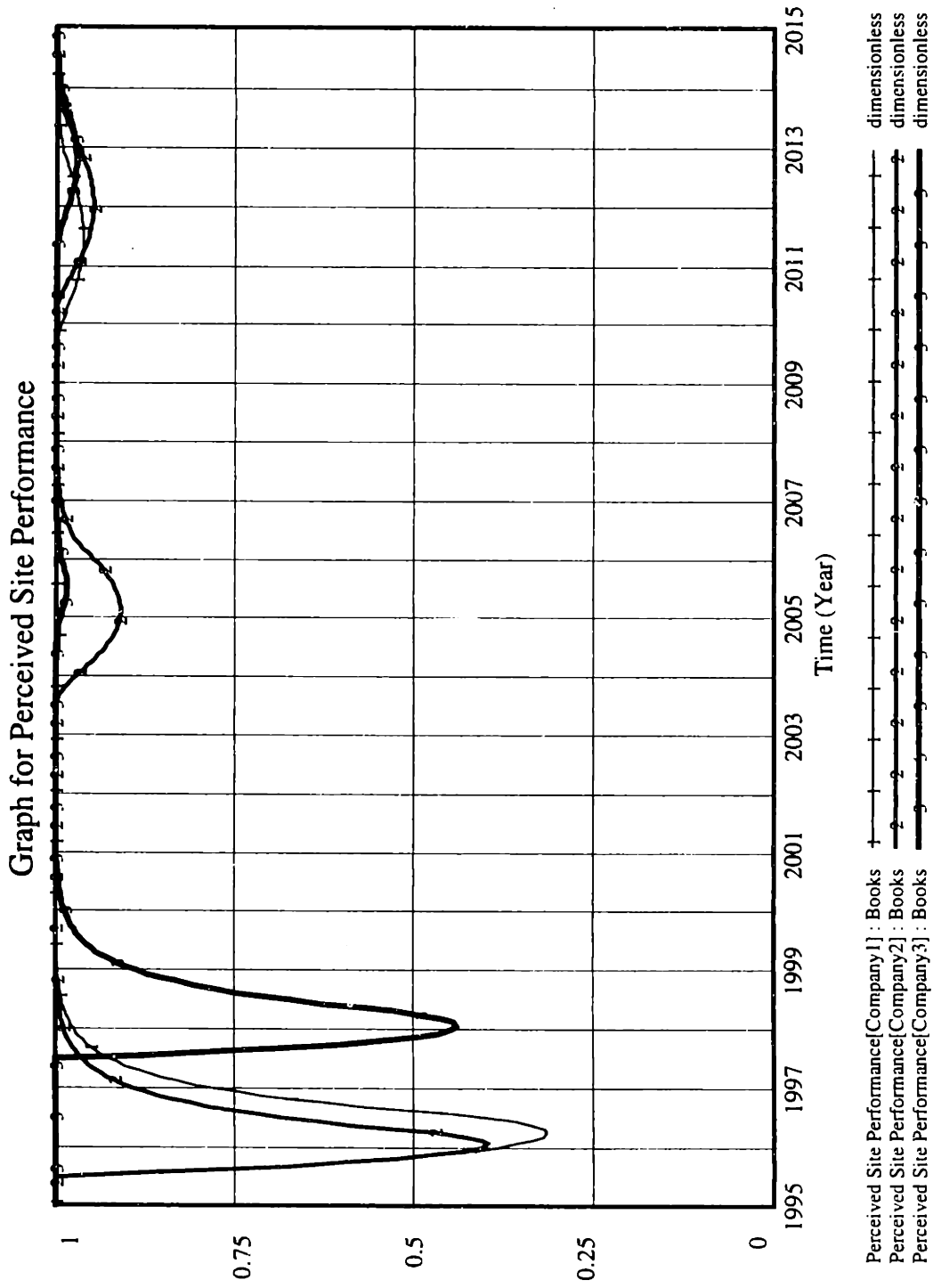
The base case produces a familiar result: the aggressive early-mover (Company 1) dominates, the bricks-and-mortar player (company 3) and others struggle to catch up.

Figure 14 - Balancing Loops



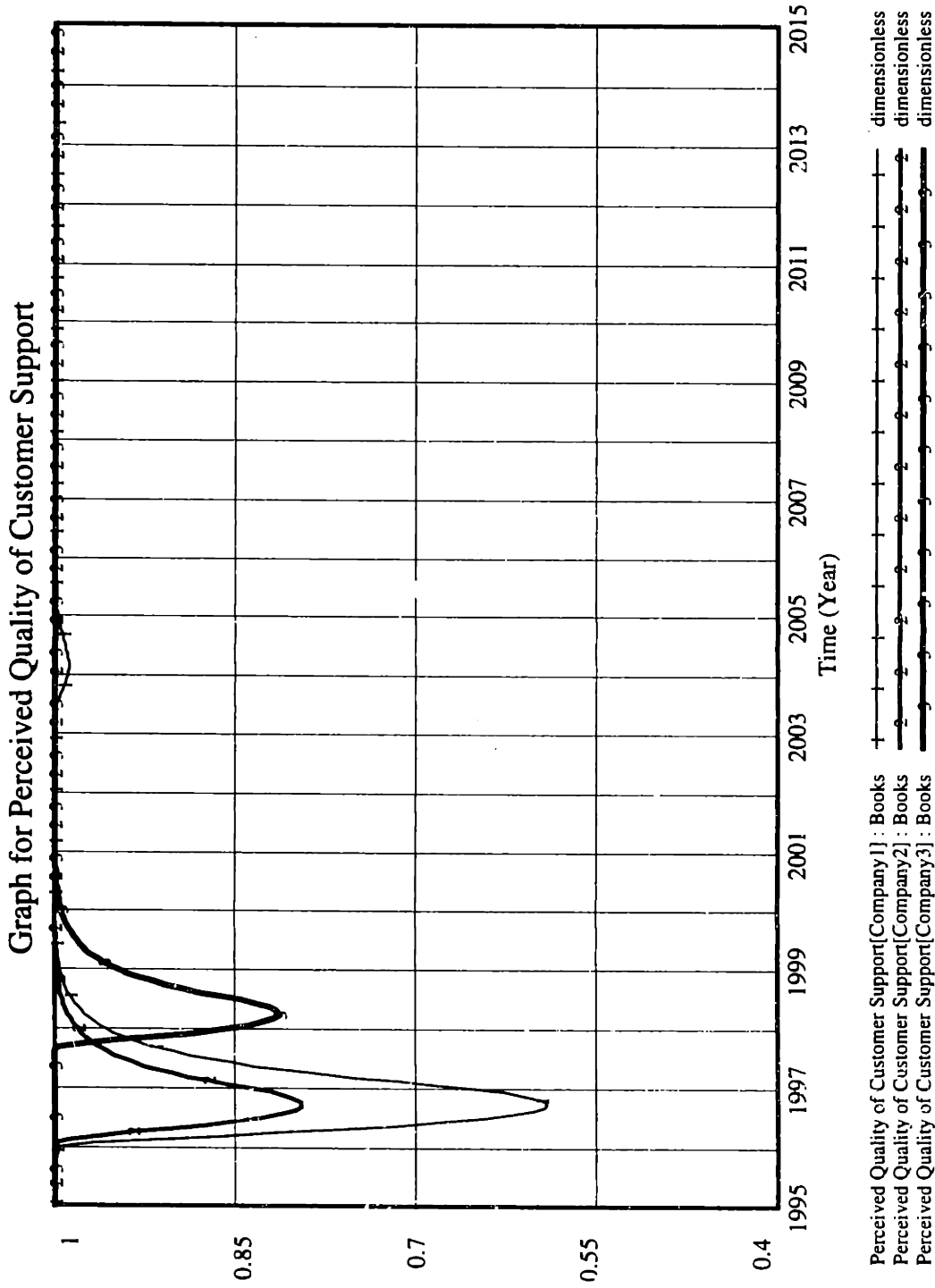
This graph shows some of the limits to rapid growth.

Figure 15 - Base Case 1 (Books)



The aggressive early-mover (company 1) shows the worst site performance during the early rapid growth, but recovers as growth stabilizes.

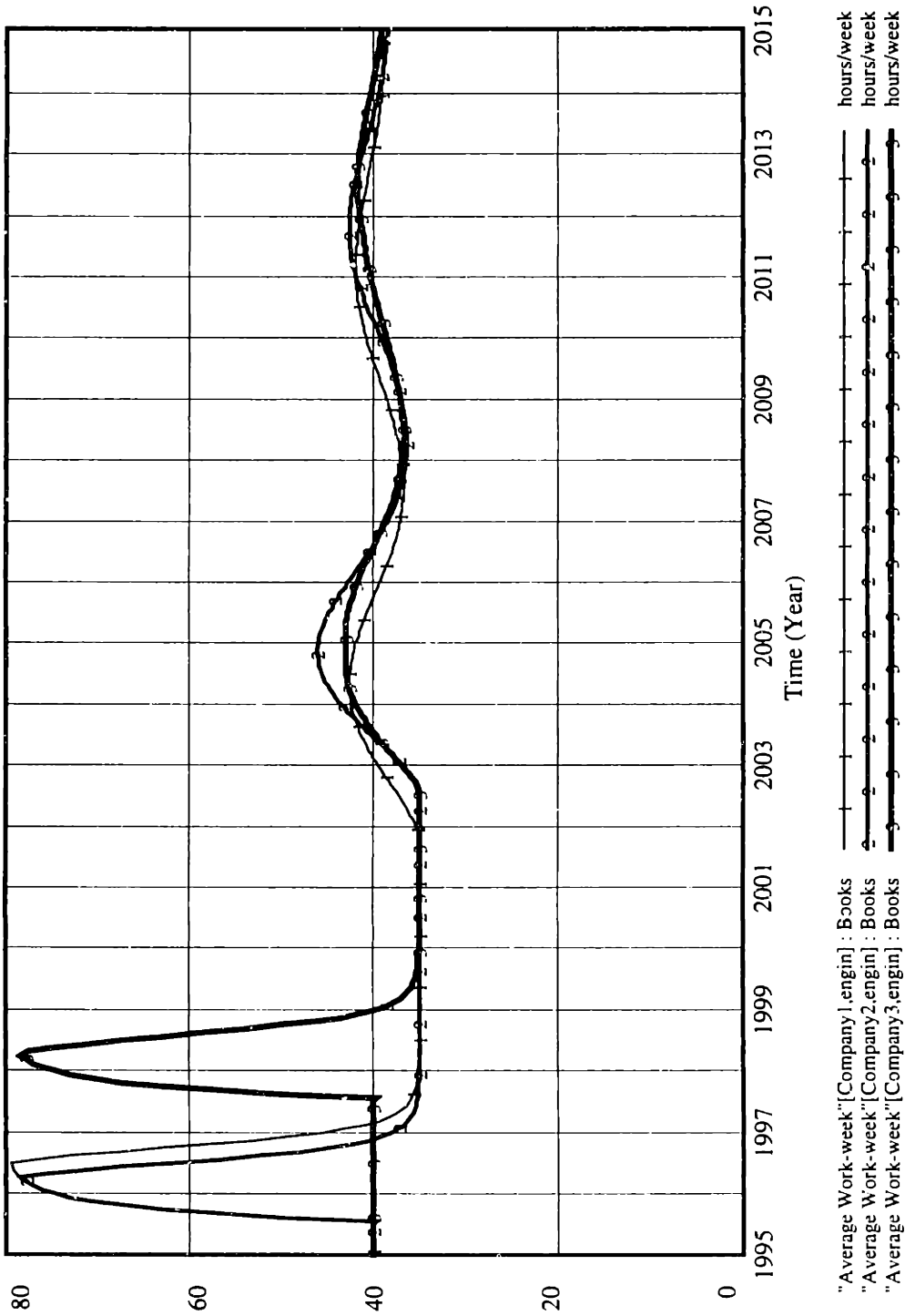
Figure 16 - Base Case 1 (Books)



The aggressive early-mover (company1) also shows the worst performance in customer support during the early rapid growth, but recovers as growth stabilizes.

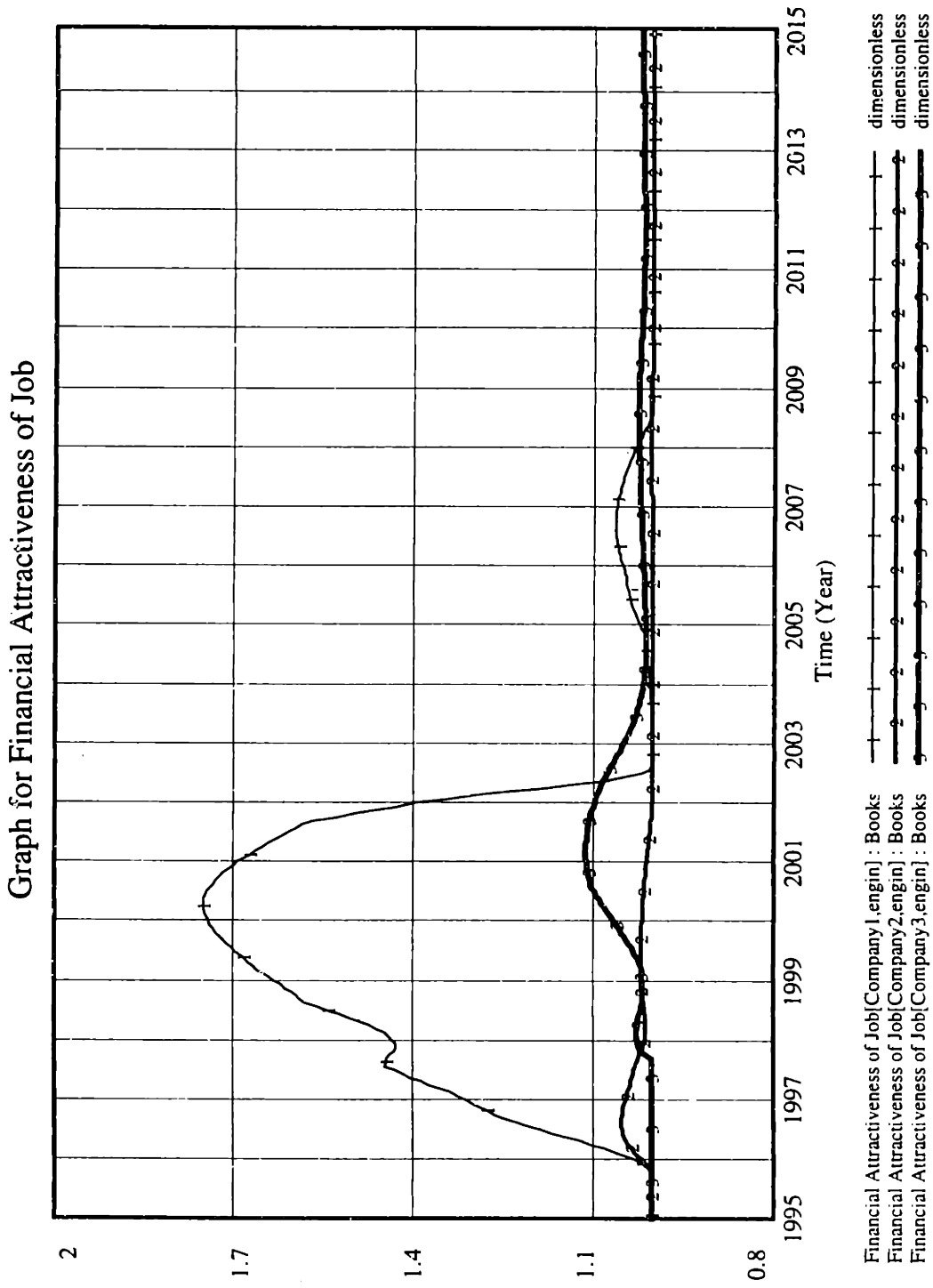
Figure 17 - Base Case 1 (Books)

Graph for Average Work-week



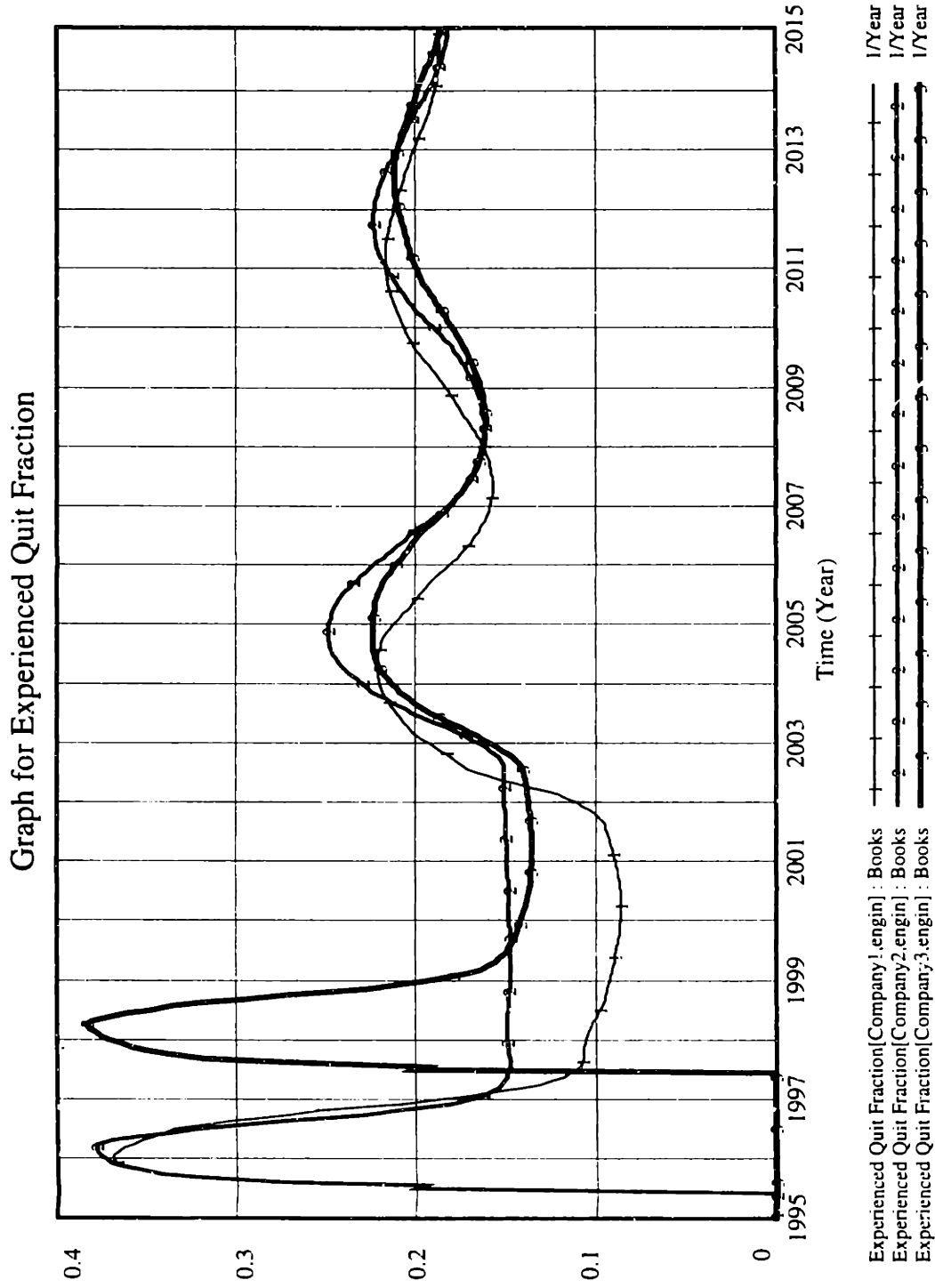
The aggressive early-mover (company1) requires its workers to work long hours during the early growth ...

Figure 18 - Base Case 1 (Books)



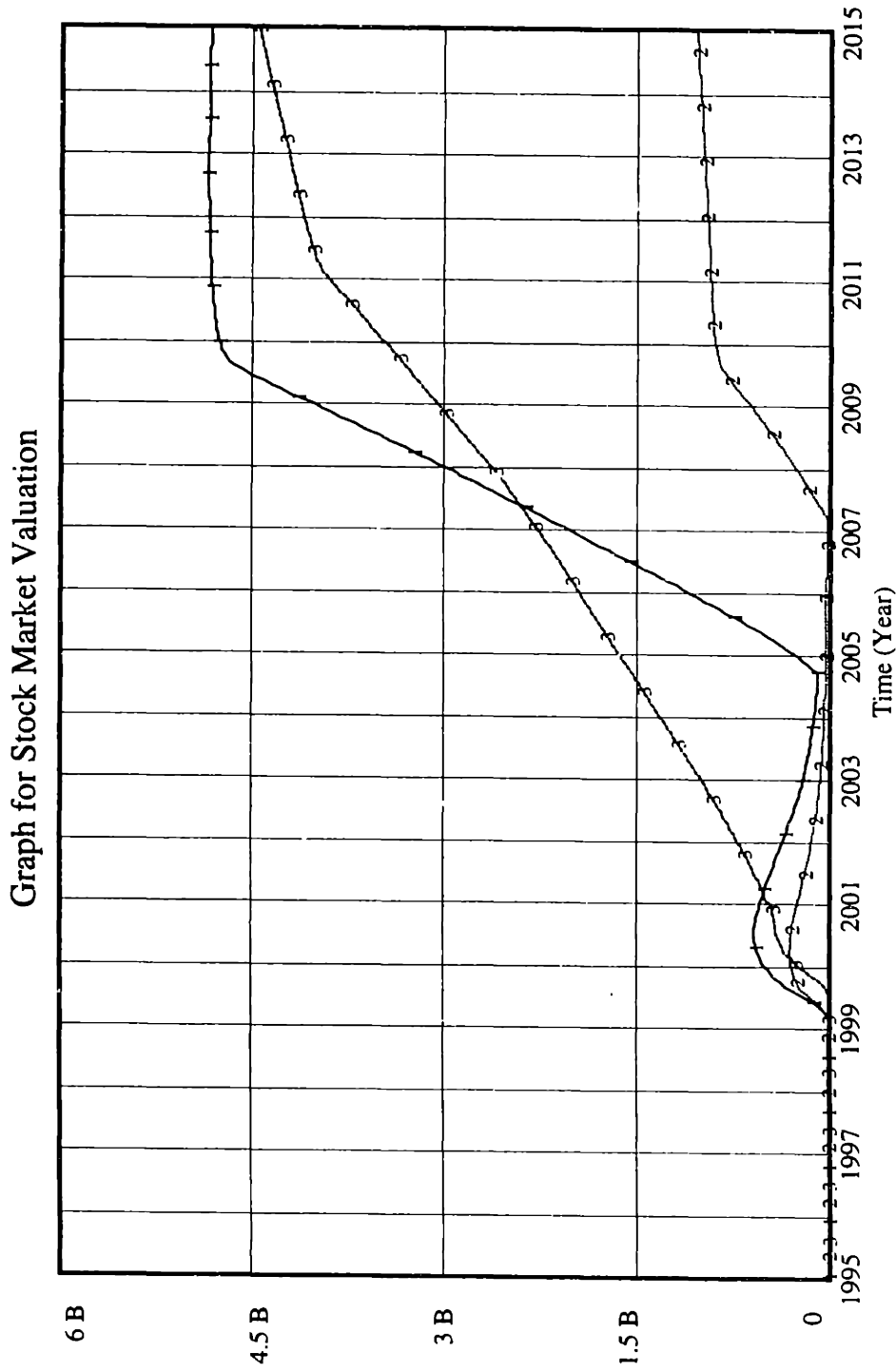
... but workers are happy because of the performance of the stock price relative to their options.

Figure 19 - Base Case 1 (Books)



Therefore the aggressive early mover (Company1) enjoys lower employee turnover than the competition.

