

Limits to growth in the new economy: exploring the 'get big fast' strategy in e-commerce[†]

Rogelio Oliva,^{a*} John D. Sterman^b and Martin Giese^c

Rogelio Oliva is an assistant professor in the Technology and Operations Management Unit at the Harvard Business School. He holds a BS in industrial and systems engineering from ITESM (Mexico), an MA in systems in management from Lancaster University (UK), and a PhD in operations management and system dynamics from MIT. His current research interests include service operations, and the transition that product manufacturers are making to become service providers.

John Sterman is the Jay W. Forrester Professor of Management and Director of the System Dynamics Group at the MIT Sloan School of Management.

Martin Giese is a management consultant with Solon Management Consulting based in Munich, Germany. He holds a law degree and a diploma in journalism from Hamburg University, a Master of Public Administration from Harvard University

Abstract

Many e-businesses have pursued a 'get big fast' (GBF) strategy, pricing low and marketing heavily to build their user base, in the belief that there were significant sources of increasing returns favoring early entrants and large players. Until early 2000 the capital markets rewarded the GBF strategy, but since then market values have collapsed and scores of new-economy firms have failed. The rise and fall of the dot coms is not merely a case of a speculative bubble. Many firms stumbled when they grew so rapidly that they were unable to fulfill orders or provide quality service. GBF proponents focus on the positive feedbacks that create increasing returns and favor aggressive firms, but have not paid adequate attention to the negative feedbacks that can limit growth, e.g., service quality erosion. The faster a firm grows, the stronger these negative feedbacks may be. We address these issues with a formal dynamic model of competition among online and click-and-mortar companies in business-to-consumer e-commerce. The model endogenously generates demand, market share, service quality, employee skill and retention, content creation, market valuation, and other key variables. The model is calibrated to the online book market and Amazon.com as a test case. We explore growth strategies for e-commerce firms and their sustainability under different scenarios for customer, competitor, and capital market behavior. Copyright © 2003 John Wiley & Sons, Ltd.

Syst. Dyn. Rev. **19**, 83–117, (2003)

Introduction: "grow or die" or "grow and die"

"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" (Sahlman and Stevenson 1985).

These words refer not to the Internet bubble that collapsed in March 2000 but to the Winchester disk drive industry in the early 1980s. The rise and fall of the disk industry in the early 1980s and the Internet stock bubble in the late 1990s show many similarities. Business to Consumer (B2C) electronic commerce

^a Harvard Business School, Morgan Hall T87, Boston, MA 02163, USA; E-mail roliva@hbs.edu

^b MIT, Sloan School of Management, 30 Wadsworth St, E53-351, Cambridge, MA 02142, USA; E-mail jsterman@mit.edu

^c Solon Management Consulting, Residenzstrasse 10, D-80333 München, Germany; E-mail mg@solon.de

* Correspondence to Professor Rogelio Oliva, Harvard Business School, Morgan Hall T87, Boston, MA 02163, USA; E-mail: roliva@hbs.edu

[†] We thank Arthur Andersen LLP (JS) and the Division of Research at the Harvard Business School (RO) for financial support of this work.

and a Master of Science in Management from MIT. His consulting work focuses on strategic planning, business modelling and M&A support for companies and private equity funds in the areas of telecommunications, the Internet and the media. He teaches seminars at the Center for Digital Technology and Management, Munich, on entrepreneurial negotiation, business planning and modelling and conflict management in teams.

has grown rapidly over the past ten years. By the late 1990s, online retailers generated huge interest from investors, and the total market capitalization for publicly listed B2C companies approached \$250 billion in December 1999 (Sood *et al.* 1999). In the first quarter of 2000, US-based Internet startups raised more than \$17 billion in venture capital, accounting for over 75% of all venture funding (NVCA 2000a); 139 companies went public in the first quarter of 2000 (NVCA 2000b). As with the disk drive industry, growth, not profit, was the metric for success.

A continuing flow of capital, however, appeared doubtful by 1999. Critics warned of “hollow companies, which have limited experience, wisdom, commitment, long-term view, allegiance to the customer, or sense of construction” (Colony 2000, p. 1), or more bluntly, that these companies were “built to flip” (Collins 2000), predicting that the Internet bubble would inevitably burst (Perkins and Perkins 1999). Warren Buffett compared Internet stocks to a chain letter, arguing “If you are very early in a chain letter, you can make money, but there’s no money created” (Edgeckuffe-Johnson 2000). And so it was: by March 31, 2000 many online retailers were trading 30% to 95% below the peak valuations they enjoyed only a few weeks earlier. Industry analysts proclaimed “The demise of Dot Com Retailers” (Sawyer *et al.* 2000). Falling valuations triggered concern over the ability of online retailers to fund their continuing losses—losses often driven by heavy advertising and low prices to stimulate growth (Sawyer *et al.* 2000). Stories about likely candidates for bankruptcy dominated the business press (Byrne 2000; Kary 2000; Larson 1999; Lewis 1999; Reuters 2000; Wolff 1999). The collapse of the Internet sector and related high-technology stocks contributed to the recession that began in the spring of 2001. Dozens of web sites now track dead and dying dot coms and the thousands of layoffs they caused, including the “Dot-Com Flop Tracker” published by the *Industry Standard* until it, too, failed in September 2001.¹

The rise and fall of the dot coms raises critical questions for investors, managers, and theorists. Why did the rapid growth strategies pursued by so many dot coms fail? What pitfalls confront companies pursuing aggressive strategies? To what extent did their success and failure depend on speculative excess in the capital markets? We address these issues with a formal dynamic model of the competition among online and click-and-mortar companies in B2C e-commerce.

Get Big Fast: The rationale for the funding frenzy during the bubble often appeared to be the “Get Big Fast” (GBF) strategy. The popularity of the GBF strategy followed growing awareness of positive feedbacks as sources of competitive advantage. These positive feedbacks include network effects, scale economies, learning curves, standards formation and the accumulation of complementary assets (Sterman 2000, Ch. 10 describes several dozen such effects). In general, the literature suggests that in the presence of such positive feedbacks, firms should pursue an aggressive strategy in which they seek to grow as rapidly as possible and preempt their rivals. Typical tactics include

pricing below the short-run profit-maximizing level (or even below the cost of goods sold), rapidly expanding capacity, advertising heavily, and forming alliances to build market clout with suppliers and workers and to deter entry of new players (Fudenberg and Tirole 1983; 1986; Spence 1981; Tirole 1990). Intuitively, such aggressive strategies are superior because they increase both industry demand and the aggressive firm's share of that demand, stimulating the positive feedbacks described above.

Recognition of positive feedbacks and the recommendation to pursue GBF strategies can be traced back at least to the early work of the Boston Consulting Group on learning curves. During the past decade, however, popularization of the positive feedback/increasing returns concept led to much broader claims for the generality of the GBF strategy. Examples include Arthur's (1989; 1994) discussion of increasing returns and Frank's (1995) theory of "winner take all" markets. A host of popularizers extolled the virtues of the GBF strategy, with few caveats and breathless exaggeration. For example, the *Wall Street Journal* (Hill *et al.* 1996) reported "W. Brian Arthur . . . has helped popularize the notion of increasing returns, which says that early dominance leads to near monopolies as customers become locked in and reluctant to switch to competitors. Now, dozens of companies are chasing market share." Similarly, Rothschild (1990, p.181) tells managers "By slashing prices below costs, winning the biggest share of industry volume, and accelerating its cost erosion, a company [can] get permanently ahead of the pack . . . [and build] an unchallengeable long-term cost advantage."

The popularity of the GBF strategy was also stimulated by some high-profile successes, some of which have attained the status of myth. These include the victory of the VHS format over Sony's Betamax in the home VCR market, AOL's rise to dominance in the US Internet Service Provider market, and, most famously, the rise of Microsoft and the Wintel (Windows and Intel) duopoly as the standard for personal computers (see Sterman 2000, Ch 10 for discussion). Netscape's decision, quickly imitated by Microsoft, to give away their web browsers was a conscious attempt to build an installed base of users and developers, who would then generate revenue through Netscape's portal and server business (Cusumano and Yoffie 1998). The spectacular success of early e-commerce entrants like Amazon.com demonstrated for many the wisdom of the GBF strategy, unleashing a rush to be the first to launch and dominate dozens of other segments, from pet supplies to funeral services.²