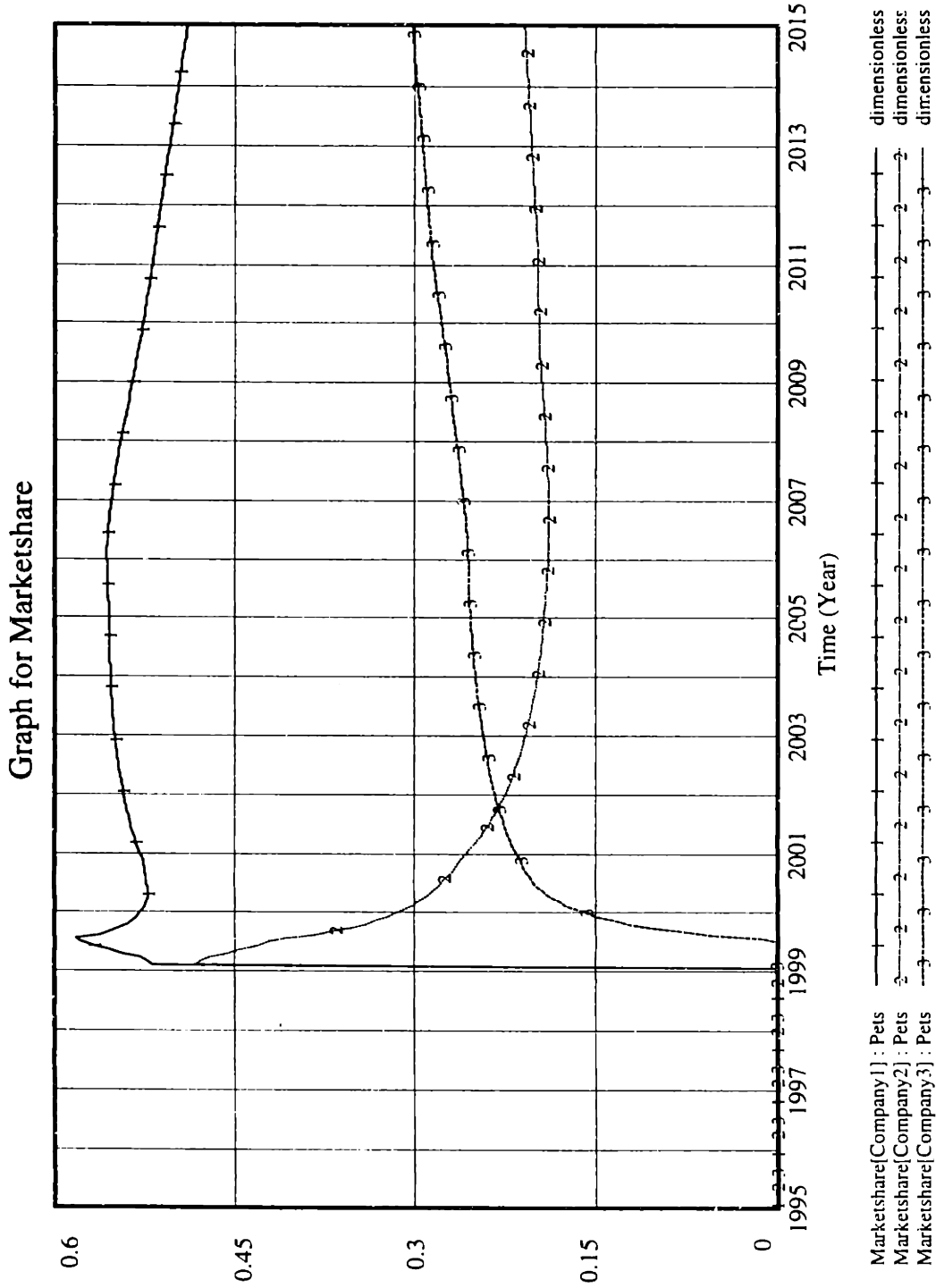
Figure 20 - Base Case 2 (Pet Supplies)



Stock Market Valuation[Company1] : Pets dollar
 Stock Market Valuation[Company2] : Pets dollar
 Stock Market Valuation[Company3] : Pets dollar

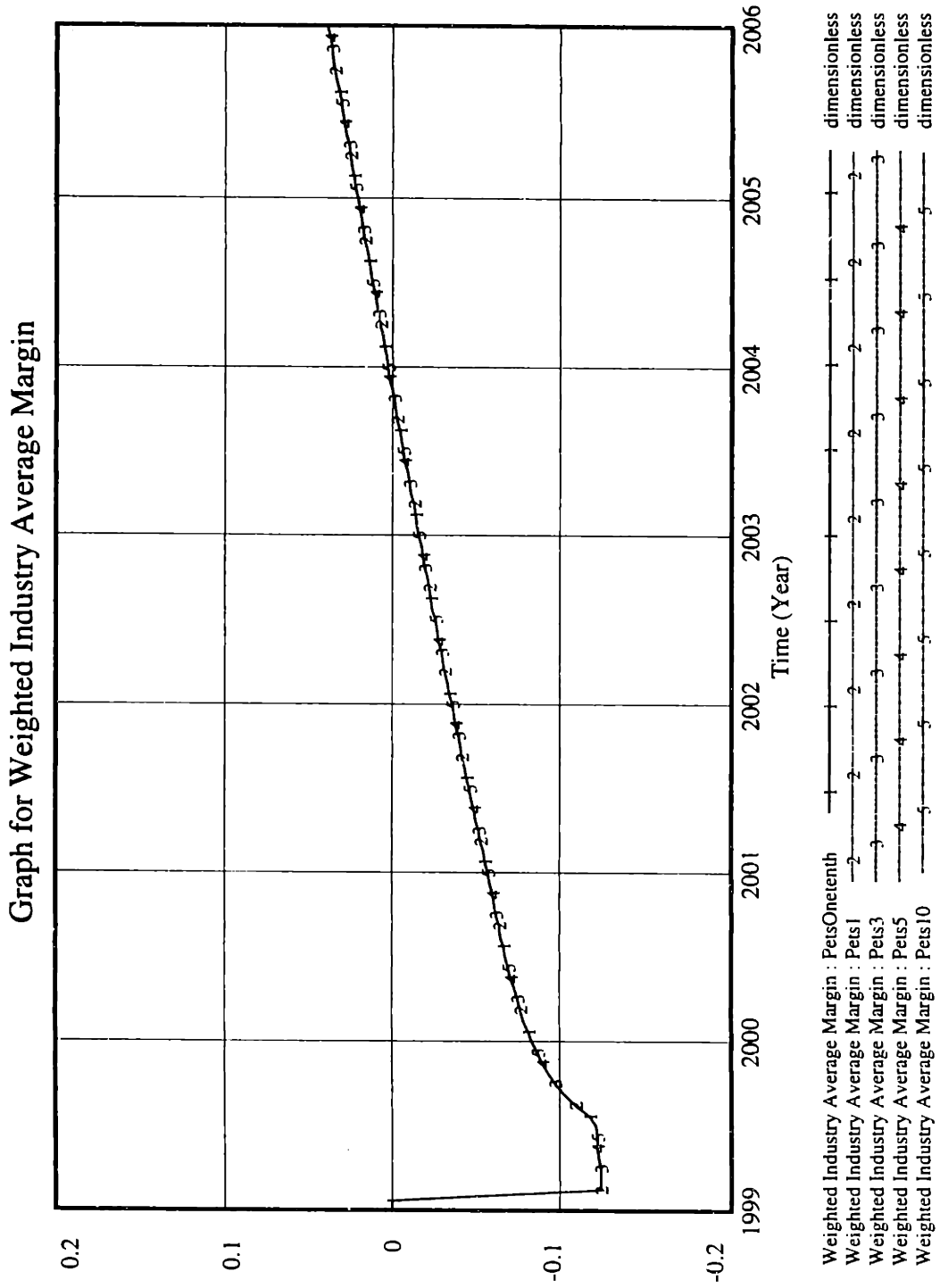
The base case produces a familiar result: the aggressive early-mover dominates, other players, including the bricks-and-mortar player struggle to catch up.

Figure 21 - Base Case 2 (Pet Supplies)



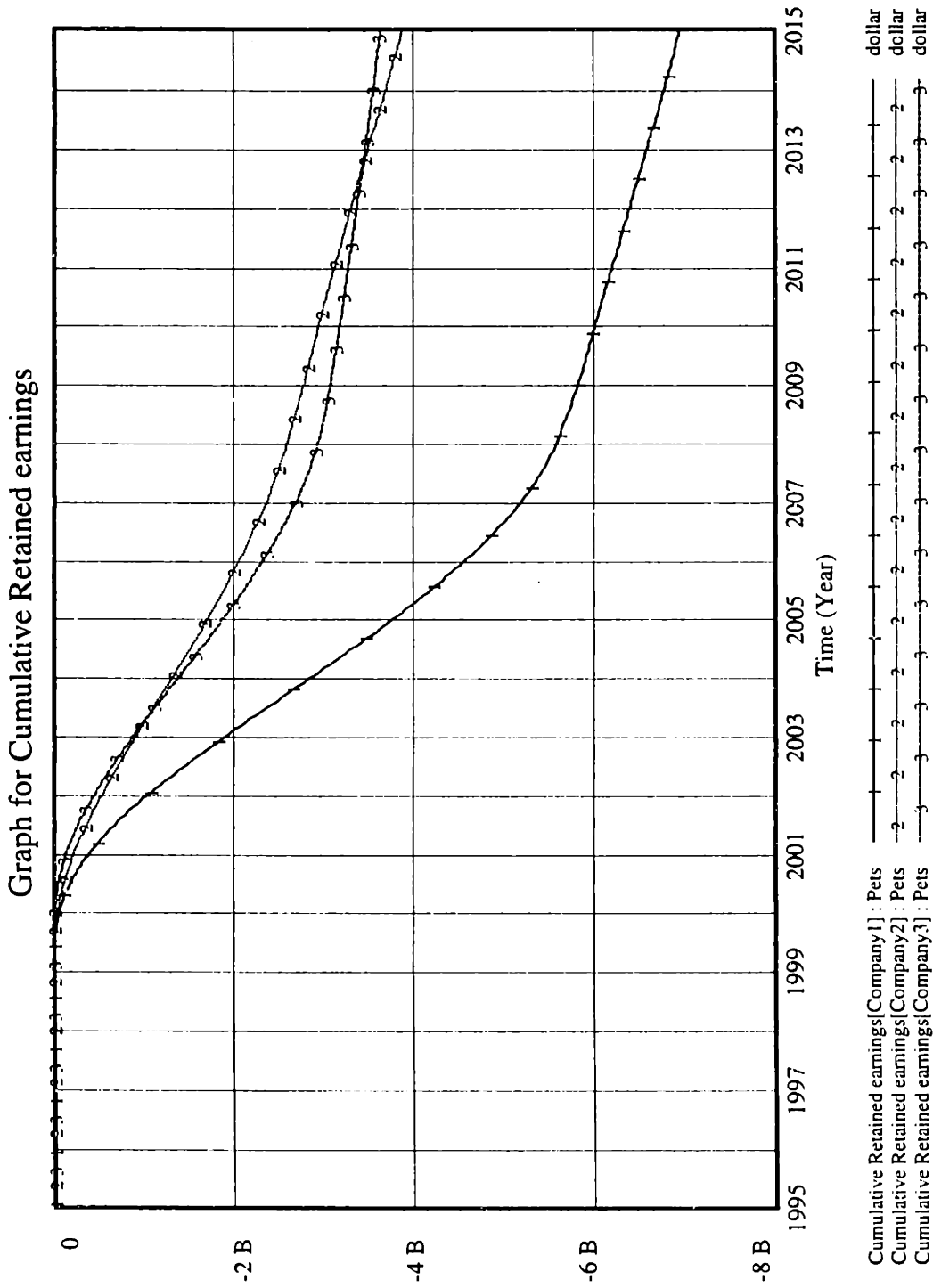
The base case produces a familiar result: the aggressive early-mover dominates, other players, including the bricks-and-mortar player struggle to catch up.

Figure 22 - Base Case 2 (Pet Supplies)



Margins in online pet supplies retailing are assumed to improve over time.

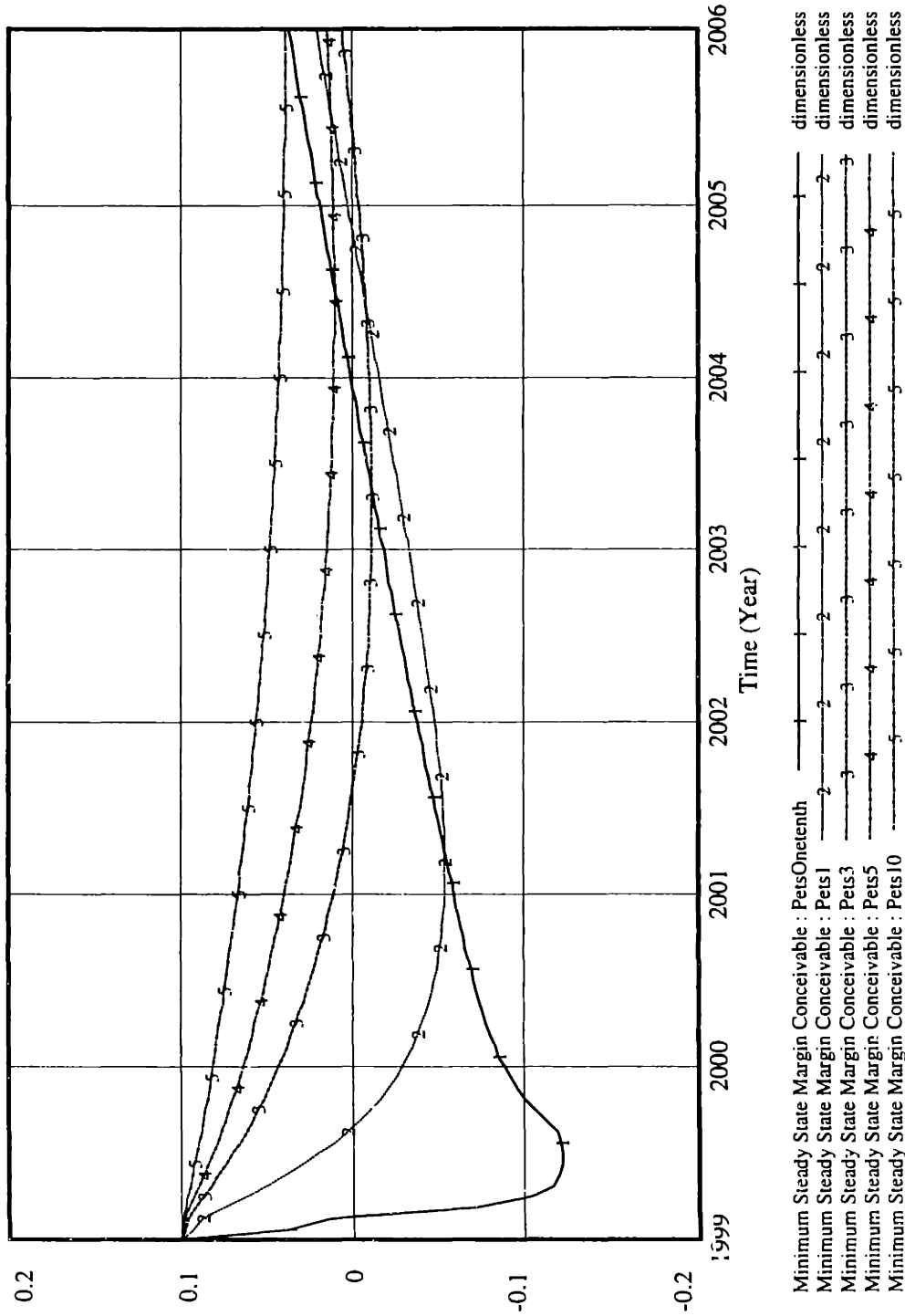
Figure 23 - Base Case 2 (Pet Supplies)



Despite a positive gross margin, companies continue to make losses.

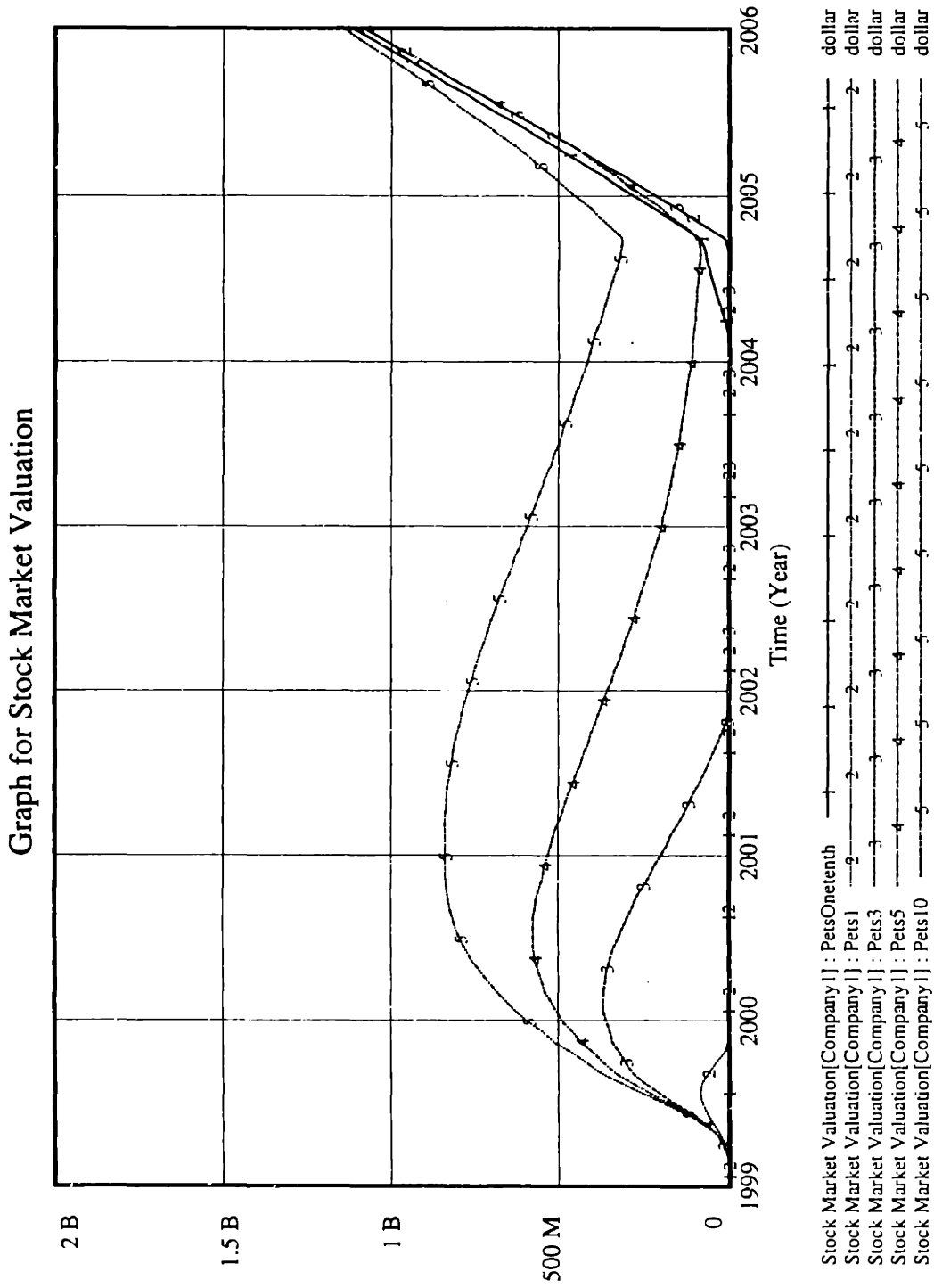
Figure 24 - Base Case 2 (Pet Supplies)

Graph for Minimum Steady State Margin Conceivable



If the adjustment time for expectations is three years or less, the market will temporarily assume that margins in the mature state are negative

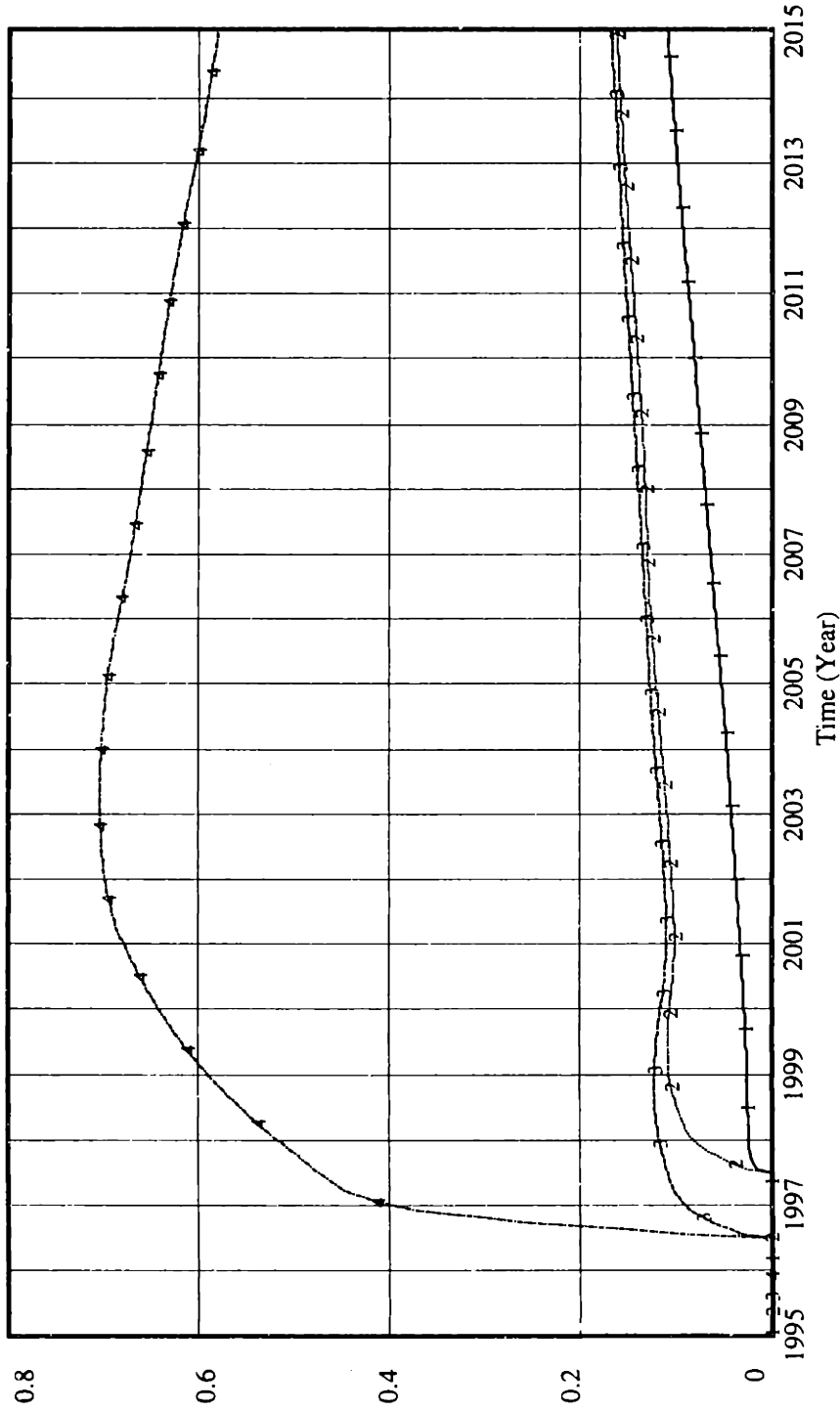
Figure 25 - Base Case 2 (Pet Supplies)



... which leads to failure as the company cannot raise money to sustain its losses.

Figure 26 - Bricks-and-Mortar Catch up

Graph for Marketshare

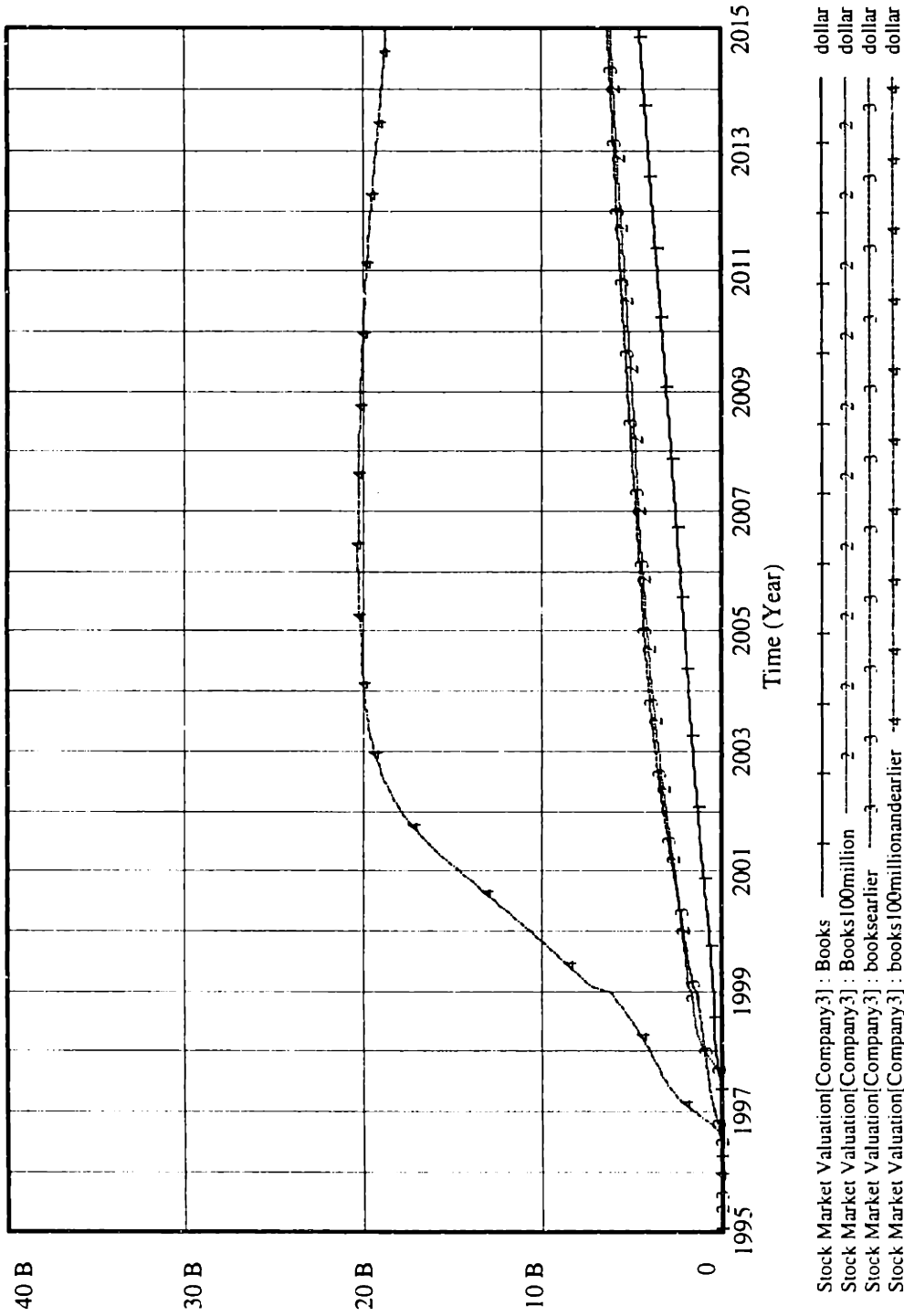


Marketshare[Company3] : Books
 Marketshare[Company3] : Books 100million
 Marketshare[Company3] : bookearlier
 Marketshare[Company3] : books100millionandearlier

The market share of the late comer (Company 3) in year 2000 increases by a factor of four if either the company spend an extra \$100 million on marketing or would have started earlier by a year. The combined impact of those changes is even more powerful.