Low prices and large investments in infrastructure mean firms pursuing the GBF strategy cannot fund their growth from operations and require significant external capital. The willingness of the capital markets to supply huge sums to firms that by any conventional measure are worth little depended on a strong faith in the efficacy of the GBF strategy: massive investment in customer acquisition to build an installed base may generate large losses in the near term, but, if successful, promised huge profits once the firm achieved the "unchallengeable" long-term advantage GBF advocates promised. During the

Internet boom of the late 1990s, investors competed vigorously to fund Initial Public Offers (IPO) and secondary offerings, bidding dot com share prices to extraordinary levels.³ By the late 1990s the rush to gain first-mover advantage in e-commerce had become a full-fledged speculative bubble rivaling the tulip mania, the South Sea bubble, and the stock market boom of the 1920s.

Yet the majority of e-commerce firms seeking to get big fast have failed. Clearly some startups entered markets in which the positive feedbacks that motivate the GBF strategy simply did not exist or were too weak (e.g., pet supplies); in these cases, the failure of the GBF strategy is expected. More interesting are those firms that did appear to benefit from positive feedbacks yet still found the GBF strategy to be difficult or unsuccessful. We argue that GBF strategies may trigger a host of negative feedbacks that can drive service quality down, eroding the attractiveness of the firm. Once a firm develops a reputation for poor service and customer growth slows, the same positive feedbacks that powered growth may become vicious cycles as customers, investors, employees, suppliers, content providers, and others lose confidence in the firm, potentially leading to a death spiral and exit.

System dynamics has long been used to study these dynamics. Inspired by his experience on the board of the Digital Equipment Corporation, Forrester's (1966) corporate growth model portrayed a high-tech firm developing new products, a sales force, manufacturing capacity, and other resources needed to meet demand. The model focused on the internal dynamics of the firm and the feedbacks among resource acquisition, quality, order fulfillment, pricing, and demand; see also Nord (1963) and Packer (1964). Forrester's (1968) Market Growth model showed how a firm could limit its own growth, and even collapse, despite operating in a market with unlimited potential, as delays in capacity acquisition eroded customer service. The People Express Management Flight Simulator (Sternan 1988) illustrates a similar dynamic through a real case in the service industry. People Express pursued a GBF strategy, growing from first flight in 1981 to the fifth largest US air carrier before collapsing in September 1986 when its poor service quality drove customers to competitors. Other models of growth have considered boom and bust caused by the interaction of positive feedbacks such as learning curves and word of mouth with market saturation (e.g., Paich and Sternan 1993). Hagel and Armstrong (1997) used system dynamics to examine the growth of online markets. Their model captures four reinforcing loops for online communities: Content Attractiveness, Member Loyalty, Member Profiles and Transaction Offering. Hagel and Armstrong (1997) argue that these loops interact synergistically so that firms able to mobilize them all will grow faster than rivals with single strengths. However, their model does not detail the negative feedbacks that might limit the growth of firms pursuing their advice, or the appropriability of the positive loops they identify.

Model structure

We drew on multiple data sources to develop and test the model. The main sources of numerical data to test and calibrate the model were industry reports (Allen 1999; Balter *et al.* 1999; Charron *et al.* 1999; Cooperstein 1999; Dykema 1999; Hagen 1999; LaTour Kadison *et al.* 1998; Li 1999; Nail 1999; Sood *et al.* 1999; Williams 1999), company reports, and Securities and Exchange Commission (SEC) filings of online retailers. We used judgment and drew on analogous industries and prior models to estimate parameters and relationships for which no numerical data were available. We drew upon established system dynamics models of the firm such as those cited above and experimental studies of managerial decision making (e.g., Sterman 1989a,b) to specify the model structure and the decision rules for the actors.

The model portrays a single online market (product category), with multiple competitors, including the online division of an established brick-and-mortar firm. We simulate the period 1995 to 2010. Widely regarded as the year that Internet retailing began, 1995 is also the year Amazon.com (our calibration case study and the largest online retailer) was launched. The year 2010 allows sufficient time to explore the ramifications of Internet saturation in the US market. Because of our interest in exploring the limits to growth in a single market, we do not capture expansion into new product categories (such as Amazon.com's move from books into CDs) or into international markets. The model can simulate the entry of new competitors at arbitrary times. We model the decision to go public explicitly because of its impact on the availability of capital and the hiring and retention of talent (Shreve 2000). The model does not, however, capture mergers and acquisitions, nor bankruptcy and exit. The lack of explicit exit is not likely to affect the results significantly since firms experiencing sustained losses tend to shrink, a form of *de facto* exit. Explicitly modeling exit is, however, an area for model elaboration.

The model consists of eight modules (Figure 1). Five of these—*User Flows*, *Site Operations*, *Human Resources*, *Financial Accounting*, and *Fundraising*—are specific to each competitor. The rest—*Market*, *Relative Performance*, and the *Financial Markets*—capture the market for the product, the allocation of total demand to each of the competitors, and the behavior of the capital markets. The *Site Operations* and *Human Resources* subsystems capture the principal assets and resources of each firm, as well as decision rules for pricing, server and warehouse infrastructure, product selection, site content, marketing expenditures, and hiring and attrition of customer support personnel and development engineers. The accounting module tracks performance and reports it to the financial markets. Finally, the fundraising subsystem allows firms to sell stock to the public to raise capital. At the market level, the performance of each competitor is assessed along seven dimensions (see Figure 1) and its relative performance affects customer acquisition and retention. Population