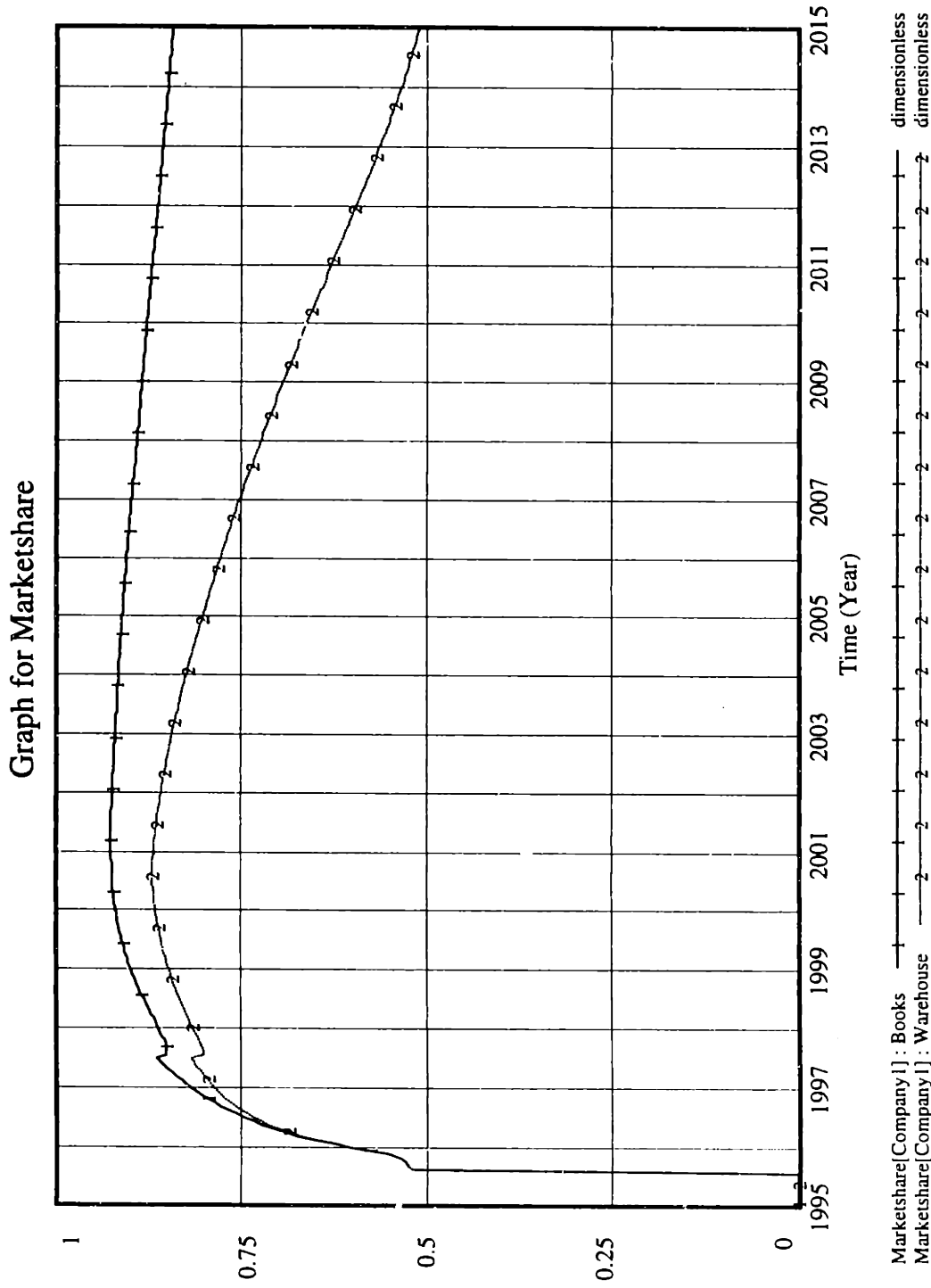
Figure 27 - Bricks-and-Mortar Catch up

Graph for Stock Market Valuation



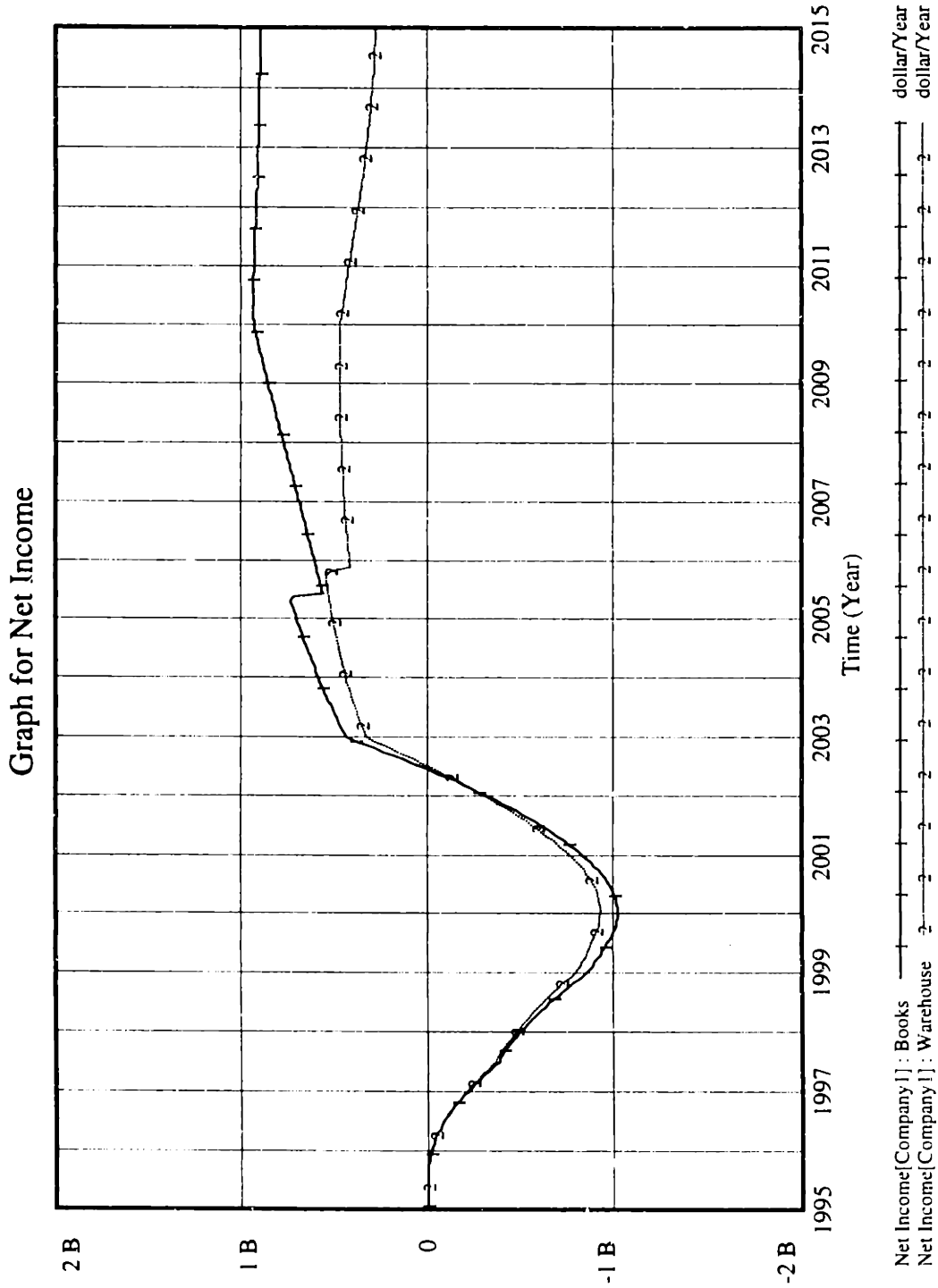
The Valuation of the late comer (Company 3) in year 2000 increases significantly if either the company spend an extra \$100 million on marketing or would have started earlier by a year. The combined impact of those changes is even more powerful.

Figure 28 - Poor Warehousing



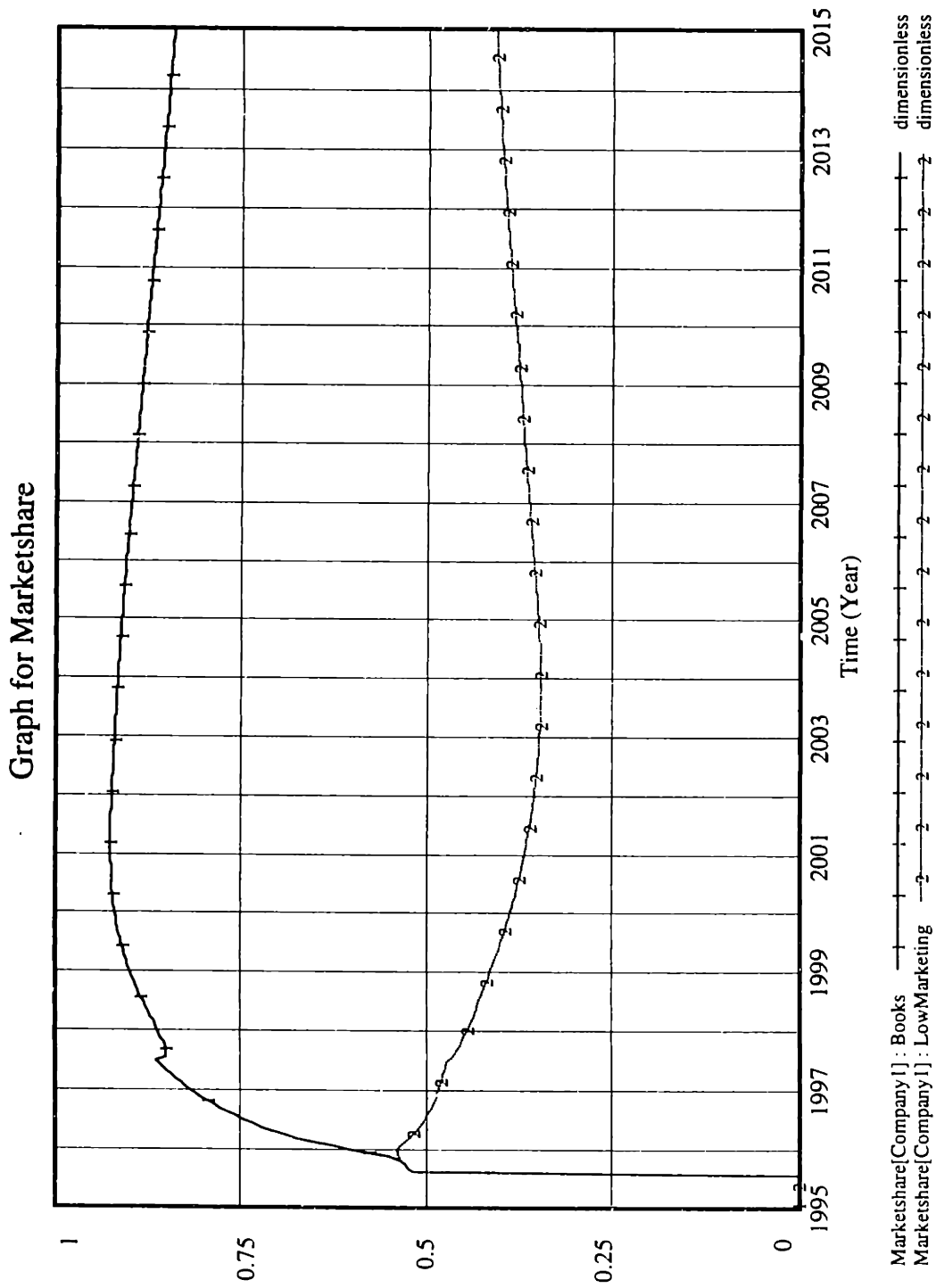
If the warehouse performance of Company 1 is reduced, it market share will suffer.

Figure 29 - Poor Warehousing



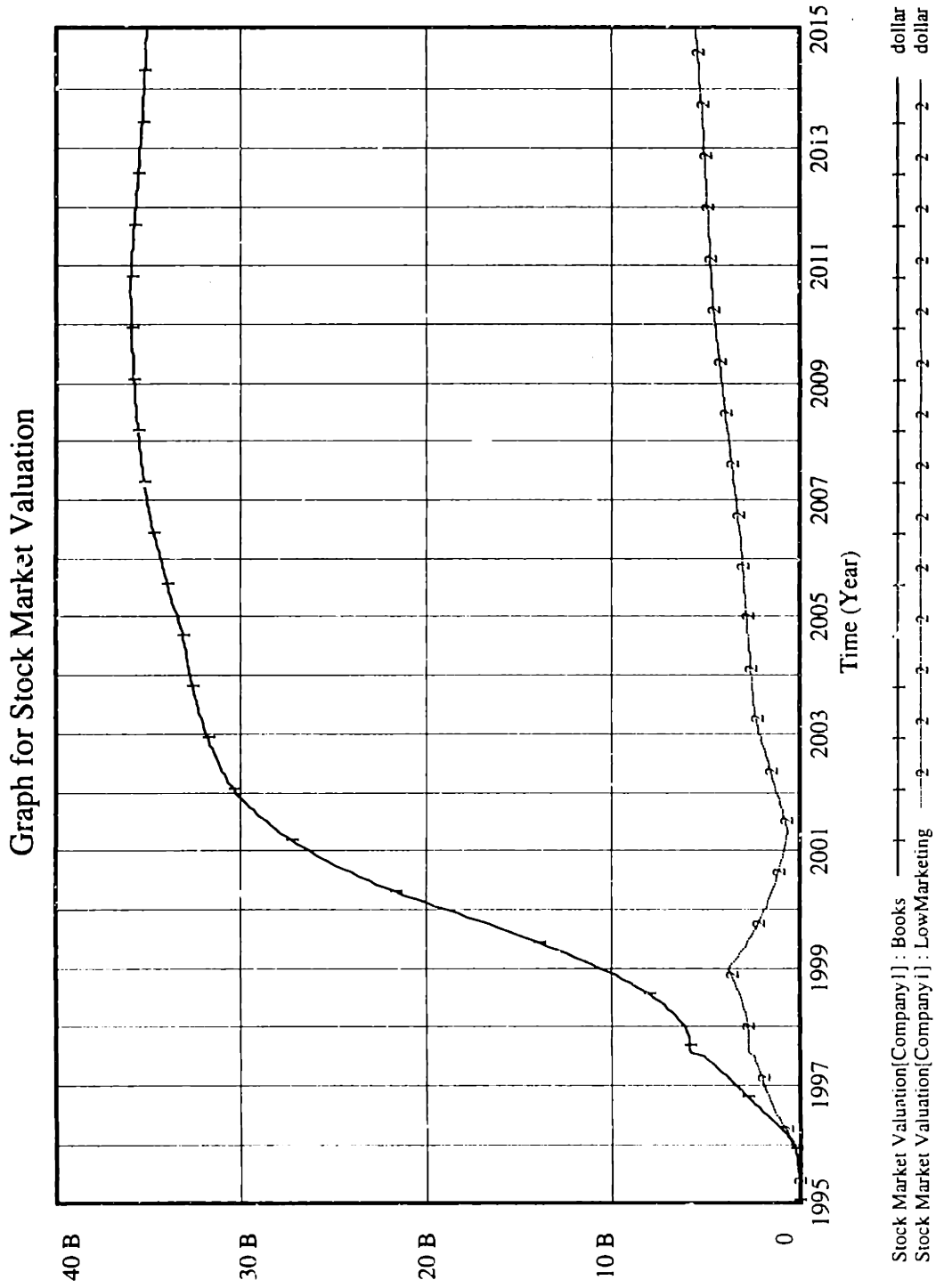
The reduced warehousing leads to small savings in the short term, but huge reduction in profits in the long term. Note: the fall in net income in 2005 is caused by the exhaustion of the tax-credit for prior losses.

Figure 30 - Low Marketing



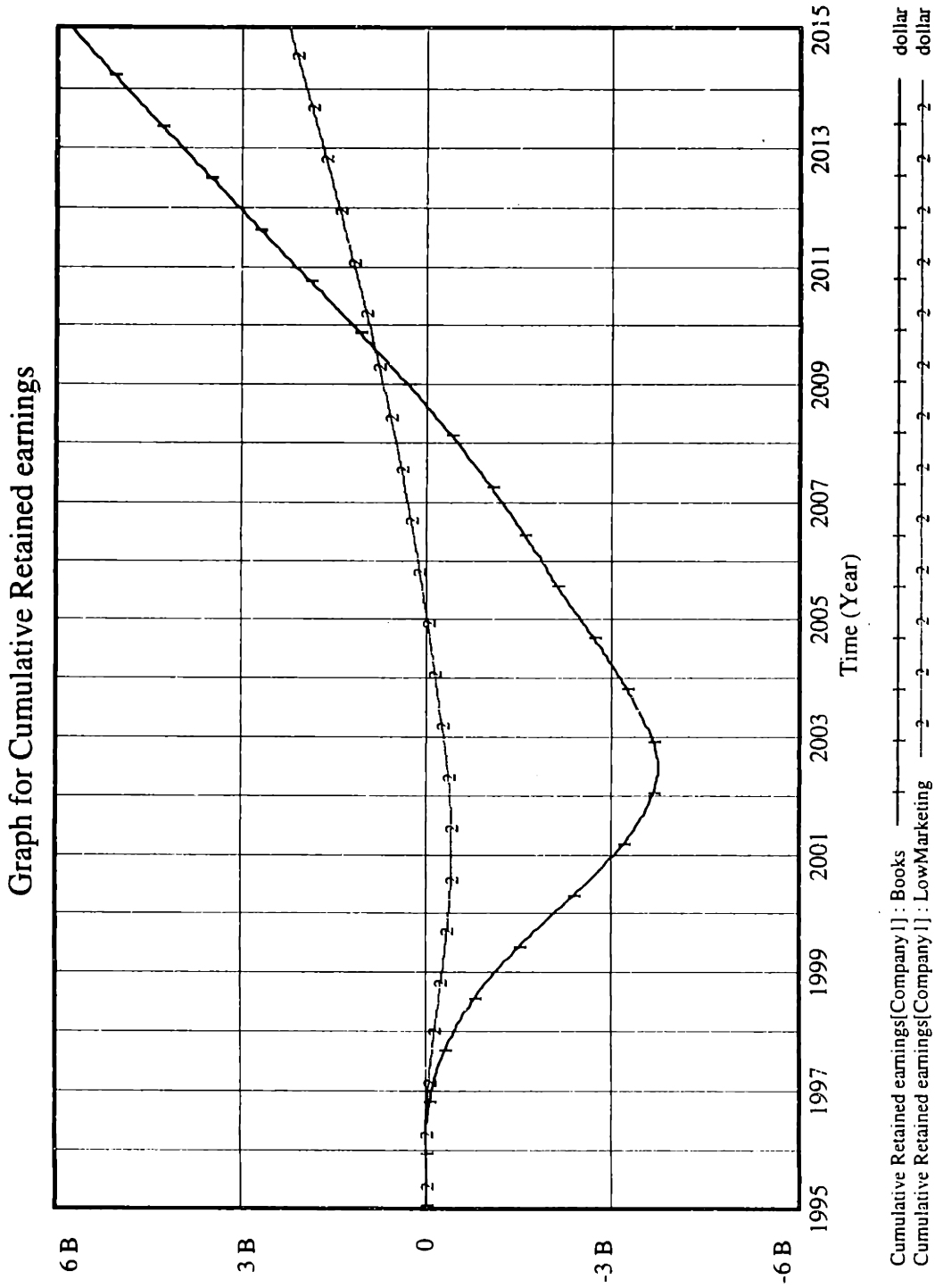
Reduced marketing spending results in a loss of market share.

Figure 31 - Low Marketing



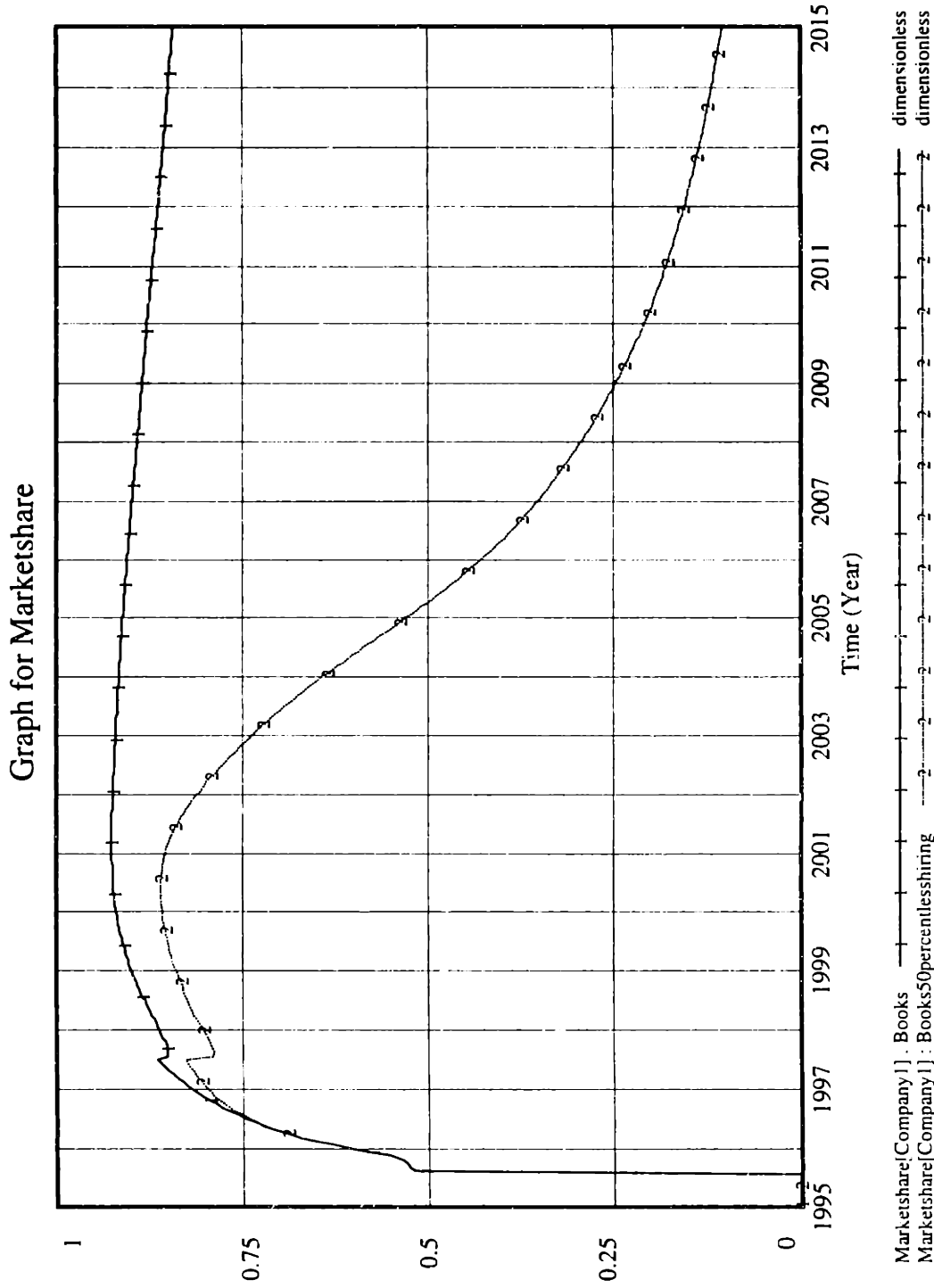
High Marketing spending is vastly superior as far as stock valuation is concerned.

Figure 32 - Low Marketing



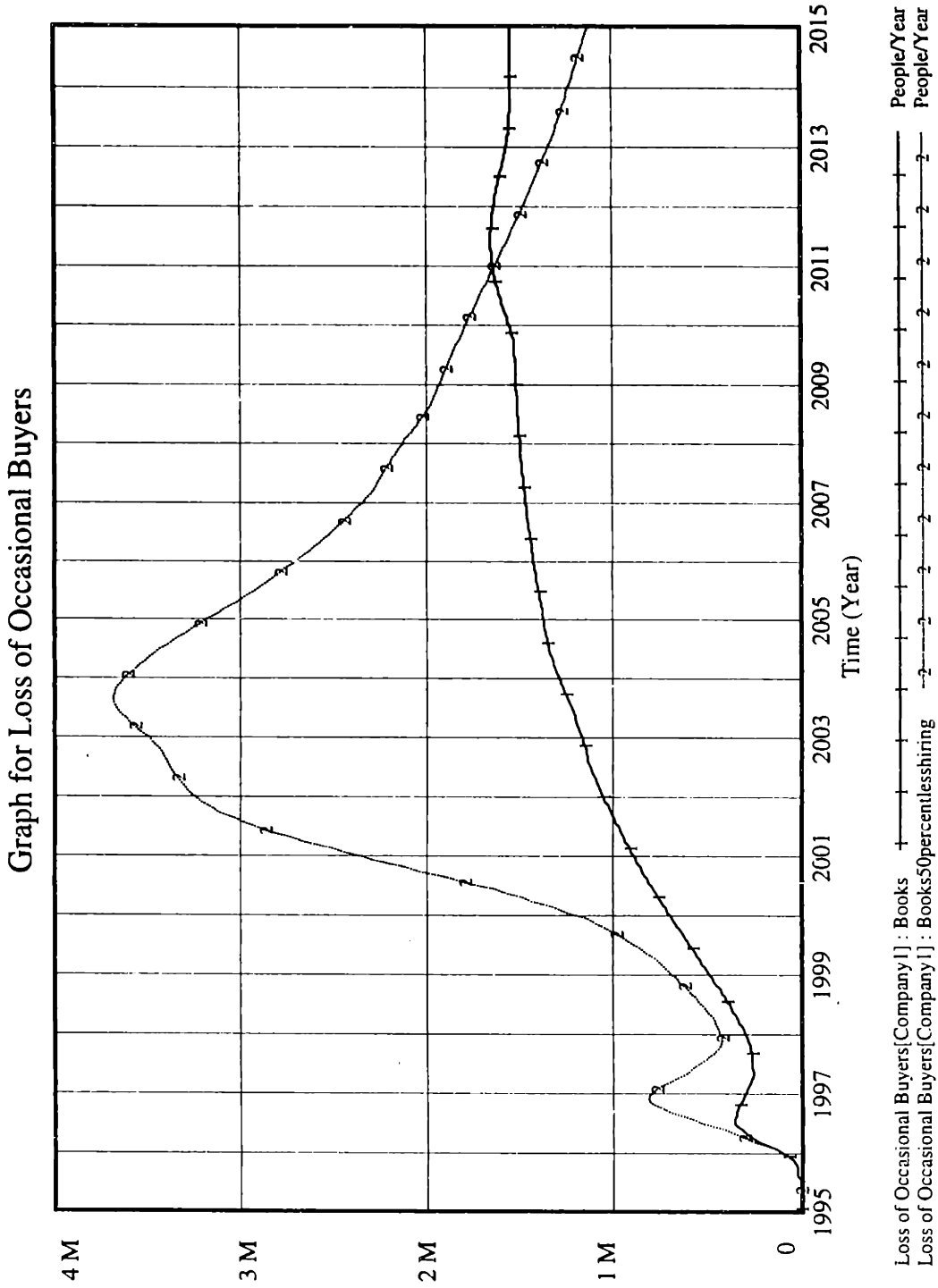
Retained earnings In the short-and-medium term, the low marketing strategy produces better retained earnings as it avoid a huge billion dollar investment upfront. Only in the long run does the high marketing spending pay of.

Figure 33 - 50% Hiring



The aggressive early-mover (Company 1) loses its dominant market position if hiring is neglected.

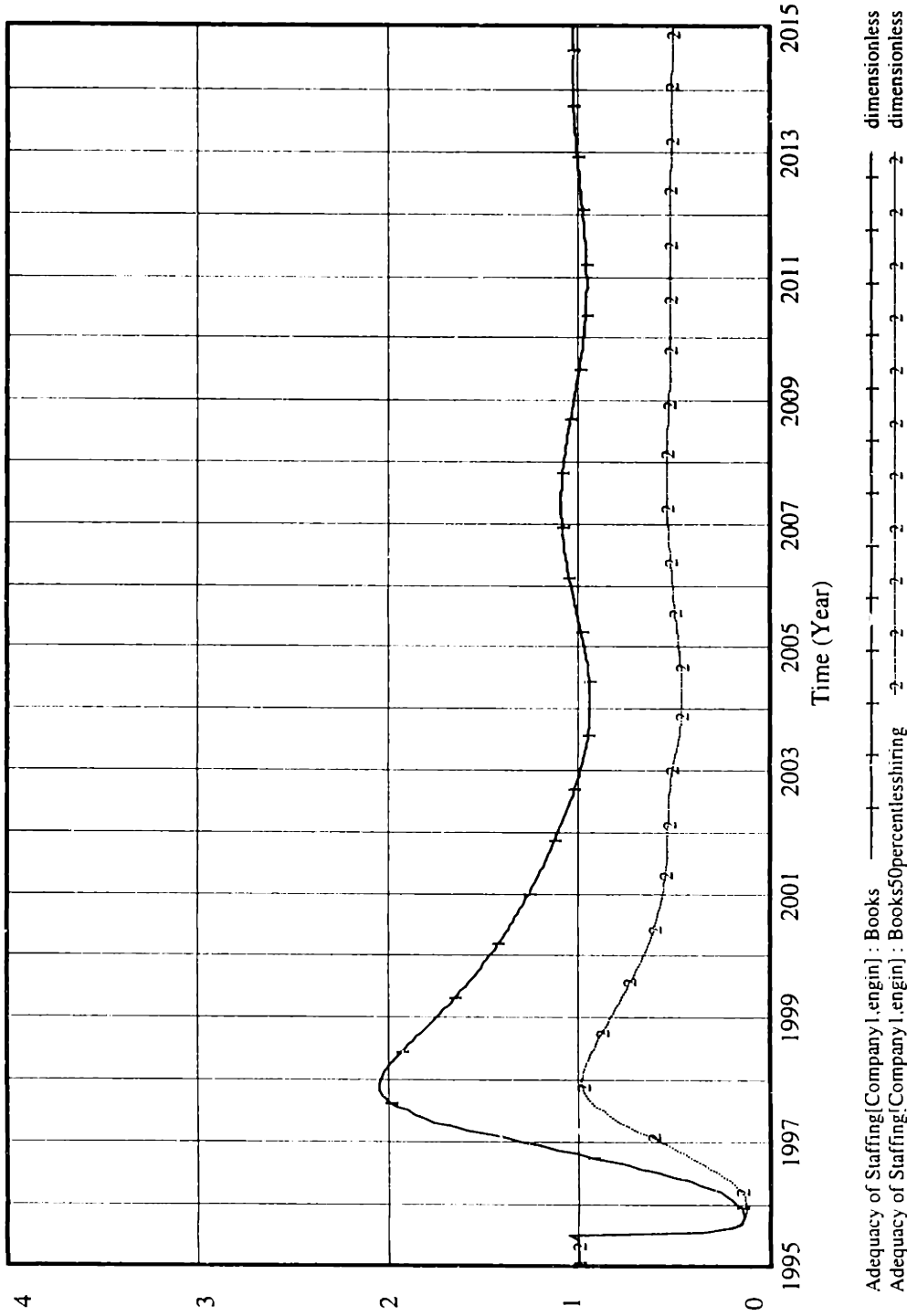
Figure 34 - 50% Hiring



The impact of reduced hiring is most visible in the area of turnovers. Millions of customers, just acquired at immense costs are lost due to poor performance.