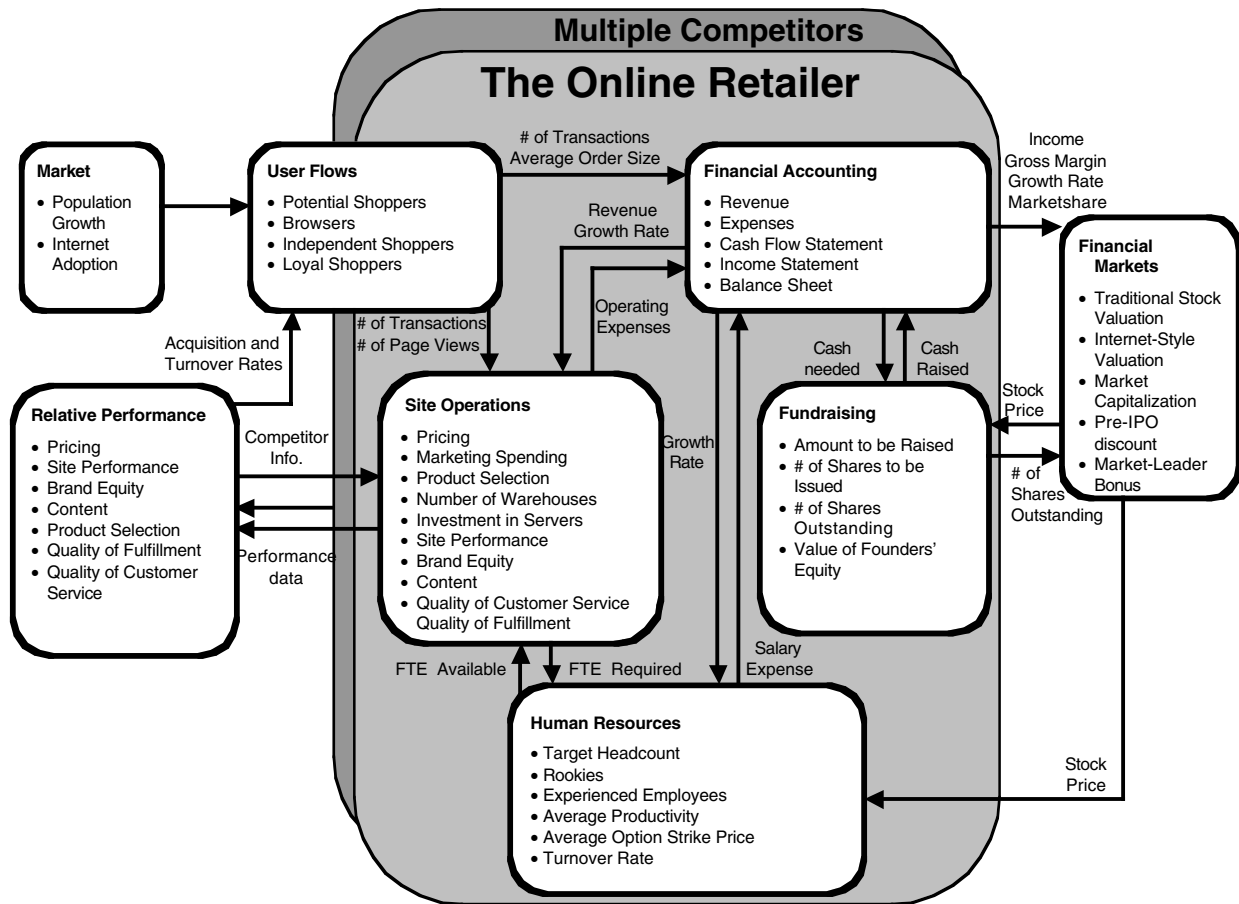


Fig. 1. Model overview

growth and Internet adoption are exogenous. Finally, macroeconomic factors such as changes in GDP and total consumer spending are excluded.

While the model is too large to describe fully here, we illustrate its structure with three important formulations: consumer choice among online retailers, employees' beliefs about the value of their options and their impact on employee retention, and the valuation of Internet stocks by the capital markets. The model and complete documentation are available at <http://www.people.hbs.edu/roliva/research/dotcom>.

Adoption of online purchasing

The *User Flows* subsystem models how online category shoppers make the decision to browse retail web sites, make purchases, develop loyalty to

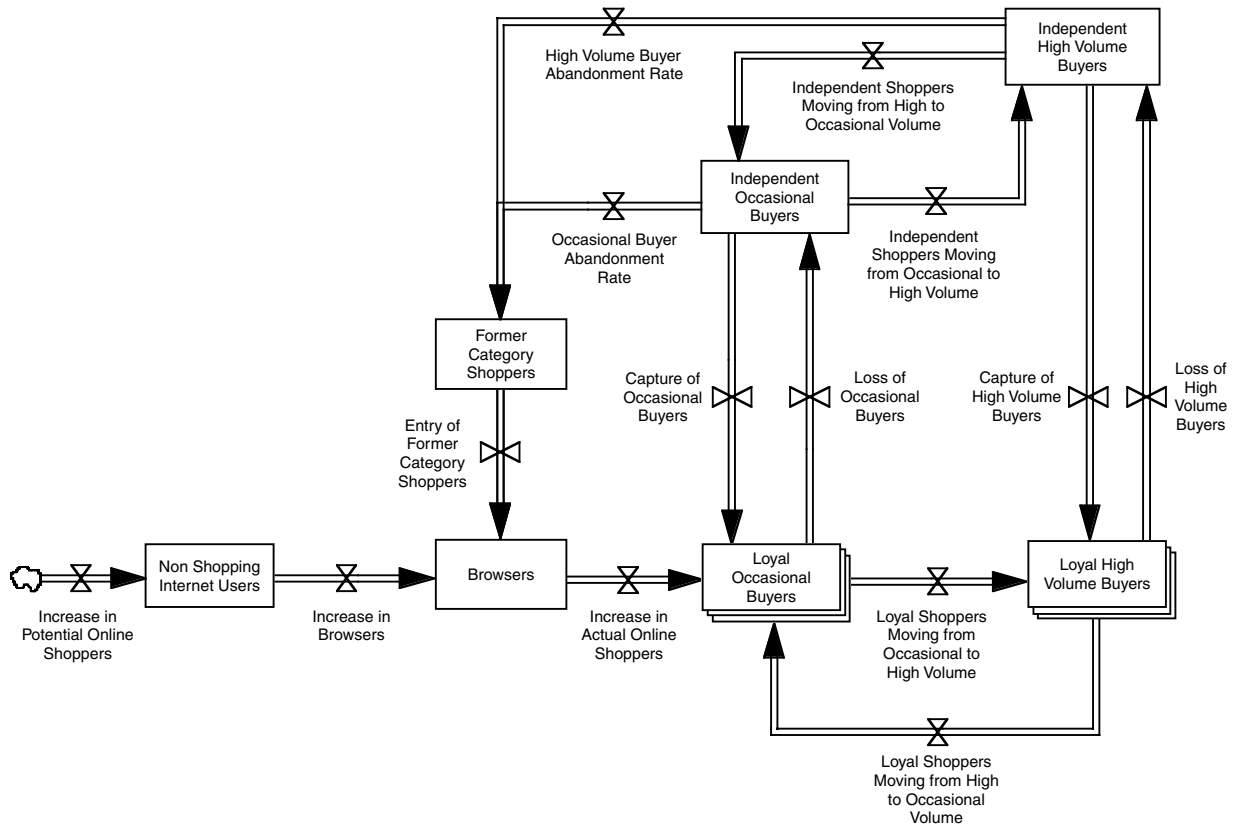


Fig. 2. User flows

an online retailer, change their preferences among retailers, increase their spending or, depending on the performance of online retailers relative to brick-and-mortar players, abandon online shopping (Figure 2). As people without computers acquire them and gain access to the Internet, they enter the stock of *Non-shopping Internet users*, those who have Internet access but have not yet shopped online in the market category considered. As people begin to browse for sites related to the category, they move into the stock of *Browsers*, defined as those exploring sites offering products in the category, but who have not yet made a purchase. Word of mouth determines how fast people decide to purchase online. Once these shoppers make their first purchase they move into one of the stocks of customers. Online shoppers are disaggregated along two dimensions: whether they show a clear preference for a particular online retailer (loyal vs. independent), and the volume of their purchase pattern for the product category

(occasional vs. high-volume). The populations of loyal occasional and high-volume customers are indexed over the set of firms competing in the category.

The increase in potential online shoppers is determined as a fraction of the overall Internet adoption rate that might be interested in the product category. Internet adoption is determined by the market module and calibrated to fit data from industry reports and forecasts (Williams 1999). The other flows that determine the overall size of the market are driven by attributes such as the performance of online retailers relative to brick-and-mortar players, the time required for new Internet users to become comfortable with online purchases, and the fraction of online shoppers likely to become high-volume buyers. To illustrate, consider the population of loyal high-volume buyers for firm j (denoted L_j^h). The number of loyal high-volume buyers increases with the recruitment of occasional shoppers who escalate to high-volume activity (r_j^{oh}). High-volume buyers can de-escalate to occasional buyers (r_j^{ho}). Shoppers can abandon their loyalty to a specific firm and become independent shoppers willing to buy from multiple firms (r_j^{hi}), and independent high-volume shoppers can become loyal to a specific firm (r_j^{ih}):

$$dL_j^h/dt = r_j^{oh} - r_j^{ho} + r_j^{ih} - r_j^{hi}, \quad j \in \{1, \dots, n\} \quad (1)$$

Shoppers escalate from loyal occasional (L_j^o) to loyal high-volume buyers (L_j^h) at a firm-specific fractional rate, ρ^{oh} :

$$r_j^{oh} = \rho_j^{oh} L_j^o \quad (2)$$

However, not all occasional shoppers will become high-volume purchasers, so the escalation rate falls below a reference rate ρ^{*oh} as the total number of high-volume shoppers T^h approaches the potential number of high-volume shoppers P^h :

$$\rho^{oh} = \rho^{*oh} \times \text{MAX}[0, (P^h - T^h)/P^h] \quad (3)$$

The potential number of high-volume online shoppers P^h is a fraction of the number of households online. The maximum function ensures the escalation rate remains non-negative even if $P^h < T^h$, which could occur if the attractiveness of online shopping declined after $T^h \approx P^h$. The total number of high volume shoppers consists of the independent high-volume shoppers I^h and the sum of high volume shoppers loyal to each firm:

$$T^h = I^h + \sum_{j=1}^n L_j^h \quad (4)$$

De-escalation from high volume to occasional purchasing is modeled simply as a fraction of the high-volume customers per year.