Figure 35 - 50% Hiring

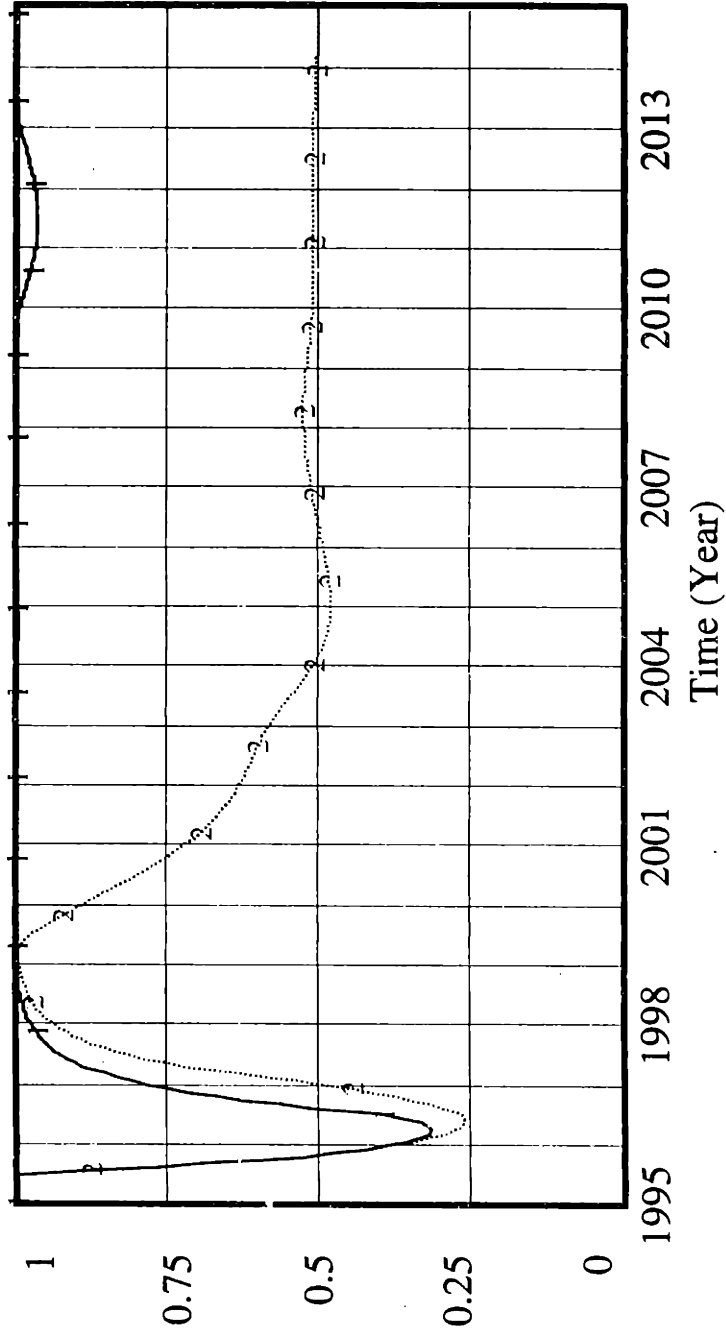
Graph for Adequacy of Staffing



Reduced hiring leads to permanent understaffing of engineers.

Figure 36 - 50% Hiring

Graph for Perceived Site Performance

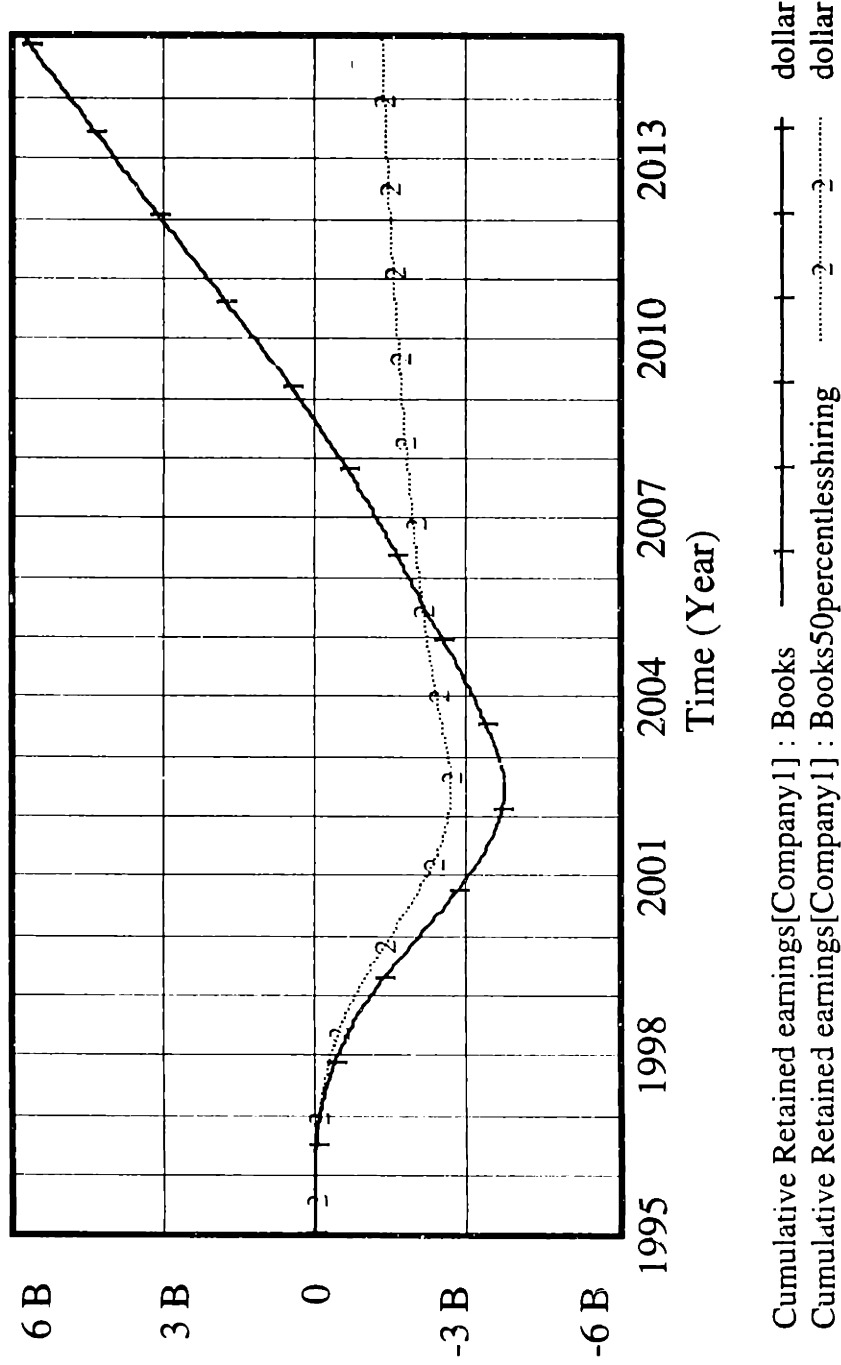


Perceived Site Performance[Company1] : Books dimensionless
 Perceived Site Performance[Company1] : Books50percentless hiring dimensionless

Without adequate staffing, Site performance falls significantly.

Figure 37 - 50% Hiring

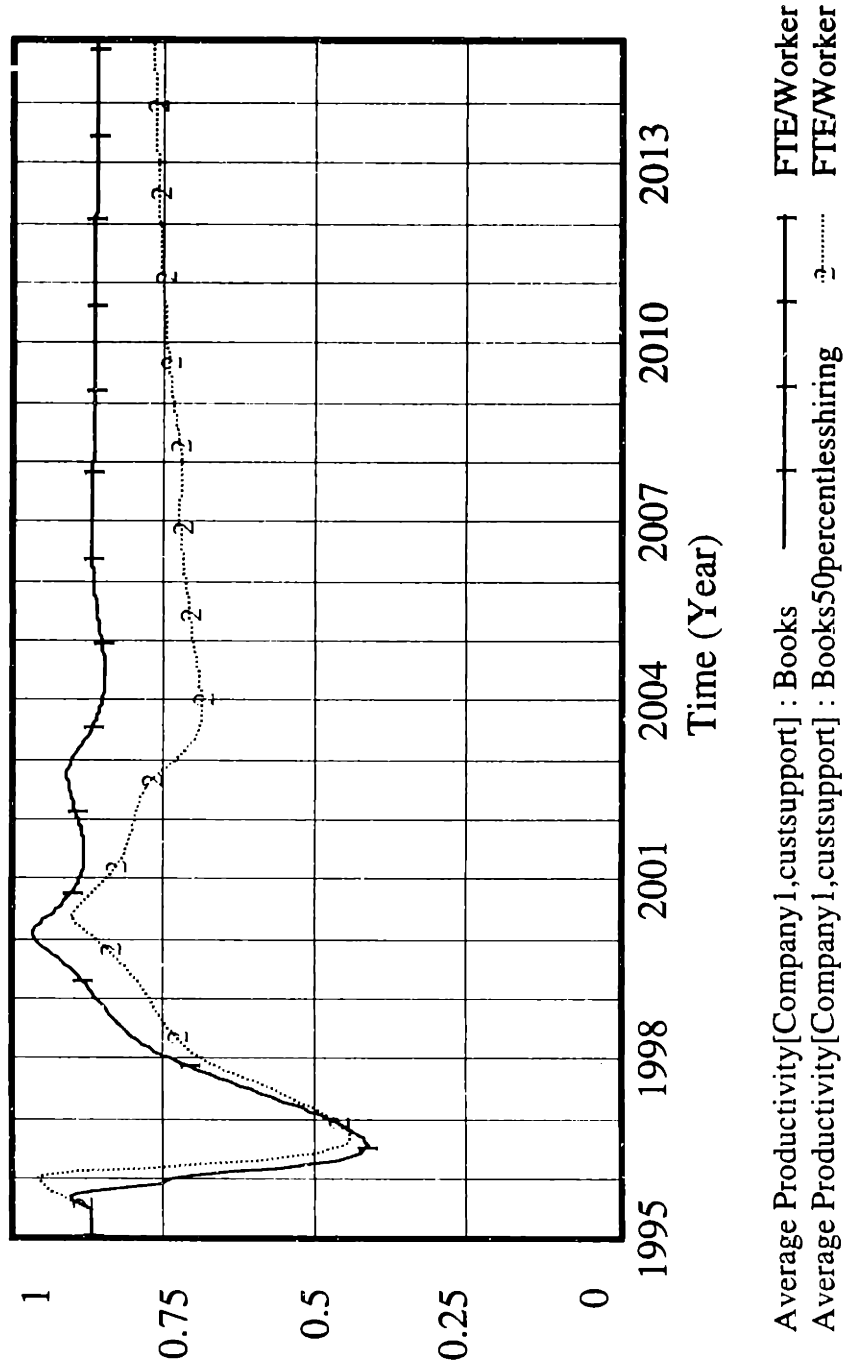
Graph for Cumulative Retained earnings



In the short-run, the savings through understaffing appear to outweigh the damage done, but in the long run the company fails to achieve profitability.

Figure 38 - 50% Hiring

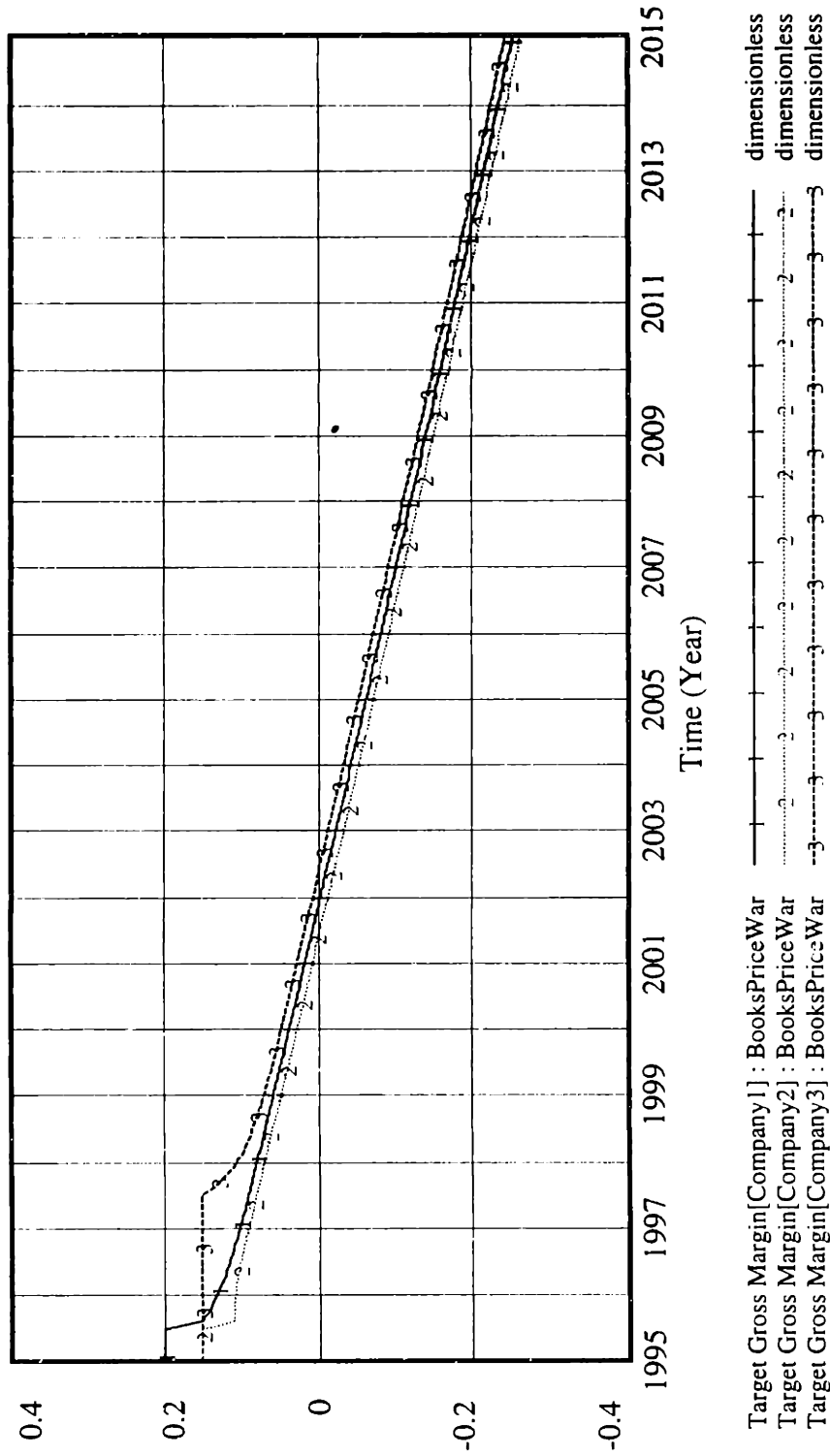
Graph for Average Productivity



The high turnover leads to a reduction in average profitability that further aggravates the personnel shortage.

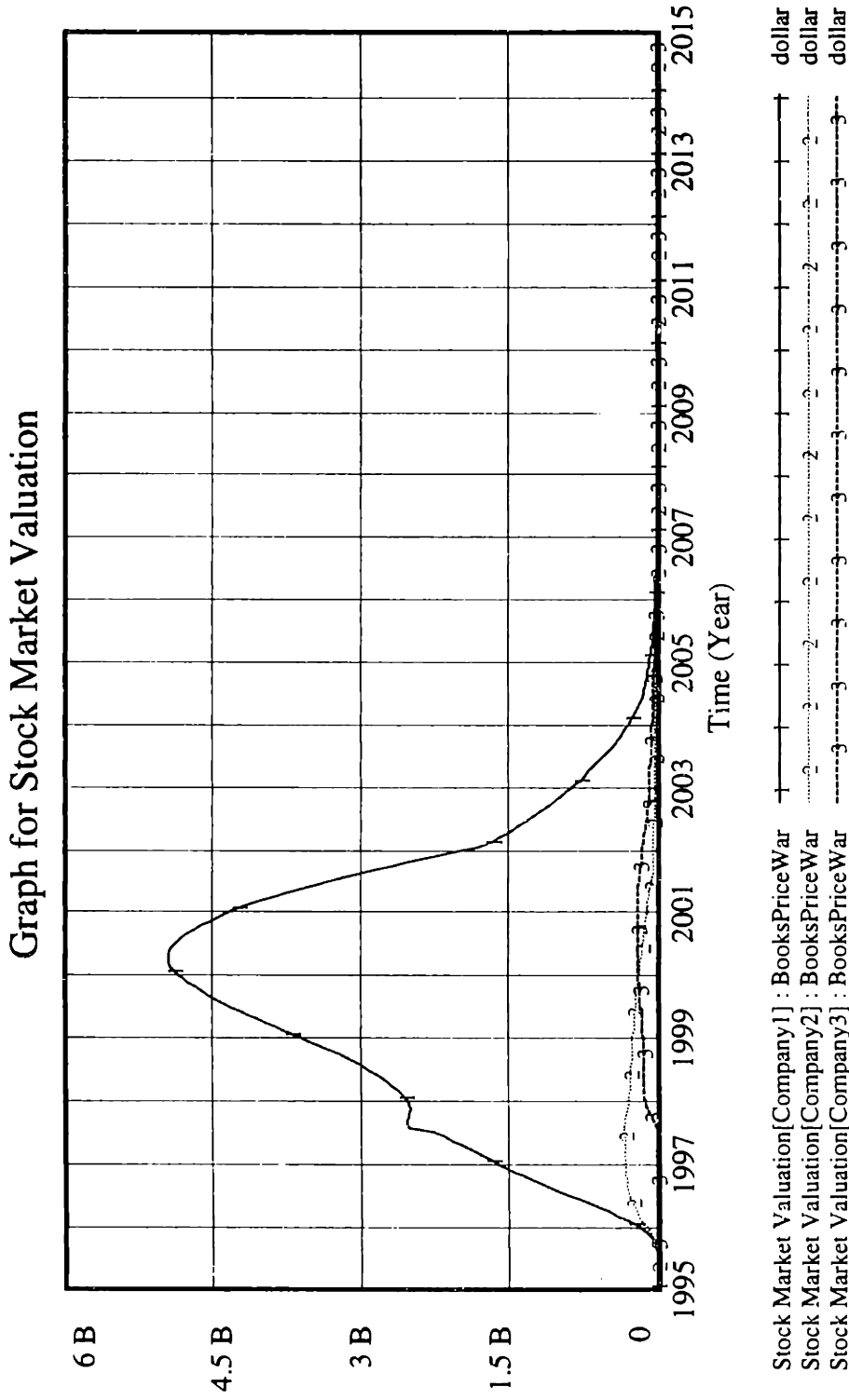
Figure 39 - Price War

Graph for Target Gross Margin



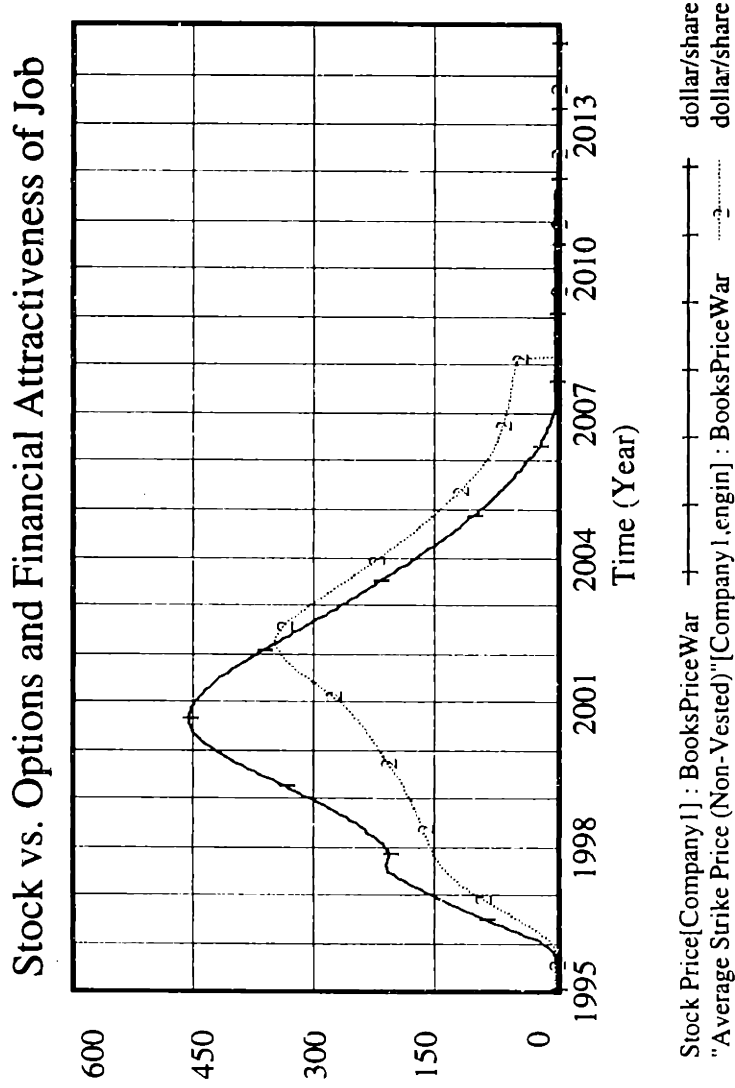
This graph shows how the competitors drive down gross margin in this scenario.

Figure 40 - Price War



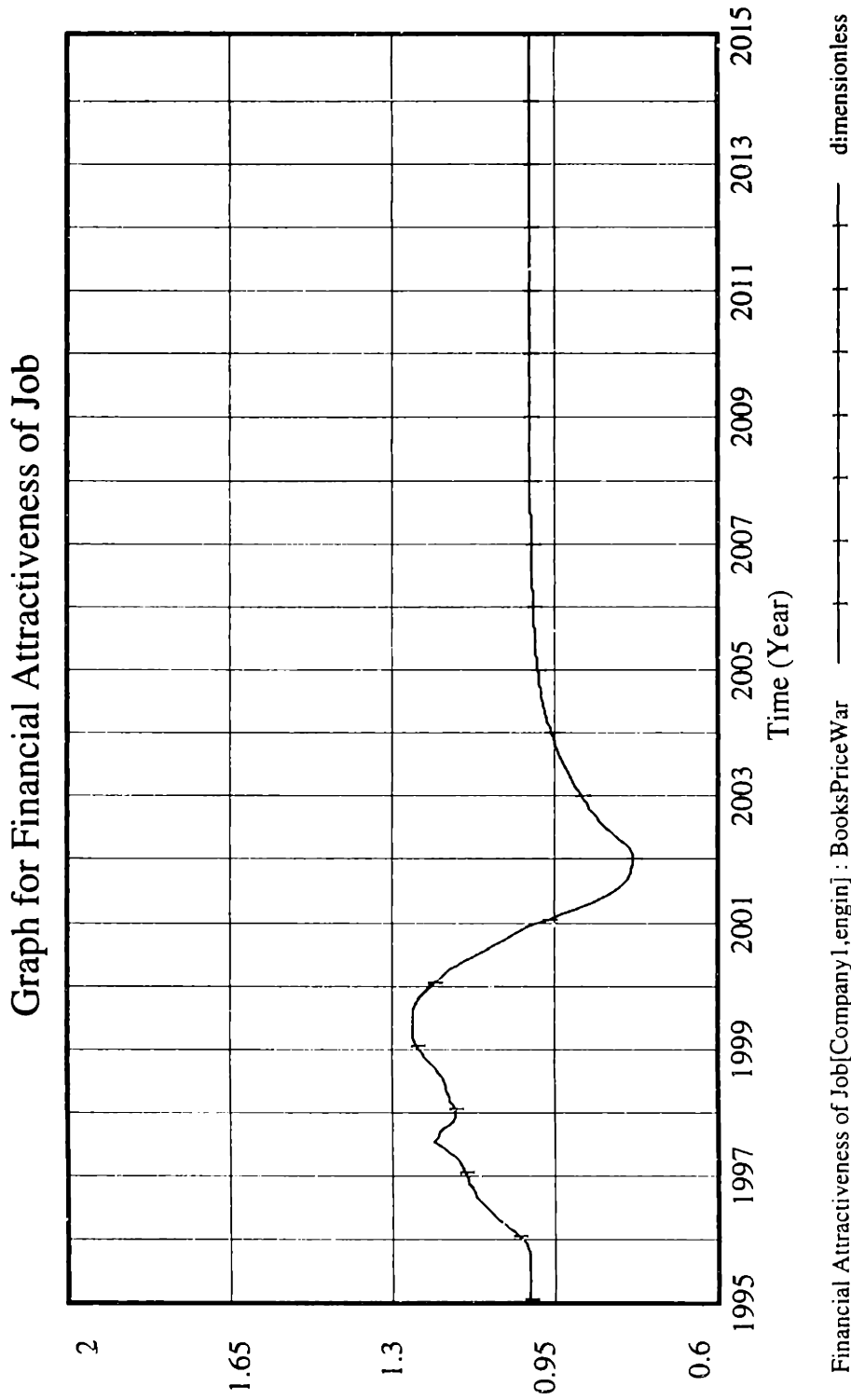
In the end, everybody loses as the financial markets stop supporting these loss-making companies. One company temporarily attracts a lot of investment, though as a level significantly lower than without the price war.

Figure 41 - Price War



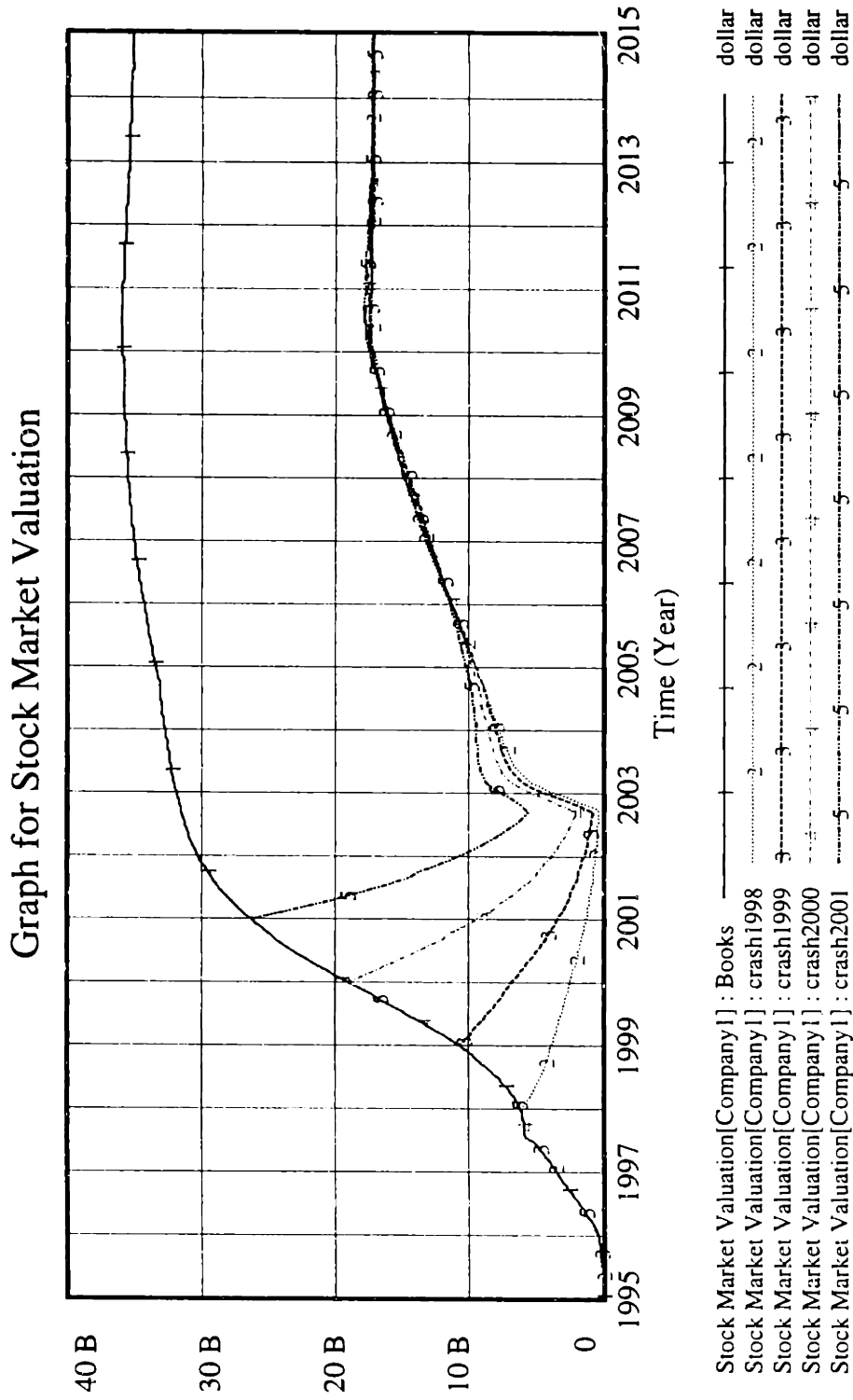
The average option strike price trails the stock price with a delay. If the stock price is higher, employees are happy and loyal. If the stock price falls the option price, employees are increasingly likely to jump ship..

Figure 42 - Price War



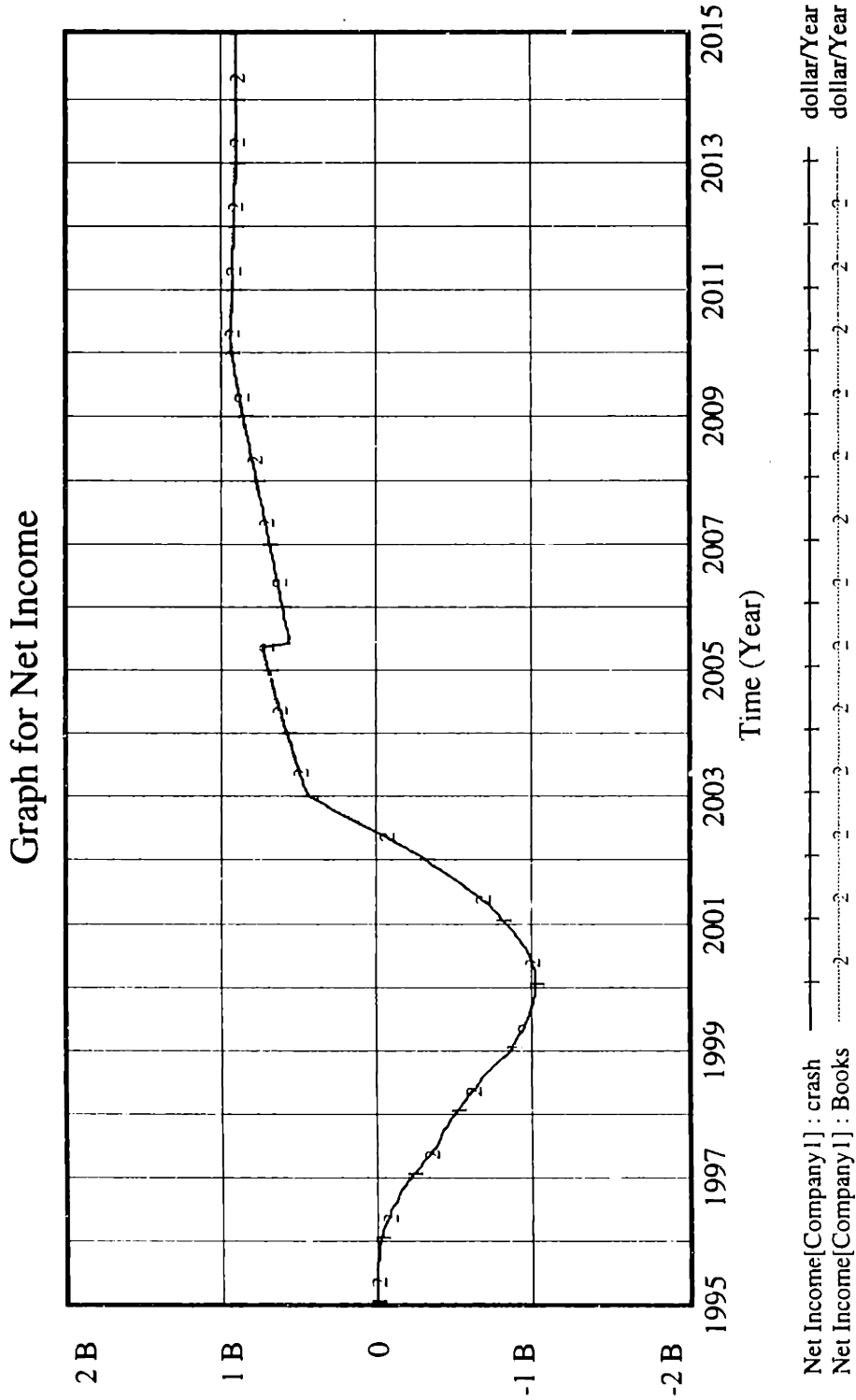
This is the impact of the stock and option performance (Figure 40) on financial attractiveness of the job..

Figure 43 - Stock Crash



This graph shows the impact of changing the stock valuation from Internet-style to traditional methods at different points in time between 1998 and 2001.

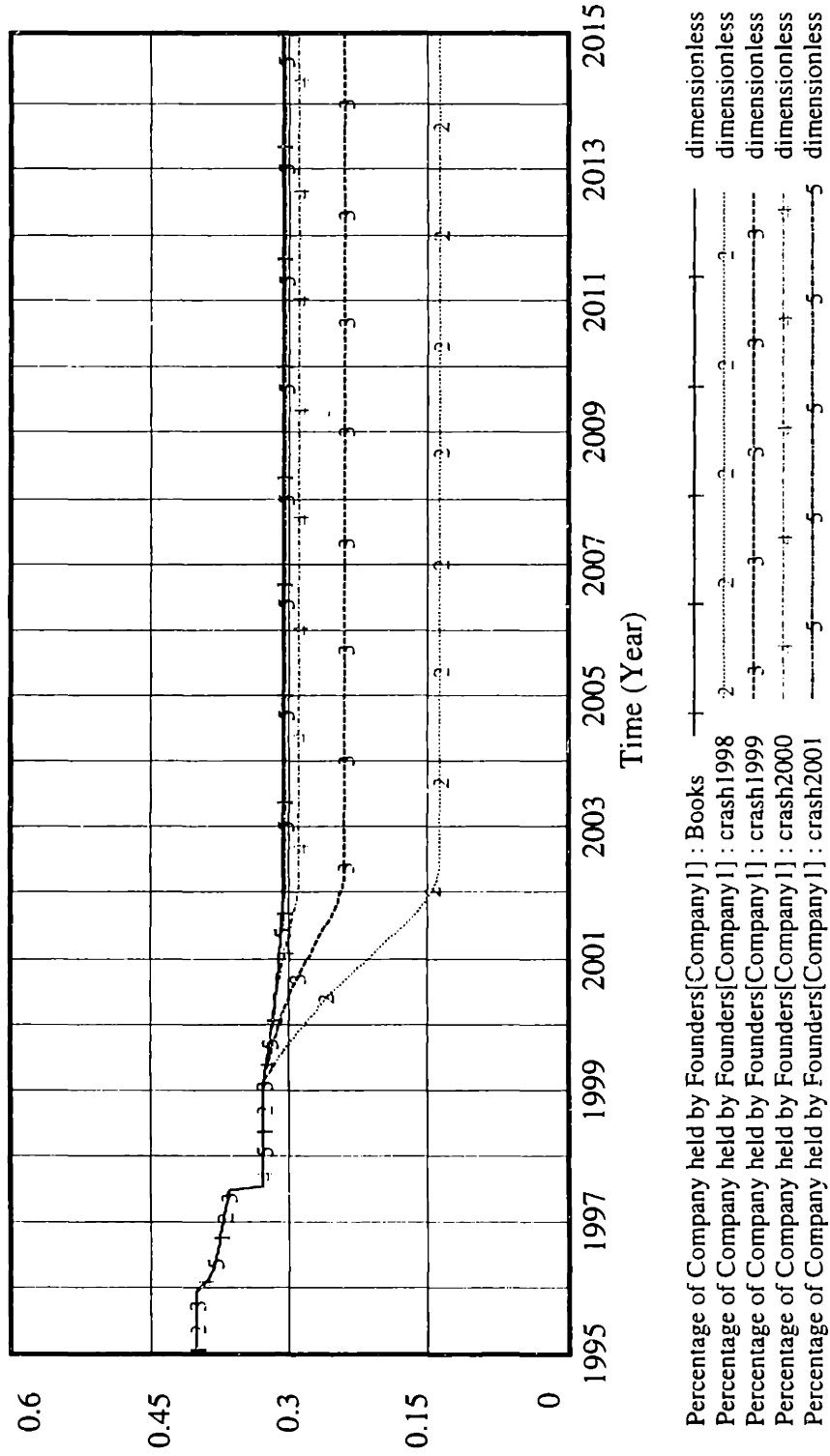
Figure 44 - Stock Crash



Company 1 survives the crash by turning profitable in 2002. The kink in income in 2005 is due to the exhaustion of the tax-shield created by prior losses.

Figure 45 - Stock Crash

Graph for Percentage of Company held by Founders



Even with company survival, the crash has a significant impact on company ownership by the founders. The earlier the crash, the higher the percentage of the company that founders had to give up to finance the losses.

Appendix B – Documentation of the Dot Com Model

The Dot Com 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 Dot Com Model allows the creation of multiple scenarios by changing the size of the potential market and the number of companies.

B.1 Calibration Module

This module was used to calibrate the model. It translates the model output in formats more commonly used by management.

(002) Acquisition Costs per Customer[company] =
ZIDZ (Total Marketing Spending[company] , New Loyal Users[company])
Units: dollar/People

This variable is used only for calibration of the model. It calculates the Acquisition cost per customer as a performance benchmark.

(003) Cost per customer Contact[company] =
ZIDZ (Customer Support Salary Cost[company] , Customer Contacts[company])
Units: dollar/contact

This variable is only used for calibration of the model. Pureplay Retailer incur average costs of \$6 per customer contact. Multichannel retailers with existing call centers and experienced staff only incur \$1.70 per call. ((If replaced by email - \$3.80 for manual, \$0.25 for automated execution)). (Shop.org)

(004) Cost per Pageview[company] =
ZIDZ (Engineering Salary Costs[company] + Server Infrastructure Investment[company] , Number of Pageviews[company])
Units: dollar/pageview

This variable is only used for calibration of the model. It tracks the cost per pageview.

(005) Customer Contacts[company] =
Number of Transactions[company] * Customer Contacts per transaction
Units: contact/Year
This variable measures the number of customer contacts with the company.

(006) Customer Support Salary Cost[company] =
(Experienced Employees[company,custsupport]
* Salary for Experienced[company,custsupport]
+ Rookie Employees[company,custsupport]
* Salary for Rookie[company,custsupport])
* Company in Operation Switch[company]
Units: dollar/Year
This calculates all costs for salaries for Customer Support personnel.

(007) Engineering Salary Costs[company] =
(Experienced Employees[company,engin]
* Salary for Experienced[company,engin]
+ Rookie Employees[company,engin]
* Salary for Rookie[company,engin])
* Company in Operation Switch[company]
Units: dollar/Year
This variable calculates the total salary expense for engineering employees.

(008) Experienced Employees[company,department] =
INTEG(Assimilation Rate[company,department]
- Experienced Quit Rate[company,department] ,
Initial Experienced Employees[company,department])
Units: Worker
There are two types of employees in this model. Rookies are less experienced and therefore less productive than experienced Employees.

(009) Inventory Costs[company] =
Product Selection[company]
* Inventory Costs per SKU
+ Real Estate Depreciation[company]
+ Warehouse Maintenance Costs[company]
* Company in Operation Switch[company]
Units: dollar/Year
The inventory costs depend on the number of SKUs and the warehouse space.

- (010) "M & S as Percentage of Sales"[company] =
 ZIDZ (Marketing and Sales[company] , Sales revenue[company])
 Units: dimensionless
 The variable is used only for calibration purposes. Historical Data: Amazon 24.2% (Q1-Q3 1999), 21.8% (1998), 27.4% (1997) and 38.7% (1996). B&N: 56.5% in Q1-Q3 1999, 113.9% in 1998, 74.1% in 1997.
- (011) Marketing and Sales[company] =
 Inventory Costs[company] + Total Marketing Spending[company]
 + Customer Support Salary Cost[company]
 Units: dollar/Year
 This variable is only used for calibration of the model. It aggregates various costs in order to calculate some performance ratios.
- (012) New Loyal Users[company] =
 Capture of High Volume Buyers[company]
 + Capture of Occasional Buyers[company]
 + First Time Buying[company]
 Units: People/Year
 This variable is used for calibration purposes only. It aggregates all new users acquired by a company.
- (013) ProdDev as Percentage of Sales[company] =
 ZIDZ (Product Development[company] , Sales revenue[company])
 Units: dimensionless
 This variable is only used for calibration of the model. Historical Data: Amazon: 12.5% (Q1-Q3 1999), 7.7% (1998), 9.4% (1997) and 15.2% (1996). B&N: 10.6% in Q1 1999, 13.8% in 1998 and 27.2% in 1997.
- (014) Product Development[company] =
 Engineering Salary Costs[company] + Total Editorial Cost[company]
 + Server Infrastructure Investment[company]
 Units: dollar/Year
 This variable is used for calibration purposes only. It measures all costs associated with product development in order to calculate some performance ratios.

B.2. Control - Simulation Control Parameters

- (016) FINAL TIME = 2015
 Units: Year
 The final time for the simulation.

(017) INITIAL TIME = 1995
Units: Year
The initial time for the simulation.

(018) SAVEPER =
TIME STEP
Units: Year
The frequency with which output is stored.

B.3. Dotcommodel – General

(020) company : Company1,Company2,Company3
The model tracks three competing companies.

(021) department : engin,custsupport
The model keeps track of two different groups of employees - engineering and customer support. Engineering comprises all management and programming and site maintenance personnel. Customer support comprises both the people dealing with fulfillment as well as with customer service.

B.4. 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 the *Site Operations Module*), *salary expenses* (from the *Human Resources Module*), *number of transactions and average order size* (from the *User Flows Module*) and *proceeds from the sale of equity* (from the *Fundraising Module*). 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.

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 the Financial Accounting Module is used as input for decisions in the Human Resources Module and the Site Operations Module. The Site Operations Module also uses the current revenue figure. The current burn rate is an input to the Fundraising Module. See section 5.6 for more details.

$$(023) \quad \text{Accounts Payable[company]} = \text{INTEG}(\text{Accounts Payable Increases[company]} - \text{Payments on Accts Payable[company]}, 0)$$

Units: dollar

This stock keeps track of accounts payable. In this model, accounts payable are paid consistently based on the normal payment time. There is no liquidity management.

$$(024) \quad \text{Accounts Payable Increases[company]} = \text{Cost of Goods Sold[company]} + \text{Adjusted Operating Expenses[company]} + \text{Actual Tax Payment[company]}$$

Units: dollar/Year

All expenses accumulate in the accounts payable until they are paid.

$$(025) \quad \text{Actual Tax Payment[company]} = \text{MAX}(0, \text{Indicated Tax Payments[company]} - \text{Payment out of Tax Credit[company]})$$

Units: dollars/Year

This variable expresses tax liabilities that the company has to pay in cash as opposed to costs that are paid out of an accumulated tax credit.

$$(026) \quad \text{Adjusted Operating Expenses[company]} = \text{Operating expenses[company]} - \text{Server Depreciation[company]} + \text{Server Infrastructure Investment[company]} - \text{Real Estate Depreciation[company]} + \text{Real Estate Infrastructure Spending[company]}$$

Units: dollars/Year

Operation Expenses are adjusted to account for differences in accounting for investments and depreciation, depending on whether Cash Flows or the Income statement are concerned.

$$(027) \quad \text{Annual Transactions per High Volume Buyer} = 6$$

Units: transactions/(Year*People)

It is assumed that high-volume buyers account for six transactions per year.

- (028) Annual Transactions per Occasional Buyer = 2
 Units: transactions/(Year*People)
 It is assumed that occasional buyers account for two transactions per year.
- (029) Balance Sheet error[company] =
 Total Assets[company] - Total Liability and Equity[company]
 Units: dollar
 This is a control variable that tests the basic accounting rule that Total assets must equal total liabilities plus equity.
- (030) Cash In[company] =
 Payments received[company] + Proceeds from Sale of Equity[company]
 Units: dollar/Year
 The flow captures all cash inflows.
- (031) Cash Out[company] =
 Payments on Accts Payable[company]
 Units: dollar/Year
 This flow captures all cash outflows.
- (032) Company in Operation Switch[company] =
 IF THEN ELSE (Time >= Starting Date[company] , 1, 0)
 Units: dimensionless
 This switch is used to decide whether a given company has already begun its operations.
- (033) Cost of Goods Sold[company] =
 Sales revenue[company] * (1- Gross Profit Margin[company])
 Units: dollar/Year
 The costs of goods sold is calculated based on the Revenue minus the Gross profit margin.
- (034) Cumulative Retained earnings[company] =
 INTEG(Retained Period Earnings[company] , 0)
 Units: dollar
 This variable measures the Retained Earnings for the company.
- (035) Current Liabilities[company] =
 Accounts Payable[company]
 Units: dollar
 The current liabilities are equal to the account payable as the model does not include longterm debt.

- (036) **Current Operating Costs[company] =**
Total Marketing Spending[company] + Cost of Goods Sold[company]
+ Server Infrastructure Investment[company] + Editorial Budget[company]
+ Salary Expense[company] + Inventory Costs[company]
Units: dollar/Year
 The current operating costs of the company are tracked by this variable.
- (037) **Decrease in Tax Credit[company] =**
Tax Credit[company] * Loss of Tax Credit - Payment out of Tax Credit[company]
Units: dollar/Year
 The Tax credit decreases either through expiration or through usage.
- (038) **Effect of Sales Revenue on Overhead percentage (**
[(0,0)-(6e+010,0.06)],(0,0.06),(6.34441e+008,0.0510526),(1.8429e+009,0.0426316)
,(3.05136e+009,0.0357895),(6.73716e+009,0.0252632),(1e+010,0.0225)
,(5e+010,0.02))
Units: dimensionless
 Overhead expenses are calculated as a percentage of revenue. The percentage is assumed to decline with increasing revenue.
- (039) **Equity[company] =**
Cumulative Retained earnings[company] + Paid in Capital[company]
Units: dollar
 This variable tracks total equity as part of the simulated balance sheet.
- (040) **"General & Administrative"[company] =**
Sales revenue[company] * Overhead as Percentage of Sales Revenue[company]
Units: dollar/Year
 This calculates overhead expenses for the companies based on a percentage of sales.
- (041) **Gross Profit Margin[company] =**
Target Gross Margin[company]
Units: dimensionless
 The Gross profit margin is determined by the target gross margin.
- (042) **Increase in Tax Credit[company] =**
MIN (0, Indicated Tax Payments[company])
Units: dollar/Year
 If the company makes losses, it creates a tax credit that it can carry forward.

(043) Indicated Tax Payments[company] =
Taxable Income[company] * Tax Assessment
Units: dollar/Year

The indicated tax payments are the product of taxable income and the tax rate.

(044) Initial Funding[company] =
PULSE (Starting Date[company] , TIME STEP) * Initial Cash[company] / TIME STEP
Units: dollars/Year

The initial funding represents the amount of cash made available to the company at its start date.

(045) Inventory Costs per SKU = 0.1
Units: dollar/(Year*SKU)

The Inventory costs are assumed to be 10 Cents per SKU/year.

(046) Loss of Tax Credit = 0.2
Units: 1/Year

The company loses its Tax Credit if it does not pay taxes within 5 years. (This formulation is admittedly imprecise.)

(047) Net Change in Accounts Payable[company] =
Accounts Payable Increases[company] - Payments on Accts Payable[company]
Units: dollar/Year

This variable measures the net change in Accounts payable by comparing the inflow and the outflow.

(048) Normal Payment Time = 0.25
Units: years

This parameter measures the normal time until accounts payable are settled. It is assumed to be 3 months.

(049) Number of Shares Held by Founders[company] =
Initial Fraction of Founder OwnerShip[company]
* Initial Number of Shares Outstanding[company]
Units: shares

This stock tracks the amount of shares held by the founders.

(050) Operating expenses[company] =
Total Editorial Cost[company] + Inventory Costs[company] + Salary Expense[company]
+ Server Depreciation[company] + Total Marketing Spending[company]
Units: dollar/Year

The operating expenses are the sum of all expenses except taxes.

- (051) Overhead as Percentage of Sales Revenue[company] =
 Effect of Sales Revenue on Overhead percentage (Sales revenue[company])
 Units: dimensionless
 G&A is calculated as a percentage of revenue. Reference Data:
 Amazon 4.6% (Q1-Q3 1999), 2.6% (1998), 4.7% (1997), 9% (1996).
 B&N: 17.8% in Q1-Q3 1999, 31% (1998) 27.4% (1997)
- (052) Paid in Capital[company] =
 INTEG(Sale of Equity[company] , 0)
 Units: dollar
 This variable tracks paid in capital raised through sale of equity.
- (053) Payment out of Tax Credit[company] =
 IF THEN ELSE (Indicated Tax Payments[company] > 0,
 IF THEN ELSE (- Tax Credit[company]/ TIME STEP
 > Indicated Tax Payments[company] , Indicated Tax Payments[company] ,
 - Tax Credit[company] / TIME STEP) , 0)
 Units: dollar/Year
 If the company has generated a tax-credit through prior losses,
 it can use this credit to offset its tax liabilities.
- (054) Payments on Accts Payable[company] =
 Required Payments on Payables[company]
 Units: dollar/Year
 Payments on Accounts payable are driven by the amounts due.
- (055) Payments received[company] =
 Sales revenue[company]
 Units: dollar/Year
 The company is assumed to instantaneously receive all amounts due to it.
- (056) Percentage of Company held by Founders[company] =
 Number of Shares Held by Founders[company] / Shares Outstanding[company]
 Units: dimensionless
 The percentage of Company held by the founders is determined by their number of shares and the (increasing) number of shares outstanding.
- (057) Percentage of Independent Business Captured by Company[company] =
 First Time Acquisition Fraction[company]
 Units: dimensionless
 The business generated by independent buyers is allocated based on the First-Time Acquisition fraction.

(058) $\text{Proceeds from Sale of Equity[company]} =$
 $(\text{New Shares Issued[company]} + \text{IPO Shares[company]}) * \text{Stock Price[company]}$
Units: dollar/Year

This represents the money raised through the sale of equity.

(059) $\text{Product Selection[company]} =$
 $\text{INTEG}(\text{Change in product selection[company]} ,$
 $\text{Initial Product selection[company]})$

Units: SKUs

The amount of products offered by the online retailer.

Reference: Amazon reached 2.5 M books on March 17, 1997 (HBS case) and 4.5 M titles in late 1999 (Gomez advisors).

(060) $\text{Real Estate Depreciation[company]} =$
 $\text{Real Estate Infrastructure[company]} * \text{Real Estate depreciation Rate}$
Units: dollar/Year

The Real Estate is depreciated over 10 years.

(061) $\text{Required Payments on Payables[company]} =$
 $\text{Accounts Payable[company]} / \text{Normal Payment Time}$
Units: dollar/Year

This measures the amount of accounts payable that need to be settled based on normal payment conventions.

(062) $\text{Retained Period Earnings[company]} =$
 $\text{Net Income[company]}$
Units: dollar/Year

This formula calculated the Retain Earnings coming from both operations and fundraising.

(063) $\text{Salary Expense[company]} =$
 $(\text{Customer Support Salary Cost[company]}$
 $+ \text{Engineering Salary Costs[company]}$
 $+ \text{"General \& Administrative"[company]})$
 $* \text{Company in Operation Switch[company]}$

Units: dollar/Year

This calculates all salary expenses of the company.

(064) $\text{Salary for Experienced[company,engin]} = 250000$
 $\text{Salary for Experienced[company,custsupport]} = 125000$
Units: dollar/(Year*Worker)

The salaries for engineers are assumed to be higher than for customer support people.

- (065) Salary for Rookie[company,engin] = 80000
 Salary for Rookie[company,custsupport] = 40000
 Units: dollar/(Year*Worker)
 The salaries for engineers are assumed to be higher than for customer support people.
- (066) Sale of Equity[company] =
 Proceeds from Sale of Equity[company] + Initial Funding[company]
 + Server Infrastructure at Beginning of Operations[company]
 Units: dollar/Year
 The Inflow to the Sale of equity is determined by the initial funding and other money raised.
- (067) Sales revenue[company] =
 Average Order Size[company] * Number of Transactions[company]
 Units: dollar/Year
 Historical Data: Amazon: \$964 M (Q1-Q3 1999), \$610 M (1998), \$148 M (1997) and \$16 M (1996). B&N: \$120 M (Q1-Q3 1999), \$48 M (1998), \$12 M (1997)
- (068) Server Depreciation[company] =
 Server Infrastructure[company] * Server Depreciation Rate
 Units: dollar/Year
 The Server Infrastructure is affected by depreciation.
- (069) Tax Assessment = 0.25
 Units: dimensionless
 The tax rate for the company is assumed to be 25 percent.
- (070) Tax Credit[company] =
 INTEG(Increase in Tax Credit[company] - Decrease in Tax Credit[company] , 0)
 Units: dollar
 If the company makes losses, it acquires a certain tax credit that it can carry forward to offset future tax liabilities.
- (071) Taxable Income[company] =
 Operating Income[company]
 Units: dollar/Year
 All operating income is assumed taxable.
- (072) Total Assets[company] =
 Server Infrastructure[company]+ Total Current Assets[company]
 + Real Estate Infrastructure[company]
 Units: dollar
 This accounting formula measures Total assets.

(073) Total Current Assets[company] =
Cash[company] + Value of Inventory[company]
Units: dollar

Total current assets are cash and value of the inventory (Note that there are no accounts receivable as all receivables are assumed to be received instantly).

(074) Total employed Capital[company] =
Equity[company]
Units: dollar

Total employed capital is equity. The model does not use long-term debt.

(075) Total Liabilities[company] =
Current Liabilities[company]
Units: dollar

This measures the total liabilities of the company. There is no long-term debt in this model.

(076) Total Liability and Equity[company] =
Equity[company] + Total Liabilities[company]
Units: dollar

This measures total liabilities plus equity.

(077) Total Marketing Spending[company] =
MAX (Minimum Marketing Spending[company] , Sales revenue[company]
* Target Percentage of Revenue Spend for Marketing[company])
* Company in Operation Switch[company]
Units: dollar/Year

The marketing spending increases brand equity.

(078) Value of Founder's Equity[company] =
Stock Price[company] * Number of Shares Held by Founders[company]
Units: dollar

The value of Founder's equity can be measured by multiplying the stock price with the shares held by the founders.