We model switching among online retailers as a two-stage process. First, loyal customers (those who buy from a specific firm) can become independent shoppers (those who allocate their purchases among different retailers according to the attractiveness of each at the moment of purchase). A certain fraction ρ_j^{hi} of each firm's loyal high-volume customers are lost and become independent each year:

$$r_j^{hi} = \rho_j^{hi} L_j^h \quad (5)$$

The turnover fraction falls as the attractiveness of the firm rises:

$$\rho_j^{hi} = \text{MIN}[\rho^{\max}, \rho^{*hi}/A_j] \quad (6)$$

where ρ^{\max} is the maximum rate of customer switching, ρ^{*hi} is the normal rate of switching from loyal to independent high-volume shopper, and A_j is a dimensionless index of the attractiveness of firm j . Attractiveness depends on seven attributes: price, product selection, site content, site performance, fulfillment accuracy and reliability, customer service, and brand equity (company image). The individual factors are nonlinear, and a multiplicatively separable function for overall attractiveness is assumed.

Independent customers can become loyal to one of the firms (including possibly the same one they originally favored). A fraction of the independents ρ_j^{ih} become loyal to firm j each year. The recapture fraction depends on the attractiveness of firm j relative to the total attractiveness of all online firms:

$$r_j^{ih} = \rho_j^{ih} I^h \quad (7)$$

$$\rho_j^{ih} = \rho^* \left(A_j / \sum_{k=1}^n A_k \right) \quad (8)$$

where ρ^* is the overall rate of customer switching. The formulations for the flows affecting the populations of occasional buyers are analogous. Finally, independent customers can abandon online shopping in the category altogether. Former shoppers may decide to try online shopping again, flowing into the browser stock when they decide to re-enter the online segment.

Labor and employee stock options

The quality of an online retailer's website, fulfillment operations, and customer service depends on the skill and experience of their employees. We therefore distinguish between new and experienced employees, following standard structures used to model hiring and on-the-job learning (e.g., Lyneis 1980; Oliva and Sterman 2001). Because employees of e-commerce firms work in an emerging new industry and must master firm-specific knowledge, we assume that all new hires are inexperienced. An important consequence of the labor experience chain is a decline in average productivity during

periods of rapid growth (Sterman 2000, Ch. 12). We also distinguish between “engineers” and “customer support personnel.” The engineer department includes people responsible for site development, IT services, and other tasks requiring technical expertise. Customer support personnel work in call centers, customer service, and order fulfillment. Further, engineers are more difficult to hire and require a longer period of on-the-job learning before they achieve full productivity compared to more routinized jobs such as providing customer service in a call center or picking, packing, and shipping orders.

Employee attrition, for both new and experienced workers, depends on the attractiveness of their jobs. Job attractiveness depends on both lifestyle and financial factors. Lifestyle attractiveness depends on the average workweek—sustained long workweeks reduce job attractiveness and increase attrition (Oliva and Sterman 2001; Sterman 2000, Ch. 14). Financial attractiveness depends on the total compensation each employee expects—higher expected compensation suppresses attrition. The effects are nonlinear. In particular, long hours have a progressively steep effect on attrition, and employees grow quite unhappy with the company and their job when their total compensation falls, for example, when their options are underwater.⁴

Most, if not all, new economy firms offer comparatively low salaries but grant stock options to employees. Total compensation for employee in department d at firm j is measured by the expected present value (EPV) of the employee’s base salary and stock options:

$$\text{EPV of Total Compensation}_{d,j} = \text{EPV of Salary}_{d,j} + \text{EPV of Stock Options}_{d,j} \quad (9)$$

We use the salary of experienced workers to assess the EPV of salary (we assume all rookies believe they will soon be promoted):

$$\text{EPV of Salary}_{d,j} = \text{Salary for Experienced}_{d,j} / \delta_j \quad (10)$$

where δ_j is the firm-specific discount rate. The discount rate incorporates employees’ assessment of the probability they will be laid off, which in turn is a function of firm liquidity:

$$\delta_j = \delta^* + \pi_j \quad (11)$$

where δ^* is a base discount rate and $\pi_j = f(\text{Liquidity}_j)$ is employees’ subjective probability the firm will lay them off or fail. Liquidity is the ratio of cash on hand to the cash required to meet payroll and other expenses.