(079) Value of Inventory[company] = 0
Units: dollar

The company is not holding the inventory - it is assumed to be held by its suppliers until the transaction occurs.

(080) Warehouse Maintenance Costs[company] =
Maintenance Costs per SquareFoot[company] * Warehouse space[company]
Units: dollar/Year
Warehouse maintenance costs are assessed based on the size of
warehouses used.

B.5. Financial Markets 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 Dot Com Model contains a stock valuation model. The model initially incorporated a proven module for a traditional stock market valuation⁴⁸ 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.

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 Dot Com Model to changes in the *time to adjust worst case expectations* is explored in section 8.4.

The Dot Com 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 Dot Com Model can simulate the effect of a burst of the Internet-valuation bubble.⁴⁹ The impact of this structure is explored further in section 9.4.

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 *Financial Market Module* exports the *stock price* to the *Fundraising Module* and the *Human Resources Module*. See section 5.8 for more details.

$$(082) \quad \text{Actual Annual Growth in Revenue[company]} = \frac{\text{ZIDZ} ((\text{Sales revenue[company]} - \text{Expected Annual Sales Revenue[company]}) , (\text{Expected Annual Sales Revenue[company]} * \text{Revenue Averaging Time}))}{\text{Revenue Averaging Time}}$$

Units: dimensionless

This formulation calculates the annualized growth rate averaged over the revenue averaging time.

$$(083) \quad \text{Annualized Market yield} = 0.07$$

Units: 1/Year

This factor drives the discount rate.

⁴⁸ Based on Reppenning/Sterman, Unanticipated Side Effects of Successful Quality Programs: Technical Documentation, August 1994, Page 156ff.

⁴⁹ Anthony Perkins, Michael Perkins, The Internet Bubble, Harper Business, New York, 1999.

(084) Breakup Value of Company[company] =
Total Assets[company] - Total Liabilities[company]
Units: dollar

In case of a breakup, it is assumed that the company is valued at the Value of its assets minus its liabilities. This is the minimum value of the company.

(085) Change in Expected Annual Revenue[company] =
(Sales revenue[company] - Expected Annual Sales Revenue[company])
/ Revenue Averaging Time
Units: dollar/(Year*Year)

This variable adjusts the Expected Annual Revenue based on the difference between Expected and experienced Sales Revenue.

(086) Change in Expected Gross Margin[company] =
(Gross Margin[company] - Expected Annual Gross Margin[company])
/ Time to adjust Expected Gross Margin
Units: dollar/(Year*Year)

This variable adjusts the Expected Gross Margin based on the difference between Expected and experienced Gross Margin.

(087) Change in Expected Operating Income[company] =
(Operating Income[company] - Expected Annual Operating Income[company])
/ Time to adjust Expected Operational Income
Units: dollar/(Year*Year)

This flow drives the change in Expected Operating Income.

(088) Change in Minimum Margin Conceivable =
(Weighted Industry Average Margin - Minimum Steady State Margin Conceivable)
/ Time to adjust Worst Case Expectation * Company in Operation Switch[Company1]
Units: dimensionless/Year

This variable drives the adjustment of expectations for the minimum margin achievable.

(089) Change in Perceived Revenue Growth[company] =
(Actual Annual Growth in Revenue[company] - Perceived Growth in Revenue[company])
/ Revenue Growth Perception Delay
Units: dimensionless/Year

This variable drives the change in perceived growth rates based on the perception delay.

(090) Change in Steady State Growth Margin[company] =
((Minimum Steady State Margin Conceivable * Sales revenue[company]) - Expected Annual Gross Margin in Steady State[company]) / Time to adjust Expected Gross Margin
Units: dollar/(Year*Year)

This variable drives the adjustment of the assumed steady state margin based on an assumed delay for adjustment of this expectation.

(091) Change in Valuation =
Weight Of Internet Type Valuation * Rate of Change
Units: dimensionless/Year

This variable allows to change the type of stock valuation model (traditional vs. Internet) used in the model.

(092) Discount rate =
Annualized Market yield
Units: 1/Year

The discount rate is determined by the annualized market yield.

(093) Earnings per Share[company] =
Net Income[company]/ Shares Outstanding[company]
Units: dollar/(Year*shares)

The earnings per share are calculated by dividing Net Income by the number of shares outstanding.

(094) Effect of Marketshare on Valuation ([0,0)-(1,6)],(0,1),(1,1))

Units: dimensionless

The Market-Share Bonus formulation has been disabled for the runs presented in this paper.

(095) Effective Growth Value ([(-1,0)-(100,100)],(-1,0),(0,0),(0.05,0.006),(0.1,0.014),(0.15,0.035) ,(0.2,0.08),(0.25,0.13),(10,10),(100,100))

Units: dimensionless

This table determines the value given to growth rates in terms of calculating the company value in the traditional valuation segment.

(096) Effective Internet Growth Value ([(-1,0)-(100,100)],(-1,0),(0,0),(0.05,0.006),(0.1,0.014),(0.15,0.035) ,(0.2,0.08),(0.25,0.13),(10,10),(100,100))

Units: dimensionless

This table determines the value given to growth rates in terms of calculating the company value in the internet-style valuation segment.

- (097) Expected Annual Earnings[company] =
Sales revenue[company]* Expected Return on Sales[company]
Units: dollar/Year
The expected annual earnings are calculated based on sales revenue and the expected return on sales.
- (098) Expected Annual Gross Margin[company] =
INTEG(Change in Expected Gross Margin[company] , Gross Margin[company])
Units: dollar/Year
The Expected annual growth margin is a stock changed by the change in expected gross margin.
- (099) Expected Annual Gross Margin in Steady State[company] =
INTEG(Change in Steady State Growth Margin[company] , 0)
Units: dollar/Year
This formulation assumes that the valuations are based on an expectation about what margins are achievable in the steady state. The assumptions about this margins are adjusted over time.
- (100) Expected Annual Operating Income[company] =
INTEG(Change in Expected Operating Income[company] ,Operating Income[company])
Units: dollar/Year
This stock tracks the expectation for the Annual operating income.
- (101) Expected Annual Sales Revenue[company] =
INTEG(Change in Expected Annual Revenue[company] , Sales revenue[company])
Units: dollar/Year
This stock tracks the expectation for the Annual Sales Revenue.
- (102) Expected Return on Sales[company] =
SMOOTH (ZIDZ (Operating Income[company] , Sales revenue[company]) ,
Return on Sales Smoothing time)
Units: dimensionless
This variable tracks the expectation for return on sales.
- (103) Gross Margin[company] =
Sales revenue[company] - Cost of Goods Sold[company]
Units: dollar/Year
The gross margin is the difference between revenue and COGS.

- (104) **Gross Margin per Share[company] =**
Gross Margin[company] / Shares Outstanding[company]
Units: dollar/(Year*share)
 The gross margin per share is calculated by dividing the total gross margin with the number of shares outstanding.
- (105) **Indicated Internet Market Value of the Firm[company] =**
Marketleader Valuation Bonus[company]
*** ("Internet-Value of Growth"[company]**
+ Present value of Gross Margin[company])
*** Pre IPO Discount[company]**
Units: dollar
 The Internet Market Value is calculated based on a factor measuring growth and a factor measuring existing gross margins.
- (106) **Indicated Traditional Market Value of the Firm[company] =**
MAX (Value of Growth[company] + Present value of Earnings[company] , 0)
Units: dollar
 The traditional Market Value is calculated based on a factor measuring growth and a factor measuring the current earnings.
- (107) **Initial Minimum Margin Conceivable = 0.1**
Units: dimensionless
 It is assumed that in this market, investors initially assume that at least a 10 percent margin is possible.
- (108) **"Internet-Value of Growth"[company] =**
MAX (0, Predicted Steady State Gross Margin[company]
*** Effective Internet Growth Value (Perceived Growth in Revenue[company])) / Discount rate**
Units: dollar
 This calculates a component of the internet-style valuation based on the growth rate experienced.
- (109) **Marketleader Valuation Bonus[company] =**
Effect of Marketshare on Valuation (Marketshare[company])
Units: dimensionless
 It is assumed that market leadership gives an additional boost to valuation.
- (110) **Marketshare[company] =**
ZIDZ (Sales revenue[company] , Total Market)
Units: dimensionless
 Market share is calculated by comparing the companies sales revenue to total sales revenue in the industry.

- (111) Minimum Company Value[company] =
 $\text{MAX} (0, \text{Breakup Value of Company}[company])$
 Units: dollar
 This setting determines the minimum valuation of the company that the founders face when raising money.
- (112) Minimum Steady State Margin Conceivable =
 $\text{INTEG}(\text{Change in Minimum Margin Conceivable}, \text{Initial Minimum Margin Conceivable})$
 Units: dimensionless
 This is the current expectation of investors about the minimum margins in the industry that are expected once steady state is reached.
- (113) Net Income[company] =
 $\text{Taxable Income}[company] - \text{Actual Tax Payment}[company]$
 Units: dollar/Year
 The Net income is the income after taxes.
- (114) Operating Income[company] =
 $\text{Gross Margin}[company] - \text{Operating expenses}[company]$
 Units: dollar/Year
 The Operating Income is calculated by deducting operating expenses from the Gross Margin.
- (115) Perceived Growth in Revenue[company] =
 $\text{INTEG}(\text{Change in Perceived Revenue Growth}[company], 0)$
 Units: dimensionless/Year
 This variable calculates the expected annual growth in revenue.
- (116) Pre IPO Discount[company] =
 $\text{IF THEN ELSE} (\text{Time} \leq \text{IPO date}[company], 0.75, 1)$
 Units: dimensionless
 The stock valuation is discounted prior to an IPO as the stock is less liquid as an investment.
- (117) Predicted Steady State Gross Margin[company] =
 $\text{MAX} (\text{Expected Annual Gross Margin}[company], \text{Expected Annual Gross Margin in Steady State}[company])$
 Units: dollar/Year
 The predicted steady state margin is the maximum of the current margin and the minimum expected margin.

- (118) Present value of Earnings[company] =
 Expected Annual Operating Income[company] / Discount rate
 Units: dollar
 The present value of current earnings projected into the future as a constant stream.
- (119) Present value of Gross Margin[company] =
 MAX (0, Expected Annual Gross Margin[company] / Discount rate)
 Units: dollar
 The present value of current gross margin projected into the future as a constant stream.
- (120) Price Earnings Ratio[company] =
 MAX (0, ZIDZ (Stock Price[company] , Earnings per Share[company]))
 Units: Year
 The Price-Earnings Ratio is calculated by comparing the Stock Price with the earnings per Share.
- (121) Price over Gross margin Ratio[company] =
 MAX (0, ZIDZ (Stock Price[company] , Gross Margin per Share[company]))
 Units: Year
 This ratio compares the stock price with the gross margin per share.
- (122) Rate of Change =
 0 + Step (-1, year of bubble bursting)
 Units: 1/Year
 This parameter can determine whether and when the type of valuation switches from Internet-Style to traditional valuation.
- (123) Return on Sales Smoothing time = 0.25
 Units: Year
 This parameter determines over which period Return on Sales will be measured.
- (124) Revenue Averaging Time = 2
 Units: Year
 Revenues are averaged over a period of 2 years.
- (125) Revenue Growth Perception Delay = 0.5
 Units: Year
 Because of quarterly reporting, it takes 3 months to adjust perceptions of the growth rate.

(126)
$$\text{Stock Market Valuation[company]} = \text{MAX} (\text{Minimum Company Value[company]} , \text{Weight Of Internet Type Valuation} * \text{Indicated Internet Market Value of the Firm[company]} + (1 - \text{Weight Of Internet Type Valuation}) * \text{Indicated Traditional Market Value of the Firm[company]})$$

Units: dollar

The stock market valuation is calculated in two ways: a traditional valuation and an internet-style valuation. The parameter Weight of Internet-Type Valuation determines which of the two valuation methods is actually applied.

(127)
$$\text{Target Gross Margin[Company1]} = 0.2$$

$$\text{Target Gross Margin[Company2]} = 0.15$$

$$\text{Target Gross Margin[Company3]} = 0.2$$

Units: dimensionless

A policy decision variable for the company manager. Historical Data on Gross profit margin from Amazon: 19.8% in Q1-Q3 1999, 21.9% in 1998, 19.5% in 1997 and 22% in 1996. B&N: 22.6% in Q1 1999, 23.1% in 1998, 15.3% in 1997. In 1999 most pet stores operated with negative gross margins.

(128)
$$\text{Time to adjust Expected Gross Margin} = 0.25$$

Units: Year

This is the time used in smoothing the expected gross margin.

(129)
$$\text{Time to adjust Expected Operational Income} = 0.25$$

Units: Year

This is the time used to smooth the expected operational income.

(130)
$$\text{Time to adjust Worst Case Expectation} = 5$$

Units: years

The delay in adjusting the expectations regarding the achievable margins in steady state. this represents the "patience" that investors have towards temporary losses.

(131)
$$\text{Total Market} = \text{SUM} (\text{Sales revenue[company!]})$$

Units: dollar/Year

The total market size is the sum of the transaction revenue of the individual companies.

- (152) Value of Growth[company] =
 (Expected Annual Earnings[company]
 * Effective Growth Value (Perceived Growth in Revenue[company]))
 / Discount rate
 Units: dollar
 The value of growth(a component of the traditional stock valuation) depends on the expected growth rate and the discount rate.
- (133) Weight Of Internet Type Valuation =
 INTEG(Change in Valuation , 1)
 Units: dimensionless
 This parameter allows to switch between the traditional and internet-style valuation of the company stocks. If the value is 1, the Internet valuation prevails. At zero, the traditional valuation dominates.
- (134) Weighted Industry Average Margin =
 Marketshare[Company1] * Target Gross Margin[Company1]
 + Marketshare[Company2] * Target Gross Margin[Company2]
 + Marketshare[Company3] * Target Gross Margin[Company3]
 Units: dimensionless
 This calculates the average margin used in the online retail market under observation.
- (135) year of bubble bursting = 1999
 Units: Year
 This is a trigger that allows to set a time at which the valuation of the companies reverts back to the traditional stock valuation method.

B.6. 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 the *Financial Accounting Module* and the *stock price* from the *Financial Markets Module*.

In a simplification from the real world, the Dot Com 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*.

(137) Adjustment for growth During Fundraising Delay[company] =
 $1 + \text{Adjustment Factor[company]} * \text{Fundraising delay[company]}$
 Units: dimensionless

The growth adjustment is calculated such that it covers the growth during the period that it takes to raise the required funds.

(138) Cash[company] =
 $\text{INTEG}(\text{Cash In[company]} - \text{Cash Out[company]} + \text{Initial Funding[company]}, 0)$
 Units: dollar

This stock tracks the amount of cash currently held by the company.

(139) Cash Perception Delay[company] = 0.083
 Units: Year

It takes one month to notice trends and changes in the Cash Flow.

(140) Desired Cash Coverage[company] = 0.167
 Units: Year

The company desires to have the cash required for the next two months on hand.

(141) Fundraising delay[company] = 0.083
 Units: Year

It is assumed to take one month to raise money once a funding need has been established.

(142) IPO date[Company1] = 1997.5
 IPO date[Company2] = 1997.5
 IPO date[Company3] = 1999
 Units: Year

The IPO date describes the day at which the company goes public by selling a substantial amount of its equity for cash.

- (143) $\text{IPO Shares[company]} = \text{PULSE}(\text{IPO date[company]}, \text{TIME STEP}) * \text{Shares Issued at IPO[company]} / \text{TIME STEP}$
 Units: shares/Year
 The shares issued at the IPO date.
- (144) $\text{Minimum Fraction of Accounts Payable Desired on Hand} = 0.1$
 Units: dimensionless
 For liquidity purposes, the company wants to have a certain fraction of its Accounts Payable on hand.
- (145) $\text{Minimum Fraction sold at IPO} = 0.1$
 Units: dimensionless
 It is assumed that at least 10% of the company are sold to the public at the IPO date.
- (146) $\text{Minimum Returns Required at IPO} = 5e+007$
 Units: dollar
 This is the minimum amount of cash returns that need to be achieved if the company conducts an IPO.
- (147) $\text{Net Change in Cash except Fundraising[company]} = \text{Cash In[company]} - \text{Cash Out[company]} - \text{Proceeds from Sale of Equity[company]}$
 Units: dollar/Year
 This variable measures all cash flows related to site operation, i.e. all cash flows except fundraising.
- (148) $\text{New cash Required[company]} = \text{MAX} (0, \text{Target Cash on hand[company]} - \text{Cash[company]})$
 Units: dollar
 This variable calculated whether and how much new cash is required based on the desired cash on hand and the current cash situation.
- (149) $\text{New Shares Issued[company]} = \text{ZIDZ} (\text{New cash Required[company]}, \text{Stock Price[company]}) / \text{Fundraising delay[company]}$
 Units: shares/Year
 This variable calculates the number of new shares issued based on the fundraising needs and the current stock price.
- (150) $\text{Perceived Net Change in Cash[company]} = \text{SMOOTH} (\text{Net Change in Cash except Fundraising[company]}, \text{Cash Perception Delay[company]}, 0)$
 Units: dollar/Year
 The perceived change in cash slightly trails the real change in cash.

(151) $\text{Shares Issued at IPO[company]} = \text{MAX} ((\text{Shares Outstanding[company]} / (1 - \text{Minimum Fraction sold at IPO}) - \text{Shares Outstanding[company]}) , \text{ZIDZ} (\text{Minimum Returns Required at IPO} , \text{Stock Price[company]}))$
 Units: shares

(152) $\text{Shares Outstanding[company]} = \text{INTEG} (\text{New Shares Issued[company]} + \text{IPO Shares[company]} , \text{Initial Number of Shares Outstanding[company]})$
 Units: shares
 The number of shares outstanding increases when new shares are issued for fundraising purposes.

(153) $\text{Stock Price[company]} = \text{Stock Market Valuation[company]} / \text{Shares Outstanding[company]}$
 Units: dollar/share
 The stock price can be derived from the market valuation and the number of shares outstanding. There are no stock splits in this model.

(154) $\text{Target Cash on hand[company]} = \text{MAX} (\text{Minimum Fraction of Accounts Payable Desired on Hand} * \text{Accounts Payable[company]} , - \text{Perceived Net Change in Cash[company]} * \text{Desired Cash Coverage[company]} * \text{Adjustment for growth During Fundraising Delay[company]})$
 Units: dollar
 This formula represents the process by which the company decides how much cash to hold ready at any given point in the company lifecycle.

(155) $\text{TIME STEP} = 0.0625$
 Units: Year
 The time step for the simulation.

B.7. Human Resources Module

The *Human Resources Module* deals with the hiring and training of engineers and customer support people. The *employee quit rate* 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 *Human Resources Module* provides information about the available manpower to the *Site Operation Module* and information about the *salary expenses* to the *Financial Accounting Module*. See section 5.5. for more details.

(157) Adjustment for Growth during Hiring Delay[company,department] =
1 + Adjustment Factor[company] * Hiring Delay[company,department]
Units: dimensionless

The growth adjustment is calculated such that it covers the growth during the period that it takes to hire the people according to the hiring plan.

(158) Assimilation Rate[company,department] =
(Rookie Employees[company,department] / Assimilation Time[company,department])
* Company in Operation Switch[company]
Units: Worker/Year

Rookies that gain sufficient experience become Experienced Employees.

(159) Assimilation Time[company,engin] = 2
Assimilation Time[company,custsupport] = 0.5
Units: Year

It's assumed that it takes 2 years on average to advance from Rookie to being an experienced employee for engineers and 6 months for a customer support person.

(160) Average Productivity[company,department] =
FTEs available for work[company,department]
/ Employees per department[company,department]
Units: FTE/Worker

Average productivity is measured by comparing the available FTEs to the headcounts. It will always be below the one because of lower productivity of rookies as well as time spend for recruiting and training.

(161) "Average Strike Price (Vested)"[company,department] =
ZIDZ (Sum of Strike Price of Vested Options[company,department] ,
Vested Employee Options[company,department])
Units: dollar/share

This variable calculated the average strike price of vested options held by employees by dividing the cumulative strike price by the number of vested options.

(162) Average Strike Price of Non Vested Options[company,department] =
ZIDZ (Sum of Strike Price of Non Vested Options[company,department]
, "Non-vested Employee Options"[company,department])

Units: dollar/share

This variable calculated the average strike price of non-vested options held by employees by dividing the cumulative strike price by the number of unvested options.

(163) Average Workweek[company,department] =
INTEG(Change in Average Workweek[company,department] ,
"Normal Work-week")

Units: hours/week

The average Workweek is a stock driven by the Change in Average Workweek.

(164) Cashing[company,department] =
Options Cashed[company,department]
* "Average Strike Price (Vested)"[company,department]

Units: dollar/Year

This calculates the amount of cash received by employees upon conversion of their stock options.

(165) Change in Average Workweek[company,department] =
IF THEN ELSE (Company in Operation Switch[company]
> 0, (Current Workweek[company,department]
- Average Workweek[company,department]) / Employee Memory , 0)

Units: hours/(Year*week)

The average workweek is most affected by recent developments.

(166) Change in Perceived Productivity[company,department] =
(Average Productivity[company,department]
- Perceived Productivity[company,department])
/ Productivity Perception Delay

Units: FTE/(Year*Worker)

This variable drives the Perception of the Average Productivity based on the current productivity and the perception delay.

(167) Change in Staffing Target[company,department] =
(Desirable Number of People[company,department]
- Staffing Target[company,department]) / HR Decisionmaking delay

Units: workers/Year

The staffing target is adjusted based on the decisionmaking delay in the human resource department.

(168) $\text{Change in Value Perception}[\text{company,department}] =$
 $(\text{Current Value of Non Vested Stock Options}[\text{company,department}]$
 $- \text{Employee Perception Of Value of Option Package}[\text{company,department}]) / \text{Value Observation Delay}$

Units: dollars/(Year*Worker)

The employees perception of the value of their stock options is adjusted by this variable.

(169) $\text{Current Value of Non Vested Stock Options}[\text{company,department}] =$
 $\text{Difference between Strike Price and Stock Price}[\text{company,department}]$
 $* \text{"Non-Vested Options per Employee"}[\text{company,department}]$

Units: dollar/Worker

This variable calculated the value of a typical employees non-vested options if they were converted today.

(170) $\text{Current Workweek}[\text{company,engin}] =$
 $\text{MIN} (\text{Maximum Workweek} , \text{MAX} (\text{Minimum Workweek} ,$
 $\text{"Normal Work-week"} * \text{Required Manpower for Site Operation}[\text{company}]$
 $/ \text{FTEs available for work}[\text{company,engin}]))$

$\text{Current Workweek}[\text{company,custsupport}] =$

$\text{MIN} (\text{Maximum Workweek} , \text{MAX} (\text{Minimum Workweek} , \text{"Normal Work-week"}$
 $* \text{Required Manpower for Customer Support}[\text{company}]$
 $/ \text{FTEs available for work}[\text{company,custsupport}]))$

Units: hours/week

This variable calculates the current workweek based on the ratio between available and required manpower.

(171) $\text{Desirable Number of People}[\text{company,engin}] =$
 $\text{Adjustment for Growth during Hiring Delay}[\text{company,engin}]$
 $* \text{Required Manpower for Site Operation}[\text{company}]$
 $/ \text{Perceived Productivity}[\text{company,engin}]$
 $\text{Desirable Number of People}[\text{company,custsupport}] =$
 $\text{Adjustment for Growth during Hiring Delay}[\text{company,custsupport}]$
 $* \text{Required Manpower for Customer Support}[\text{company}]$
 $/ \text{Perceived Productivity}[\text{company,custsupport}]$

Units: Worker

The Desirable Number of people is determined based on the required manpower and the perceived productivity. It is adjusted for the current rate of growth of the company.

(172) **Desired Number of New Hires[company,department] =**
((Staffing Target[company,department]
- Employees per department[company,department])
/ Hiring Delay[company,department])
*** Company in Operation Switch[company]**

Units: Worker/Year

The Company hires people to fill the gap between current headcount and desired headcount.

(173) **Difference between Strike Price and Stock Price[company,department] =**
Stock Price[company] - Average Strike Price of Non Vested
Options[company,department]

Units: dollar/share

This variable calculates the difference between current stock price and the average strike price on non-vested employee options.

(174) **Dropped[company,department] =**
Average Strike Price of Non Vested Options[company,department]
*** Options Dropped[company,department]**

Units: dollar/Year

This outflow adjusts the cumulative strike price of options for those options dropped.

(175) **Dropping Delay = 0.25**

Units: years

This variable insures that the Non-Vested Employee Options do not turn negative.

(176) **Effect of Average Workweek on Job Attractiveness (**
[(0,0)-(80,2)],(30,2),(35,1.33),(40,1),(42.5,0.9),(45,0.825),(50,0.725)
,(55,0.65),(60,0.6),(80,0.5))

Units: dimensionless

If the average workweek falls below 40 hours, there is a positive impact on the Attractiveness of the Job. If it exceeds 40 hours, the job becomes increasingly unattractive.

(177) Effect of Option Performance on Financial Attractiveness of the Job (
 [(-1e+007,-0.4)-(1e+007,2)],(-1e+007,0),(-1e+006,0.2),(-250000,0.3)
 ,(-100000,0.4),(-50000,0.5),(-25000,0.6),(-10000,0.75),(0,1),(10000,1.1)
 ,(25000,1.25),(50000,1.4),(100000,1.575),(250000,1.75),(500000,1.9)
 ,(1e+006,2),(1e+007,2))

Units: dimensionless

If the option strike price and the stock price are equal, employees are assumed to be neutral and Financial attractiveness is 1. If the stock price is higher, employees are happy and Financial attractiveness increases. If the stock price falls below the strike price, employees become increasingly unhappy with their options as the likelihood of any return vanishes.!!!

(178) Employee Cash in Fraction[company,department] = 0.1

Units: 1/Year

It is assumed that employees who stay with the company cash in about 10 percent of their vested options annually.

(179) Employee Memory = 0.25

Units: years

This variable determines how far back employees look when evaluating their workload.

(180) Employee Perception Of Value of Option Package[company,department] =
 INTEG(Change in Value Perception[company,department] , 0)

Units: dollars/Worker

This stock tracks how employees perceive the value of their option packages based on the current stock performance. A huge negative value expresses an increased likelihood that the options are worthless.

(181) Employee Stock Option Pool[company,department] =
 INTEG(- Options Granted[company,department]
 + Options Dropped[company,department] ,
 Fraction of equity reserved for employees[company,department]
 * Initial Number of Shares Outstanding[company])

Units: shares

This variable tracks the amount of stock options available to be granted based on the assignment of an employee stock option pool.

(182) Employees per department[company,department] =
 Rookie Employees[company,department] Experienced Employees[company,department]

Units: Worker

Employees per department are the Sum of Rookies and Experienced Employees.

(183)
$$\text{Experienced Quit Fraction}[\text{company,department}] = \frac{\text{Standard Annual Quit Fraction}[\text{company,department}]}{\text{Job Attractiveness}[\text{company,department}]} * \text{Company in Operation Switch}[\text{company}]$$

Units: 1/Year

The Experienced Quit Fraction is the normal quit fraction adjusted for the Job Attractiveness.

(184)
$$\text{Experienced Quit Rate}[\text{company,department}] = \text{Experienced Employees}[\text{company,department}] * \text{Experienced Quit Fraction}[\text{company,department}]$$

Units: Worker/Year

Some experienced Employees leave the company to pursue other opportunities.

(185)
$$\text{Financial Attractiveness of Job}[\text{company,department}] = \text{Effect of Option Performance on Financial Attractiveness of the Job (Employee Perception Of Value of Option Package}[\text{company,department}])$$

Units: dimensionless

The financial attractiveness of the job is driven by the performance of the non-vested options held by the employees relative to the stock price.

(186)
$$\text{Fraction of Vested Options}[\text{company,department}] = \text{MIN} (1, \text{MAX} (0, \text{Vested Employee Options}[\text{company,department}] / (\text{"Non-vested Employee Options"}[\text{company,department}] + \text{Vested Employee Options}[\text{company,department}])))$$

Units: dimensionless

This parameter determines the amount of vested options among total options granted in order to determine how many unvested option the average person leaving has had.

(187)
$$\text{FTEs available for work}[\text{company,department}] = \text{MAX} (1, \text{Experienced Employees}[\text{company,department}] * \text{FTEs per experienced}[\text{company,department}] + \text{Rookie Employees}[\text{company,department}] * \text{FTEs per rookie}[\text{company,department}] - \text{FTEs to recruiting}[\text{company,department}] - \text{FTEs to training}[\text{company,department}])$$

Units: FTE

This parameter measures the available manpower by taking into account the lower productivity of rookies as well as the amount of time experienced employees spend for training and hiring.

- (188) $\text{FTEs per experienced[company,department]} = 1$
 Units: FTE/employee
 Experienced employees operate at full productivity.
- (189) $\text{FTEs per rookie[company,engin]} = 0.15$
 $\text{FTEs per rookie[company,custsupport]} = 0.25$
 Units: FTE/employee
 This constant determines the productivity of a rookie relative to an experienced worker. It is assumed lower for an engineering rookie than for a rookie in customer service.
- (190) $\text{FTEs required for selection per hire[company,department]} = 0.01$
 Units: Year*FTE/Worker
 Fraction of time from an experienced person required to interview and select employees through the hiring process. This is the net result, i.e. time per person hired.
- (191) $\text{FTEs required of training per rookie[company,department]} = 0.05$
 Units: FTE/employee
 Fraction of time of an experienced person to supervise/train a rookie (for the duration of the assimilation period).
- (192) $\text{FTEs to recruiting[company,department]} =$
 $\text{FTEs required for selection per hire[company,department]}$
 $* \text{Rookie Hire Rate[company,department]}$
 Units: FTE
 The aggregate time of experienced employees spent for recruiting purposes.
- (193) $\text{FTEs to training[company,department]} =$
 $\text{FTEs required of training per rookie[company,department]}$
 $* \text{Rookie Employees[company,department]}$
 Units: FTE
 This calculates the amount of manpower not available for productive work because of time spent training rookies.
- (194) $\text{Granting[company,department]} =$
 $\text{Options Granted[company,department]} * \text{Issuing Price[company,department]}$
 Units: dollar/Year
 This flow tracks the cumulated strike price of options granted to new employees.

- (195) **Hiring Delay[company,engin] = 0.25**
Hiring Delay[company,custsupport] = 0.167
Units: years
 The average time it takes to hire a rookie in engineering and in customer support.
- (196) **HR Decisionmaking delay = 0.083**
Units: years
 The is a small processing delay of one month until Staffing Targets are set based on the calculations of this model.
- (197) **Issuance Rate = 1**
Units: 1
 This factor is used for unit conversion between options and shares.
- (198) **Issuing Price[company,department] =**
Stock Price[company] * Issuance Rate
Units: dollar/share
 It is assumed that options are always issued at the current stock price of the company.
- (199) **Job Attractiveness[company,department] =**
Financial Attractiveness of Job[company,department]
 *** Lifestyle Attractiveness of Job[company,department]**
Units: dimensionless
 Job Attractiveness is influenced both by the intensity of the workweek and by the financial attractiveness of the job.
- (200) **Lifestyle Attractiveness of Job[company,department] =**
Effect of Average Workweek on Job Attractiveness (Average Workweek[company,department])
Units: dimensionless
 The Life-Style attractiveness of the job is driven by the average workweek.
- (201) **Maximum Fraction of Pool Granted to one Employee[company,department]**
= 0.005
Units: dimensionless/Worker
 This formulation prevents depletion of the Employee Stock Option pool by limiting the fraction that any one employee can receive.
- (202) **Maximum Workweek = 80**
Units: hours/week
 There is a limit to how many hours people can spend at their job, even if there is still more work to do.

(203) Minimum Workweek = 35

Units: hours/week

Even if the workload is low, there is some minimum number of hours that workers will still spend at the job.

(204) "Non-vested Employee Options"[company,department] =
INTEG(Options Granted[company,department]
- Option Vesting Rate[company,department]
- Options Dropped[company,department] ,
(Employees per department[company,department])
* Options Granted at Hiring[company,department])

Units: shares

This stock tracks the number of non-vested employee options.

(205) "Non-Vested Options per Employee"[company,department] =
"Non-vested Employee Options"[company,department]
/ Employees per department[company,department]

Units: shares/Worker

This variable calculates the number of non-vested options per employee.

(206) "Normal Work-week" = 40

Units: hours/week

The standard workweek is assumed to have 40 hours.

(207) Option Vesting Rate[company,department] =
MIN ("Non-vested Employee Options"[company,department]
/ TIME STEP , ("Non-vested Employee Options"[company,department]
+ Vested Employee Options[company,department])
/ Vesting Period[company,department])
* Company in Operation Switch[company]

Units: shares/Year

This flow measures the amount of options vesting.

(208) Options Cashed[company,department] =
Vested Employee Options[company,department]
* Employee Cash in Fraction[company,department]
+ Options dropped by people leaving[company,department]
* Fraction of Vested Options[company,department]

Units: shares/Year

This outflow aggregates all vested options being cashed.

(209) $\text{Options Dropped[company,department]} =$
 $\text{MIN ("Non-vested Employee Options"[company,department]$
 $\text{/ Dropping Delay , Options dropped by people leaving[company,department]}$
 $\text{* (1 - Fraction of Vested Options[company,department]))}$

Units: shares/Year

Options that are dropped by quitting employees return to the Employee Stock Option Pool.

(210) $\text{Options dropped by people leaving[company,department]} =$
 $\text{Rookie Quit Rate[company,department]}$
 $\text{* Options Granted at Hiring[company,department]}$
 $\text{+ Experienced Quit Rate[company,department]}$
 $\text{* (Options Granted at Hiring[company,department]}$
 $\text{+ Options Granted at Promotion[company,department])}$

Units: shares/Year

This variables calculates the number of non-vested and vested options dropped by people quitting.

(211) $\text{Options Granted[company,department]} =$
 $\text{Options Granted at Hiring[company,department]}$
 $\text{* Rookie Hire Rate[company,department]}$
 $\text{+ Options Granted at Promotion[company,department]}$
 $\text{* Assimilation Rate[company,department]}$

Units: shares/Year

The Employee Stock Option Pool is depleted through options granted at hiring and at promotion.

(212) $\text{Options Granted at Hiring[company,department]} =$
 $\text{MIN (Target Hiring Option Grant[company,department] ,}$
 $\text{Employee Stock Option Pool[company,department]}$
 $\text{* Maximum Fraction of Pool Granted to one Employee[company}$
 ,department])

Units: shares/Worker

The amount of options granted to employees is reduced over time as the employee stock option pool depletes.

(213) $\text{Options Granted at Promotion[company,department]} =$
 $\text{MIN (Target Options Granted at Promotion[company,department] ,}$
 $\text{Maximum Fraction of Pool Granted to one Employee[company,department]}$
 $\text{] * Employee Stock Option Pool[company,department])}$

Units: shares/Worker

This formula calculates the amount of options granted at promotion.

$$(214) \quad \text{Perceived Productivity[company,department]} = \text{INTEG}(\text{Change in Perceived Productivity[company,department]} , \\ \text{(Experienced Employees[company,department]} \\ * \text{ FTEs per experienced[company,department]} \\ + (\text{ FTEs per rookie[company,department]} \\ - \text{ FTEs required of training per rookie[company,department]}) \\ * \text{ Rookie Employees[company,department]}) \\ / \text{ Employees per department[company,department]})$$

Units: FTE/Worker

This variable measures the companies perception of productivity per employee. It trails true productivity because of the delay in perception.

$$(215) \quad \text{Productivity Perception Delay} = 0.5$$

Units: Year

The companies need time to measure productivity and to adjust their estimates about average productivity.

$$(216) \quad \text{Rookie Employees[company,department]} = \text{INTEG}(\text{Rookie Hire Rate[company,department]} \\ - \text{Assimilation Rate[company,department]} \\ - \text{Rookie Quit Rate[company,department]} , \\ \text{(Experienced Employees[company,department]} \\ * (\text{Standard Annual Quit Fraction[company,department]} \\ * \text{Assimilation Time[company,department]})))$$

Units: Worker

There are two types of employees in this model. Rookies are less experienced and therefore less productive than experienced Employees.

$$(217) \quad \text{Rookie Fraction[company,department]} = \text{Rookie Employees[company,department]} \\ / \text{ Employees per department[company,department]}$$

Units: dimensionless

The Rookie Fraction measures the percentages of rookies among the workforce of a particular department.

$$(218) \quad \text{Rookie Hire Rate[company,department]} = \text{MAX} (0, \text{Desired Number of New Hires[company,department]} \\ + \text{Total Quit Rate[company,department]})$$

Units: Worker/Year

The Rookie hire rate is set such as to compensate for leaving employees and move the company towards the desired staffing level. The company does not fire people.

- (219) **Rookie Quit Fraction[company,department] =**
MIN (0.9, Standard Annual Quit Fraction[company,department]
/ Job Attractiveness[company,department])
*** Company in Operation Switch[company]**
Units: 1/Year
 The Rookie Quit Fraction is the normal quit fraction adjusted for the Job Attractiveness. A maximum quit rate of 90 percent is assumed.
- (220) **Rookie Quit Rate[company,department] =**
Rookie Quit Fraction[company,department]
*** Rookie Employees[company,department]**
Units: Worker/Year
 Some Rookies leave the company again to pursue other opportunities.
- (221) **Staffing Target[company,department] =**
INTEG(Change in Staffing Target[company,department] ,
Desirable Number of People[company,department])
Units: Worker
 The staffing target measures the number of employees that the company wants to employ.
- (222) **Standard Annual Quit Fraction[company,engin] = 0.2**
Standard Annual Quit Fraction[company,custsupport] = 0.4
Units: 1/Year
 The Normal Annual Quit Rate is assumed 20% for engineers and 40% for customer support people.
- (223) **Sum of Strike Price of Non Vested Options[company,department] =**
INTEG(Granting[company,department] - Vesting[company,department]
- Dropped[company,department] , 1)
Units: dollar
 This stock helps to track the average strike price of non-vested employee options.
- (224) **Sum of Strike Price of Vested Options[company,department] =**
INTEG(Vesting[company,department] - Cashing[company,department] , 1)
Units: dollar
 This stock helps to track the average strike price of vested employee options.
- (225) **Target Hiring Option Grant[company,engin] = 250**
Target Hiring Option Grant[company,custsupport] = 125
Units: shares/Worker
 This is the target number of options granted to each employee.

(226) Target Options Granted at Promotion[company,engin] = 500

Target Options Granted at Promotion[company,custsupport] = 125

Units: shares/Worker

This is the target number for option grants at promotion.

(227) Total Quit Rate[company,department] =

Experienced Quit Rate[company,department] + Rookie Quit Rate[company,department]

Units: Worker/Year

The total quit rate is the sum of Rookies and Experienced Employees leaving.

(228) Value Observation Delay =

TIME STEP

Units: years

It takes one time step for employees to observe the value of their options relative to the stock.

(229) Vested Employee Options[company,department] =

INTEG(Option Vesting Rate[company,department]

- Options Cashed[company,department] , 0)

Units: shares

This stock tracks the number of vested employee options.

(230) Vesting[company,department] =

Option Vesting Rate[company,department]

* Average Strike Price of Non Vested Options[company,department]

Units: dollar/Year

This flow accounts for the strike price of vested options.

(231) Vesting Period[company,department] = 4

Units: Year

The stock options vest over a period of 4 years.

B.8. Market Module

The *Market Module* is the simplest module in the Dot Com Model, because it does not use inputs from other sections of the model. Its sole purpose is to model the diffusion of the Internet, thus generating the number of potential users that is used by other parts of the model. This purpose is achieved by a word-of-mouth adoption process calibrated with data from Forrester

Research.⁵⁰ 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.

$$(233) \quad \text{Change in Penetration} = \frac{(\text{Maximum Internet penetration} - \text{Potential Internet Penetration})}{\text{Penetration adjustment time}}$$

Units: 1/Year

This section generates the initial internet growth pattern as a background for the companies to acquire and lose customers.

$$(234) \quad \text{Contacts between Potential users and Actual Users} = \text{Potential Internet User} * \text{Sociability of Potential Users} * (\text{Total Internet Users} / \text{Population})$$

Units: contact/Year

This word-of-mouth loop is only used to generate the S-shaped growth pattern of internet users.

$$(235) \quad \text{Conversion through Word of Mouth} = \frac{\text{Contacts between Potential users and Actual Users}}{\text{Effectiveness of contacts}}$$

Units: People/Year

This variable captures the conversion of potential users in actual users based on word of mouth.

$$(236) \quad \text{Effectiveness of contacts} = 0.003$$

Units: People/contact

This variable determines the effectiveness of contacts in the Word-of-Mouth loop that drives Internet-Adoption. It was calibrated to match Forrester Research data.

$$(237) \quad \text{Entering Potential Users} = \frac{(\text{MAX}(\text{Indicated Potential Internet User} - \text{Sum of Potential and Actual Users}, 0))}{\text{Time to enter}}$$

Units: People/Year

People become potential users before they become actual users.

⁵⁰ Forrester Research, Post-Web Retail (September 1999).

- (238) **Indicated Potential Internet User =**
Population * Potential Internet Penetration
Units: People
The size of the population and the declining computer prices determine the potential online population.
- (239) **Initial Internet Penetration = 0.225**
Units: dimensionless
The Initial fraction of potential Internet penetration.
- (240) **Maximum Internet penetration = 0.65**
Units: dimensionless
There is a maximum level of penetration that the internet can achieve.
- (241) **Net Population Growth =**
Population * Net Population Growth Rate
Units: People/Year
The annual growth of the US population is the product of the population and the net growth rate.
- (242) **Net Population Growth Rate = 0.0105**
Units: 1/Year
The U.S. population growth by 1.05 percent annually through immigration and a positive net birth rate. (Based on Forrester Data)
- (243) **New Internet Users =**
Conversion through Word of Mouth
Units: People/Year
This variable is the key output of the market module. It is the rate of people going online at any time. The model is calibrated to have this rate match Forrester Research data for 1995-2004.
- (244) **Penetration adjustment time = 4**
Units: years
This is the time driving the increased penetration rate. Note that the only function of the segment of the model is to generate the flow of users getting online.
- (245) **Population =**
INTEG(Net Population Growth , 2.59e+008)
Units: People
US population,calibrated with Forrester Data.

- (246) Potential Internet Penetration =
 $\text{INTEG}(\text{Change in Penetration}, \text{Initial Internet Penetration})$
 Units: dimensionless
 The potential Internet penetration increases over time (as the usefulness of the Internet increases and the costs fall).
- (247) Potential Internet User =
 $\text{INTEG}(\text{Entering Potential Users} - \text{New Internet Users}, \text{Indicated Potential Internet User} - \text{Total Internet Users})$
 Units: People
 This variable measures people on the brink of getting online.
- (248) Sociability of Potential Users = 1000
 Units: contact/(Year*person)
 This word of mouth-Structure is only used to generate a S-shaped curve of internet adopters.
- (249) Sum of Potential and Actual Users =
 $\text{Potential Internet User} + \text{Total Internet Users}$
 Units: People
 This variable tracks the all potential and actual users.
- (250) Time to enter = 0.5
 Units: Year
 This delay is part of the simplified construction that generates a rate of users getting online in accordance with Forrester data.

B.9. Relative Performance Module

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. 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. See section 5.4. for more detail.

- (253) **Attractiveness of Fulfillment[company] =**
XIDZ (Perceived Industry Average for Fulfillment[company] ,
Time Required for Fulfillment[company] , 1)
Units: dimensionless
 The time required for fulfillment is compared with the industry average. A value above 1 indicates above average performance, a value below 1 indicates below average performance.
- (254) **Average Order Size[company] =**
Price[company] * Effect of Content on Average Order (Relative Attractiveness of
Content[company])
Units: dollar/transactions
 The average order size can differ if the online retailer manages to upsell additional products based on the quality of content on the site.
- (255) **Brand Equity[company] =**
INTEG(Total Marketing Spending[company] - Loss of brand equity[company]
+ Brand Equity At Beginning of Operations[company]
+ "Free Riding on Bricks-and-Mortar advertising"[company] , 0)
Units: dollar
 Brand equity is measured in dollar. It is assumed to increase through advertising spending and to decline automatically if advertising ends.
- (256) **Bricks and Mortar Margin = 0.3**
Units: dimensionless
 This is the assumed gross margin in the bricks-and-mortar industry.
- (257) **Bricks and Mortar Price Level =**
Bricks and Mortar COGS / (1 - Bricks and Mortar Margin)
Units: dollar/transactions
 This formulation calculates the Bricks-and-Mortar Price in relation to which the attractiveness of online prices is established.
- (258) **Change in Perceived Industry Average[company] =**
(Weighted Industry Average for Fulfillment[company]
- Perceived Industry Average for Fulfillment[company])
/ Perception Delay for Fulfillment
Units: days/Year
 This variables drives the adjustment of perceived fulfillment delays based on the perception delay.

- (259) **Company starts =**
SUM (PULSE (Starting Date[company!] ,TIME STEP) / TIME STEP)
Units: dimensionless/Year
 This formulation is used to account for the number of companies in operation.
- (260) **Content[company] =**
INTEG(Editorial production[company] + User Generated Content[company]
- Obsolescence[company] , 0)
Units: webpages
 Content of the webpages can be self-generated or user-generated. It is erased once it becomes obsolete.
- (261) **Effect of Content on Average Order (**
[(0,0)-(1,2)],(0,1),(0.25,1),(0.33,1.05),(0.5,1.25),(0.6,1.45),
(0.7,1.7),(0.8,1.875),(1,2))
Units: dimensionless
 This lookup assumes that companies can double their average order volume through good content on their website.
- (262) **Fraction of Sales Lost Due to Non Availability of Product[company] =**
IF THEN ELSE (Company in Operation Switch[company] > 0,
Lookup for Sales Lost (Product Selection[company]
/ Total Number of SKUs Available) , 1)
Units: dimensionless
 This parameter determines the likelihood that the buyer tries to buy a product not offered by the company. In this case, the company loses the sale.
- (263) **"Indicated First-Time Acquisition Fraction"[company] =**
(Relative attractiveness of Brand[company]
*** Relative Attractiveness of Price[company]**
*** (1 - Fraction of Sales Lost Due to Non Availability of Product[**
company]))
Units: dimensionless
 This parameter determines the fraction of First-Time users that a site captures.
- (264) **Lookup for Recapture Fraction based on Site Experience (**
[(0,0)-(6,10)],(0,0),(0.5,0.1),(1,0.5),(2,2),(3,4),(5,10))
Units: 1/Year
 This lookup determines the likelihood to convert an independent shoppers into a loyal shoppers based on site performance.

- (265) Lookup for relative attractiveness of price (
 [(0,0)-(1.6,6)],(0,2),(0.6,1.6),(0.8,1.4),(0.9,1.25),(1,1),(1.1,0.7)
 ,(1.2,0.35),(1.25,0))
 Units: dimensionless
 This lookup translates relative differences in price in
 attractiveness with 1 being average.!!!
- (266) Lookup for Sales Lost (
 [(0,0)-(1,1)],(0,1),(0.025,1),(0.05,0.9),(0.1,0.75),(0.175,0.6)
 ,(0.25,0.45),(0.375,0.25),(0.5,0.15),(0.75,0.05),(1,0))
 Units: dimensionless
 This lookup determines how many sales are lost if the company
 stocks less than 100 percent of the products available in the
 product category.
- (267) Lookup for Turnover rate based on Perceived Site performance (
 [(0,0)-(1,1)],(0,1),(0,1),(0.1,0.7),(0.3,0.45),(0.5,0.3),(0.7,0.2)
 ,(0.9,0.12),(1,0.1))
 Units: dimensionless/Year
 This lookup determines turnover rates based on site performance.
 It assumes a minimum turnover rate of 10 percent even if the
 site performs perfectly.
- (268) Number of Companies in the market =
 INTEG(Company starts , 0)
 Units: dimensionless
 This variable keeps track of the number of companies in
 operation.
- (269) Perceived Industry Average for Fulfillment[company] =
 INTEG(Change in Perceived Industry Average[company] ,
 Minimum Time for Fulfillment[company])
 Units: days
 This variable expresses the perception about average fulfillment
 times in the industry.
- (270) Perceived Quality of Customer Support[company] =
 SMOOTH (Current Quality of Customer Support[company] ,
 Customer Memory)
 Units: dimensionless
 The perceived quality of customer support is determined by the
 performance over the period remembered by the customers.
- (271) Perception Delay for Fulfillment = 0.25
 Units: years
 It takes 3 month for a perception to build for fulfillment times.

(272) $\text{Price}[\text{company}] = \frac{\text{Company in Operation Switch}[\text{company}] * \text{Company Cost of Goods sold}[\text{company}]}{(1 - \text{Target Gross Margin}[\text{company}])}$

Units: dollar/transactions

Prices are set based on cost of good sold and the target profit margin.

(273) $\text{Relative attractiveness of Brand}[\text{company}] = \frac{\text{ZIDZ}(\text{Brand Equity}[\text{company}], \text{Total Brand Equity})}{\text{Total Brand Equity}}$

Units: dimensionless

The relative attractiveness of brands is calculated by compared the brand equity of one company to the sum of brand equity. The relative attractiveness therefore will be between 0 (low) and 1 (high).

(274) $\text{Relative Attractiveness of Content}[\text{company}] = \frac{\text{ZIDZ}(\text{Content}[\text{company}], \text{Total Content})}{\text{Total Content}}$

Units: dimensionless

The relative attractiveness of content is calculated by compared the content of one company to the sum of content. The relative attractiveness therefore will be between 0 (low) and 1 (high).

(275) "Relative Attractiveness Of Online Shopping vs. Bricks and Mortar" = 1

Units: dimensionless

This parameter allows the creation of scenarios where bricks-and-mortar is more or less attractive than in the default version. At a value of 1, this parameter will not affect the other equations in the model. At a value above 1, it favors online-shopping. A value below 1 favors Bricks-and-Mortar.

(276) $\text{Relative Attractiveness of Price}[\text{company}] = \text{IF THEN ELSE}(\text{Company in Operation Switch}[\text{company}] = 0, 1, \text{Lookup for relative attractiveness of price}(\text{Relative price}[\text{company}]))$

Units: dimensionless

A low price is more attractive that a high price. this factor becomes more important at price comparison becomes easier.

(277) $\text{Relative price}[\text{company}] = \frac{\text{ZIDZ}(\text{Price}[\text{company}], \text{Bricks and Mortar Price Level})}{\text{Bricks and Mortar Price Level}}$

Units: dimensionless

The relative price is established by comparison with the average price level. A value below 1 is good and a value above 1 is expensive.

(278) **Relative Site Experience[company] =**
Perceived Quality of Customer Support[company]
*** Attractiveness of Fulfillment[company] * Relative Attractiveness of Price[company]**
*** (1 - Fraction of Sales Lost Due to Non Availability of Product[company])**
Units: dimensionless

The Site experience aggregates various relative measures into one aggregate score.

(279) **Sum of Indicated First Acquisition Fractions =**
SUM ("Indicated First-Time Acquisition Fraction"[company!])
Units: dimensionless

This formulation helps to standardize the first-time acquisition fractions of the competing companies.

(280) **Total Brand Equity =**
SUM (Brand Equity[company!])
Units: dollar

Total brand equity is the sum of the brand equity of the individual companies.

(281) **Total Content =**
SUM (Content[company!])
Units: webpages

Total content is the sum of content on the individual companies' websites.

(282) **Total Number of SKUs Available = 5e+006**
Units: SKU

This number describes the total number of SKUs available in the product category. It is about 5 million for books and about 30.000 to 50.000 for pet supplies.

(283) **Turnovers due to poor performance[company] =**
Lookup for Turnover rate based on Perceived Site performance (Perceived Site Performance[company])
Units: 1/Year

The site performance is a key driver of turnovers.

(284) **Weighted Industry Average for Fulfillment[company] =**
SUM (Weighted Time for Fulfillment[company!])
Units: days

This is the industry average for time for fulfillment, weighted by marketshare.

(285) **Weighted Time for Fulfillment[company] =**
Time Required for Fulfillment[company] * Marketshare[company]
Units: days

This is an auxiliary variable used to calculate the weighted industry average for time for fulfillment.

B.10. 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, site 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 Module* output, such as *sales revenue* and *expected annual growth in earnings*, and competitive data from the *Relative Performance Module* are used for the investment and spending decisions contained in the *Site Operations Module*. (See section 5.3 for more detail).

(288) **Adequacy of Server Infrastructure[company] =**
IF THEN ELSE (Company in Operation Switch[company] = 0, 1,
ZIDZ (Server Infrastructure[company] , Required Server Infrastructure[company]))
Units: dimensionless

This variable compares the existing server infrastructure with the required server infrastructure. The outcome contributes to the calculation of Site performance.

(289) **Adequacy of Staffing[company,engin] =**
IF THEN ELSE (Company in Operation Switch[company] = 0, 1,
ZIDZ (FTEs available for work[company,engin] ,
Required Manpower for Site Operation[company]))
Adequacy of Staffing[company,custsupport] =
IF THEN ELSE (Company in Operation Switch[company] = 0, 1,
ZIDZ (FTEs available for work[company,custsupport] ,
Required Manpower for Customer Support[company]))
Units: dimensionless

This variable compares the available manpower with the manpower

required. Note the differences for engineering and customer support.

- (290) Adjustment Factor[company] =
MIN (Perceived Growth in Revenue[company] , Maximum Adjustment)
Units: dimensionless/Year
The adjustment factor is based on the Expected Growth rate in revenue, but capped at a maximum value.
- (291) Adjustment for economies of scale for Customer Support ([(0,0)-(5e+008,1)],(0,1),(500000,0.9),(1e+006,0.81),(5e+006,0.7) ,(1e+007,0.6),(5e+007,0.25),(1e+008,0.15),(5e+008,0.1))
Units: dimensionless
This lookup account for economies of scale in customer support. The underlying assumption is that economies of scale are significant and can reach a factor of ten if volume increases.
- (292) Adjustment for Economies of Scale for Site Operation ([(0,0)-(1e+010,1)],(0,1),(1e+007,0.6),(5e+007,0.4),(1e+008,0.25) ,(2e+008,0.2),(5e+008,0.15),(1e+009,0.125),(5e+009,0.1),(1e+010,0.1))
Units: dimensionless
This lookup account for economies of scale in site operations. The underlying assumption is that economies of scale are significant and can reach a factor of ten if pageviews increase.\!\!
- (293) Adjustment for Growth during Procurement[company] =
1 + Adjustment Factor[company] * Server Procurement Delay
Units: dimensionless
This formulation is used in various parts of the model to allow adjustment of hiring, fundraising, procurement and other processes for the expected growth rate.
- (294) Adjustment for Server Depreciation =
1 + (Server Depreciation Rate * Server Procurement Delay)
Units: dimensionless
This formulation adjusts server procurement for the depreciation that occurs during the procurement process.
- (295) Annual Fractional Loss of Brand Equity = 0.4
Units: 1/Year
This parameter determines the fraction of brand equity that is lost annually if no new advertising occurs.

(296) **Brand Equity At Beginning of Operations[company] =**
PULSE (Starting Date[company] , TIME STEP) * Initial brand equity[company]
/ TIME STEP

Units: dollar/Year

This Inflow makes sure the initial brand equity (for example the brand equity derived from an existing bricks-and-mortar operation) is only taken into account after the company begins its online operations.

(297) **Bricks and Mortar advertising[Company1] = 0**
Bricks and Mortar advertising[Company2] = 0
Bricks and Mortar advertising[Company3] = 1.5e+007

Units: dollar/Year

This variable captures the advertising volume of a Bricks-and-Mortar partner to which a URL can be added without extra cost.

(298) **Bricks and Mortar COGS = 40**

Units: dollar/transactions

The Cost of procurement for a typical product experienced by a bricks-and-mortar in the relevant industry.

(299) **Change in product selection[company] =**
Company in Operation Switch[company] * (Desired Product selection[company]
- Product Selection[company]) / Time to change Product selection

Units: SKUs/Year

This inflow is the rate at which a company manages to increase its product selection.

(300) **Change in Warehouse Space[company] =**
MAX ((Desired Warehouse Space[company] - Warehouse space[company])
/ Time to adjust warehouse space , Minimum Change in Warehouse Space)

Units: SquareFeet/Year

The rate of change in warehouse space.

(301) **Company Cost of Goods sold[company] =**
Bricks and Mortar COGS * Company Modifier of procurement costs[company]

Units: dollar/transactions

This parameter defines the average cost of goods sold for the product category. This can differ among company based on economies of scale and volume discounts.

(302) **Company Modifier of procurement costs[company] = 1**

Units: dimensionless

This variable allows to capture different costs in procurement. It's currently not used.

- (303) Cost of allowing user generated Content[company] = $1e+006$
 Units: dollar/Year
 It is assumed that the facilitation of user-generated content costs a fixed amount annually, no matter how many users use this service.
- (304) Cost of building warehouse space = 30
 Units: dollar/squarefoot
 The costs per squarefoot of warehouse space build. Reference point: Pets.com is building a 300.600 SQFT warehouse for \$7-9M. (SEC filings).
- (305) Cost per selfgenerated webpage[company] = 1
 Units: dollar/webpage
 The production cost per self-generated webpage is assumed a constant.
- (306) Cost per user generated webpage[company] =
 $ZIDZ (\text{Cost of allowing user generated Content[company] , } \\ \text{User Generated Content[company] })$
 Units: dollar/webpage
 This variable calculates the costs per user-generated webpage.
- (307) Current Quality of Customer Support[company] =
 $\text{MIN} (1, \text{Adequacy of Staffing[company,custsupport] })$
 Units: dimensionless
 This variable agregates criteria such as call center waiting time and email response time into a qualitative criterion called customer support. 1 means flawless customer support, 0 means dreadful service.
- (308) Current Site Performance[company] =
 $\text{MIN} (1, \text{Adequacy of Server Infrastructure[company] } \\ * \text{Adequacy of Staffing[company,engin] })$
 Units: dimensionless
 The current site performance measures the Site performance. It's an aggregate measure for parameters such as uptime and response time. 1 means flawless and quick performance, 0 means unacceptably poor performance.
- (309) Customer Contacts per transaction = 0.2
 Units: contact/Transaction
 It is assumed that every fifth transaction requires a transaction between customer support personnel and the customer.

- (310) Customer Memory = 0.5
 Units: Year
 The customers remember good or bad experiences for an average period of 6 months.
- (311) Desired Product selection[Company1] = 5e+006
 Desired Product selection[Company2] = 3e+006
 Desired Product selection[Company3] = 5e+006
 Units: SKUs
 In the book market, there are at least 5.000.000 products. For pet supplies, there are about 40.000.
- (312) Desired Server Infrastructure[company] =
 Required Server Infrastructure[company] * Adjustment for Server Depreciation
 * Adjustment for Growth during Procurement[company]
 Units: dollars
 This formula calculates the desired server infrastructure based on current needs and adjustments for depreciation and traffic growth.
- (313) Desired Time for Fulfillment[Company1] = 2.5
 Desired Time for Fulfillment[Company2] = 4
 Desired Time for Fulfillment[Company3] = 3
 Units: days
 This decision variable determines the goal for the company's fulfillment efforts in terms of days needed to process the order.
- (314) Desired Warehouse Space[company] =
 XIDZ (Effect of Number of Transactions on Warehousing needs (Number of Transactions[company]) * Desired Product selection[company] ,
 Desired Time for Fulfillment[company] , 1)
 * FulfillmentTime conversion factor
 * Company in Operation Switch[company]
 Units: SquareFeet
 The total Warehouse requirement is calculated based on the desired number of SKUs and the current number of transactions.

(315) "ease of User Content-Generation"[Company1] =
 1 * Company in Operation Switch[Company1]
 "ease of User Content-Generation"[Company2] =
 1 * Company in Operation Switch[Company2]
 "ease of User Content-Generation"[Company3] =
 1 * Company in Operation Switch[Company3]

Units: dimensionless

This parameter captures whether management facilitates the generation of content such as book reviews by the users. With a value of 1, management fully supports this, with 0, they don't at all.

(316) Editorial Budget[Company1] = 1e+006
 Editorial Budget[Company2] = 1e+006
 Editorial Budget[Company3] = 2e+006

Units: dollar/Year

The manager can decide how much money to spend for content produced by editorial staff.

(317) Editorial production[company] =
 Editorial Budget[company] / Cost per selfgenerated webpage[company]
 * Company in Operation Switch[company]

Units: webpages/Year

This Inflow expresses the creation of self-generated content through editorial staff..

(318) Effect of Number of Transactions on Warehousing needs ([(0,0)-(1e+009,40000)],(0,0),(100,10),(1000,31),(10000,100),(100000,310),(1e+006,1000),(1e+007,3100),(1e+008,10000),(1e+009,31000))

Units: dimensionless

This variable describes the impact of the number of transactions handled on warehousing needs.\!\\!

(319) Effectiveness of Free Riding = 0

Units: dimensionless

This parameter expresses how effective the mentioning of an URL with existing Bricks-and-mortar advertising is relative to targeted marketing only for the online brand. A factor of 1 would indicate equal effectiveness. A value of 0 would indicate no impact at all.

- (320) "Free Riding on Bricks-and-Mortar advertising"[company] =
 Bricks and Mortar advertising[company] * Effectiveness of Free Riding
 * Company in Operation Switch[company]
 Units: dollars/Year
 This construction allows to take into account that some online
 retailers have bricks-and-mortar parent companies who can
 promote their URLs for free during their existing advertising
 campaigns.
- (321) FTE required per Customer Contact[company] = 0.0001
 Units: Year*FTE/contact
 One customer representative can handle 10000 requests per year.
- (322) FTE required per PageView = 1.5e-006
 Units: Year*FTE/pageview
 The parameter measures the manpower required to support one
 pageview.
- (323) FulfillmentTime conversion factor = 0.0002
 Units: days*SquareFeet/SKUs
 This factor determines the time for fulfillment based on the
 number of transactions, the product selection and the available
 infrastructure.
- (324) "High-Volume Buyer Pageviews" = 200
 Units: Pageviews/(Year*People)
 It is assumed that loyal high-volume buyers generate 200
 pageviews per year.
- (325) Independent Shopper Pageviews[company] =
 Total independent pageviews
 * Percentage of Independent Business Captured by Company[company]
 Units: Pageviews/(Year*People)
 This formula calculates additional pageviews from independent
 Shoppers.
- (326) Initial Server Infrastructure[company] = 50000
 Units: dollar
 The value of the initial server infrastructure (measured in
 dollars) available for the company at its simulated start date.

- (327) Lookup for propensity to contribute based on pages already contributed
 ((0,0)-(6e+007,1)],(0,0.1),(100000,0.15),(500000,0.3),(1e+006,0.4)
 ,(5e+006,0.7),(1e+007,0.8),(5e+008,1))
 Units: dimensionless
 It is assumed that users are more likely to contribute to a content-rich site to which other users have already contributed.
- (328) Loss of brand equity[company] =
 Brand Equity[company] * Annual Fractional Loss of Brand Equity
 Units: dollar/Year
 The impact of past advertising fades over time.
- (329) Maintenance Costs per SquareFoot[company] = 1
 Units: dollar/(Year*squarefoot)
 It is assumed that maintenance of the warehouses costs about 1\$ per Squarefoot per Year.
- (330) Maximum Adjustment = 2.5
 Units: dimensionless/Year
 This variable sets a maximum to the adjustmetn based on the current growth rate in order to avoid overreactions to a temporarily high growth rate.
- (331) Maximum page generation per user[company] = 1
 Units: webpages/(Year*People)
 This is the maximum of content a user will produce per year.
- (332) Minimum Change in Warehouse Space = 0
 Units: SquareFeet/Year
 Prevents the deconstruction of Warehouse Space.
- (333) Minimum Manpower for Customer Support[company] = 5
 Units: FTE
 This is the minimum manpower required for customer support.
- (334) Minimum Manpower Required for Site Operation[company] = 5
 Units: FTE
 This is the minimum manpower required to operate the web site.
- (335) Minimum Marketing Spending[Company1] = 1e+006
 Minimum Marketing Spending[Company2] = 1e+006
 Minimum Marketing Spending[Company3] = 1e+006
 Units: dollar/Year
 The manager can set a minimum spending for marketing as a floor independent of current revenue.

- (336) Minimum Server Infrastructure required[company] = 10000
 Units: dollar
 This is the minimum infrastructure required to run the website.
- (337) Minimum Time for Fulfillment[company] = 2
 Units: days
 Even with a perfect fulfillment system, there is a minimum delay for fulfillment.
- (338) Number of Pageviews[company] =
 Loyal Occasional Buyer[company] * Occasional Buyer Pageviews
 + "Loyal High-Volume Buyer"[company] * "High-Volume Buyer Pageviews"
 + Independent Shopper Pageviews[company] * ("Independent High-Volume Buyer"
 + Independent Occasional Buyer + Potential Category Shoppers)
 Units: Pageviews/Year
 This variable calculates the number of pageviews based on the different user groups and their usage patterns.
- (339) Obsolescence[company] =
 Content[company] / Time to Obsolescence
 Units: webpages/Year
 Content that is no longer relevant is discarded regularly.
- (340) Occasional Buyer Pageviews = 100
 Units: Pageviews/(Year*People)
 It is assumed that loyal occasional buyers generate 100 pageviews per year.
- (341) Page generation per user[company] =
 Maximum page generation per user[company]
 * Lookup for propensity to contribute based on pages already contributed
 (Content[company])
 Units: webpages/(Year*People)
 The contribution of content per user is driven by the amount of content already contributed by other users.
- (342) Perceived Site Performance[company] =
 SMOOTH (Current Site Performance[company] , Customer Memory)
 Units: dimensionless
 The perceived site performance is determined by the performance over the period remembered by the customers.
- (343) Real Estate depreciation Rate = 0.1
 Units: 1/Year
 The average depreciation time for Real Estate is assumed to be ten years.

(344) Real Estate Infrastructure[company] =
 INTEG(Real Estate Infrastructure Spending[company]
 - Real Estate Depreciation[company] , 0)

Units: dollar

This measures the book value of the Real Estate investment based on expenses incurred and depreciation.

(345) Real Estate Infrastructure Spending[company] =
 MAX (0, (Change in Warehouse Space[company]
 + Warehouse Space at Start of Operations[company])
 * Cost of building warehouse space)

Units: dollar/Year

Companies can reduce their warehouse space, but don't get their money back.

(346) Required Manpower for Customer Support[company] =
 MAX (Number of Transactions[company]
 * FTE required per Customer Contact[company]
 * Customer Contacts per transaction
 * Adjustment for economies of scale for Customer Support (Number of Transactions[company]) ,
 Minimum Manpower for Customer Support[company])
 * Company in Operation Switch[company]

Units: FTE

This formula calculates the amnpower needed for customer support based on the number of transactions.

(347) Required Manpower for Site Operation[company] =
 MAX (FTE required per PageView * Number of Pageviews[company]
 * Adjustment for Economies of Scale for Site Operation (Number of Pageviews[company]) ,
 Minimum Manpower Required for Site Operation[company])
 * Company in Operation Switch[company]

Units: FTE

This formual calculates the manpower required on the engineering site based on site traffic.

(348) Required Server Infrastructure[company] =
 MAX (Number of Pageviews[company] * Server Requirements per Pageview
 * Adjustment for Economies of Scale for Site Operation (Number of Pageviews[
 company]) ,
 Minimum Server Infrastructure required[company])
 * Company in Operation Switch[company]

Units: dollar

This variable calculates the required server infrastructure based on the amount of site traffic.

(349) Server Depreciation Rate = 0.33

Units: 1/Year

The average depreciation delay is assumed to be 3 years.

(350) Server Infrastructure[company] =
 INTEG(Server Infrastructure Investment[company] - Server Depreciation[company]
 + Server Infrastructure at Beginning of Operations[company] , 0)

Units: dollar

The server infrastructure is a stock increased through investments and decreased through depreciation.

(351) Server Infrastructure at Beginning of Operations[company] =
 PULSE (Starting Date[company] , TIME STEP)
 * Initial Server Infrastructure[company] / TIME STEP

Units: dollar/Year

(352) Server Infrastructure Investment[company] =
 MAX (0, (Desired Server Infrastructure[company]
 - Server Infrastructure[company]) / Server Procurement Delay)

Units: dollar/Year

This calculates the amount of investment in server infrastructure based on the gap between goal and status quo and the server procurement delay.

(353) Server Procurement Delay = 0.33

Units: years

It takes 4 months to procure the new servers desired.

(354) Server Requirements per Pageview = 0.5

Units: dollar*Year/pageview

This measures the required investment in server infrastructure.

(355) Target Percentage of Revenue Spend for Marketing[Company1] =
 0.4 - RAMP (0.075, 1999, 2003) - RAMP (0.00714, 2003, 2010)
 Target Percentage of Revenue Spend for Marketing[Company2] =
 0.15 - RAMP (0.02, 2000, 2005)
 Target Percentage of Revenue Spend for Marketing[Company3] =
 0.6 RAMP (0.1, 1999, 2003) - RAMP (0.0143, 2003, 2010)

Units: dimensionless

The manager can decide on marketing spending by dedicating a certain percentage of revenue to marketing.

(356) Time Required for Fulfillment[company] =
 MAX (XIDZ (Effect of Number of Transactions on Warehousing needs (Number of Transactions[company]) * Product Selection[company] , Warehouse space[company] , 1) * FulfillmentTime conversion factor , Minimum Time for Fulfillment[company])
 * Company in Operation Switch[company]

Units: days

This formula determines the time for fulfillment based on the number of transaction and the available warehouse space.

(357) Time to adjust warehouse space = 2

Units: Year

It takes two years to build warehouse space.

(358) Time to change Product selection = 1.5

Units: Year

It takes 1.5 years to achieve the desired level of product selection.

(359) Time to Obsolescence = 0.5

Units: Year

It is assumed that content becomes obsolete within 6 months.

(360) Total Editorial Cost[company] =
 ("ease of User Content-Generation"[company]
 * Cost of allowing user generated Content[company]
 + Editorial Budget[company]) * Company in Operation Switch[company]

Units: dollar/Year

Total editorial costs are the sum of costs for self-generated and user-generated content.

(361) Total independent pageviews = 100

Units: Pageviews/(Year*People)

This is an assumption about the number of pageviews per independent user.

(362) Total number of loyal users[company] =
Loyal Occasional Buyer[company] + "Loyal High-Volume Buyer"[company]
Units: People

This variable aggregates loyal buyers of the company,
independent of their volume of purchases.

(363) User Generated Content[company] =
Total number of loyal users[company] * Page generation per user[company]
* "ease of User Content-Generation"[company]
Units: webpages/Year

New user-generated content is created based on the number of
users and the contribution per user.

(364) Warehouse space[company] =
INTEG(Change in Warehouse Space[company]
+ Warehouse Space at Start of Operations[company] , 0)
Units: SquareFeet

This stock tracks the warehouse space build by the company.
Reference:BandN build a 350.000 SQFeet distribution center in
1997.

(365) Warehouse Space at Start of Operations[company] =
PULSE (Starting Date[company] , TIME STEP) * Initial Warehouse Space[company]
/ TIME STEP
Units: SquareFeet/Year

This construction allows to account for existing warehouse space
at the time a company begins operations.

B.11. Starting Conditions

This section allows the creation of different scenarios by setting different starting conditions
for the various companies.

(368) Fraction of equity reserved for employees[company,engin] = 0.1333
Fraction of equity reserved for employees[company,custsupport] = 0.0667
Units: dimensionless

This parameter describes the amount of equity reserved for
future employees. A typical startup reserves about 20% of the
equity for future employees.

(369) Initial brand equity[Company1] = 50000

Initial brand equity[Company2] = 50000

Initial brand equity[Company3] = 2.5e+006

Units: dollar

The amount of brand equity available for the company at its simulated start date. Should be small for startups and potentially larger for web businesses using a bricks-and-mortar brand.

(370) Initial Cash[Company1] = 1e+007

Initial Cash[Company2] = 1e+007

Initial Cash[Company3] = 1e+008

Units: dollar

The amount of cash available for the company at its simulated start date.

(371) Initial Experienced Employees[Company1,engin] = 5

Initial Experienced Employees[Company2,engin] = 5

Initial Experienced Employees[Company3,engin] = 5

Initial Experienced Employees[Company1,custsupport] = 5

Initial Experienced Employees[Company2,custsupport] = 5

Initial Experienced Employees[Company3,custsupport] = 5

Units: workers

The initial staffing available for the company at its simulated start date.

(372) Initial Fraction of Founder OwnerShip[company] = 0.4

Units: dimensionless

This variable expresses how much equity is left in the hands of the founders at the beginning of the simulation. If it is below 1, it is assumed that the founders have already gone through a round of financing and have exchanged equity for cash.

(373) Initial Number of Shares Outstanding[company] = 1e+007

Units: shares

The number of shares outstanding when the company starts business.

(374) Initial Product selection[Company1] = 1e+006

Initial Product selection[Company2] = 1e+006

Initial Product selection[Company3] = 3e+006

Units: SKUs

The initial product selection (measured in stock-keeping units) available for the company at its simulated start date. Large B&M Bookstores carry up to 3 million SKUs. Bricks-and-Mortar Pet Superstore carry about 10,000 SKUs.

(375) Initial Warehouse Space[Company1] = 50000
Initial Warehouse Space[Company2] = 50000
Initial Warehouse Space[Company3] = 50000
Units: SquareFeet
Initial Warehouse Space available for the company at its simulated start date. Pets.com opened a 140.000 SQFT facility in September 1999 and announced a 300.000 SQFT facility at costs of \$ 7-9 M for Q1 2000.

(376) Starting Date[Company1] = 1995.5
Starting Date[Company2] = 1995.5
Starting Date[Company3] = 1997.5
Units: Year
Companies can start at any point during the simulated period.

B.12. .User Flows Module

(378) Capture of High Volume Buyers[company] =
("Independent High-Volume Buyer"
* Experienced Buyers Recapture Fraction[company])
* Company in Operation Switch[company]
Units: People/Year
Independent High-Volume buyers can become loyal buyers again based on the experienced buyer recapture fraction that differs for the different companies.

(379) Capture of Occasional Buyers[company] =
(Independent Occasional Buyer
* Experienced Buyers Recapture Fraction[company])
* Company in Operation Switch[company]
Units: People/Year
Independent Occasional buyers can become loyal buyers again based on the Experienced Buyer Recapture Fraction that differs for the different companies.

(380) Default Time to abandon = 2
Units: years
It is assumed that independent buyers abandon online shopping after an average of two years if they do not develop loyalty for one site.

(381) Delay to consider shopping online = 1.5
Units: Year
For most people, it takes a certain familiarity with the web before they consider purchasing online.

(382) Expected Fraction of High Volume Purchasers in Online Segment = 0.4

Units: dimensionless

This parameter determines which fraction of purchasers will reach the high-volume segment.

(383) Expected Penetration of Online Audience for Product Category (

[(0,0)-(1,0.6)],(0,0.5),(0.2,0.4),(0.4,0.325),(0.6,0.275),(0.8,0.225),
(1,0.2))

Units: dimensionless

This lookup allows to adjust the expected sales volume if there is a reason to assume that early Internet-adopters behave differently from later adopters with regard to the product under scrutiny. For books, one might expect the early internet adopters to be disproportionately literate. For pet supplies, there is no basis to assume that pets are distributed differently between early and late adopters. Note that 60% of U.S. households own a pet and 40% of those households own more than one pet. (Pets.Com SEC-filings).!!!

(384) Experienced Buyers Recapture Fraction[company] =

Lookup for Recapture Fraction based on Site Experience (Relative Site Experience[company])

Units: 1/years

The rate at which the companies gain loyal users from the pool of independent users depends on their site experience.

(385) First Time Acquisition Fraction[company] =

ZIDZ ("Indicated First-Time Acquisition Fraction"[company] ,
Sum of Indicated First Acquisition Fractions)

Units: dimensionless

This fraction determines the success of the company in capturing new users among those who have not shopped online for the product before.

(386) First Time Buying[company] =

(Potential Category Shoppers / Time to become comfortable buying online)
* Share of First Time Buyers[company]

Units: People/Year

The Rate at which people start buying online.

(387) Getting Online =

New Internet Users

Units: People/Year

Users get online at a certain rate and become Non-Shopping Internet-Users.

- (388) High Volume Buyer Abandon Rate =
 "Independent High-Volume Buyer" / Time to abandon
 Units: People/Year
 This rate measures how many high-volume buyers stop online shopping in favor of returning to bricks-and-mortar shopping.
- (389) "Independent High-Volume Buyer" =
 INTEG(- SUM (Capture of High Volume Buyers[company!])
 + SUM (Loss of High Volume Buyers[company!])
 - High Volume Buyer Abandon Rate , 0)
 Units: People
 This group represents people who buy high volumes but are not affiliated with any particular online retailer.
- (390) Independent Occasional Buyer =
 INTEG(SUM (Loss of Occasional Buyers[company!])
 - SUM (Capture of Occasional Buyers[company!])
 - Occasional Buyer Abandon Rate , 0)
 Units: People
 This group represents purchasers of moderate volumes of books who are not affiliated with any particular online retailer.
- (391) Loss of High Volume Buyers[company] =
 "Loyal High-Volume Buyer"[company] * Turnover Fraction[company]
 Units: People/Year
 This flow measures the loss of loyal shoppers who become independent shoppers.
- (392) Loss of Occasional Buyers[company] =
 Loyal Occasional Buyer[company] * Turnover Fraction[company]
 Units: People/Year
 This flow measures the loss of loyal shoppers who become independent shoppers.
- (393) "Loyal High-Volume Buyer"[company] =
 INTEG(Repeat Purchases[company] + Capture of High Volume Buyers[company]
 - Loss of High Volume Buyers[company] , 0)
 Units: People
 This group of people represents high-volume purchasers who are loyal to one online retailer unless special circumstances occur.

(394) Loyal Occasional Buyer[company] =
INTEG(First Time Buying[company] - Loss of Occasional Buyers[company]
- Repeat Purchases[company] + Capture of Occasional Buyers[company] , 0)
Units: People

These people shop online on a regular basis, though the volumes are small. They are loyal in the sense that they buy always at the same site and they stay loyal unless they get disappointed.

(395) "Non-Shopping Internet Users" =
INTEG(Getting Online - Surfing for retail sites + High Volume Buyer Abandon Rate
+ Occasional Buyer Abandon Rate , Total Internet Users)
Units: People

These are users of the Internet who have not yet started shoppingonline for the product.

(396) Number of Transactions[company] =
Annual Transactions per Occasional Buyer * (Loyal Occasional Buyer[company]
+ Independent Occasional Buyer * Percentage of Independent Business Captured by
Company[company]) + Annual Transactions per High Volume Buyer
* ("Loyal High-Volume Buyer"[company] + "Independent High-Volume Buyer"
* Percentage of Independent Business Captured by Company[company])
Units: transactions/Year

This variable calculated the number of transaction based on the different user groups and their usage patterns.

(397) Occasional Buyer Abandon Rate =
Independent Occasional Buyer / Time to abandon
Units: People/Year

This is the rate with with occasional buyers stop shopping online and return to bricks-and-mortar-shopping.

(398) Percentage of Population online =
Total Internet Users / Population
Units: dimensionless

This measures the fraction of the US population that is online.

(399) Potential Category Shoppers =
INTEG(Surfing for retail sites - SUM (First Time Buying[company!]) , 0)
Units: People

These are people who are interested to shop online and who are already checking out various online retailers. They have not yet made a purchase and have not developed loyalty to any particular company.

(400) Repeat Purchases[company] =

$$\text{MAX} (0, (\text{Loyal Occasional Buyer}[company] / \text{Time to reach high Volumes} \\ * (\text{Size of Relevant High Volume Segment} - \text{Total High Volume Buyers}) \\ / \text{Size of Relevant High Volume Segment}))$$

Units: People/Year

This flow measures the amount of people becoming high-volume purchasers. It's driven both by size of the loyal occasional buyer pool but limited such as to prevent the high-volume segment to grow bigger than expected.

(401) Share of First Time Buyers[company] =

$$\text{First Time Acquisition Fraction}[company]$$

Units: dimensionless

The share of first time buyers is determined through the first time acquisition fraction which is an aggregate measure of several performance criteria of the retailing operation.

(402) Size of Relevant High Volume Segment =

$$\text{Expected Fraction of High Volume Purchasers in Online Segment} \\ * \text{Size of relevant Online Segment}$$

Units: People

This calculates the maximum size of the High-Volume segment.

(403) Size of relevant Online Segment =

$$\text{Total Internet Users} \\ * \text{Expected Penetration of Online Audience for Product Category} \\ (\text{Percentage of Population online}) \\ * \text{"Relative Attractiveness Of Online Shopping vs. Bricks and Mortar"}$$

Units: People

Only a fraction of the potential shoppers is relevant for the product category examined. This adjustment is done with this structure.

(404) Surfing for retail sites =

$$\text{IF THEN ELSE} (\text{SUM} (\text{Company in Operation Switch}[company!]) \\ > 0, ((\text{Size of relevant Online Segment} - (\text{Total Internet Users} \\ - \text{"Non-Shopping Internet Users"})) / \text{Delay to consider shopping online}), 0)$$

Units: People/Year

The flow of people who start visiting online retailers websites but don't yet complete purchases.

- (405) Time to abandon =
 Default Time to abandon
 * "Relative Attractiveness Of Online Shopping vs. Bricks and Mortar"
 Units: years
 This is the time it takes independent shoppers to abandon online shopping in favor of bricks-and-mortar shopping.
- (406) Time to become comfortable buying online = 2
 Units: years
 It takes the average online-user two years to become comfortable with the idea of buying online.
- (407) Time to reach high Volumes = 2
 Units: Year
 It is assumed that it takes occasional buyers two years to reach higher volumes of purchases.
- (408) Total High Volume Buyers =
 "Independent High-Volume Buyer" + SUM ("Loyal High-Volume Buyer"[company!])
 Units: People
 This calculates the total number of high-volume buyers, including independent.
- (409) Total Internet Users =
 INTEG(New Internet Users , 1.5e+007)
 Units: People
 This tracks the number of people connected to the Internet.
- (410) Turnover Fraction[company] =
 XIDZ (XIDZ (XIDZ (Turnovers due to poor performance[company] ,
 Attractiveness of Fulfillment[company] , 1) ,
 Perceived Quality of Customer Support[company] , 1) ,
 Relative Attractiveness of Price[company] , 1)
 / "Relative Attractiveness Of Online Shopping vs. Bricks and Mortar"
 Units: dimensionless/Year
 The Turnover rate is driven by various factors.

End of Model.