Employees may have vested and nonvested options. Only the expected value of nonvested options matters to the attrition decision since those with vested options can exercise them even after they leave the firm. The expected present value of nonvested options is assessed using the same discount rate, and assuming all nonvested options vest after the average vesting period λ :

$$\begin{aligned} \text{EPV of Stock Options}_{d,j} &= \text{Expected Value of Nonvested Stock Options}_{d,j} \\ &\times \exp(-\delta_j \times \lambda_{d,j}) \end{aligned} \quad (12)$$

When their options are in the money, employees value them at roughly the current difference between the stock price and average strike price. If the stock price declines and the options go underwater, the subjective value gradually declines: options that are worthless today still have some value, but that value falls as the current price falls farther below the strike price.

The model assumes a standard stock option plan in which some options are granted to new hires and additional options are granted to all employees on an ongoing basis as part of their compensation package. Options are issued at the current stock price and vest continuously over a vesting period. We represent the granting, vesting, expiration, exercise, and average strike price of options using standard co-flows (Sternman 2000, Ch. 12; see the model documentation for details). Our formulation allows for the endogenous repricing of options as a policy in the case where the stock price falls below the average strike price (as was done by, e.g., Microsoft, after declines in its share price left many employees with their options underwater).

The variable discount rate and stock options capture important positive feedbacks. The better a firm performs, the greater the EPV of total compensation will be, both because rising stock prices boost option value and because success provides ready access to capital, cutting the risk of layoff and failure, reducing the discount rate and hence increasing the present value of options and salary. With higher expected compensation, employee attrition falls, raising the average experience and productivity of workers and reducing training and recruiting costs. More experienced and productive workers deliver higher customer service, increasing firm attractiveness and leading to still greater success. These positive loops are highly nonlinear, however, and operate more strongly as vicious cycles if a company experiences financial distress and increasing attrition.

Valuation of Internet stocks

We model the way capital markets value the firm and the firm's ability to raise external capital endogenously. Traditional valuation models seek to estimate the present value of expected future profits. In valuing established businesses it is commonly assumed that net income will grow at a constant fractional rate g often estimated from the trend in past profits. In that case, the present value of future earnings (the firm's market value) is given by:

$$V_j = \frac{\text{Net Income}(t_0)}{r - g} \quad (13)$$

where r is the discount rate. However, Eq. 13 fails for high growth rates (where $r - g < 0$) or for cases where current profits are negative. Such traditional valuation models perform poorly for e-commerce startups, which often consistently (and intentionally) lose money during their startup phase,

particularly if they pursue GBF strategies. As the Internet and technology boom grew, analysts and company executives proposed alternative valuation models to justify their high market values and gain access to capital. These models typically focused on the growth of revenue or gross profit, not net income, assuming that, after an initial period of losses driven by the GBF strategy, costs would stabilize and the firm would be able to earn a return on sales that would generate profits in the long run. High revenue growth and the assumption of future positive returns on sales can then justify very high valuations even when a firm has never been profitable. Such models are supported by Trueman *et al.* (2000), who found “that gross profits [for new economy firms] are positively and significantly associated with [share] prices”; they were unable to detect a positive relation between share prices and net income.

To capture such new economy valuation logic, we model the market value of the firm V as the greater of the present value of expected profits or its salvage (breakup) value (the firm subscript is omitted for clarity):

$$V = \text{MAX}(\text{Breakup Value}, \text{EPV of Profit} \times \text{Pre IPO Discount}) \quad (14)$$

The Pre IPO Discount reflects the reduction in market value for privately held firms due to the low liquidity of the private placement market. (Initially, each pure e-commerce entrant in the model is assumed to be privately held. Each firm goes public at a specified date, at which point the Pre IPO Discount becomes unity.) The EPV of Profit is based on expected profits and a growth-adjusted discount factor:⁵

EPV of Profit

$$= \text{MAX}(0, \text{Expected Net Income}) / \text{Growth Adjusted Discount Factor} \quad (15)$$

The growth adjusted discount factor is a nonlinear function of the discount rate r and the expected rate of growth in future earnings g :

$$\begin{aligned} \text{Growth Adjusted Discount Factor} &= f(r - g) \\ &= \begin{cases} r - g & \text{for } r - g \geq 0.04 \\ 0.04 \times \exp[\alpha(r - g) - 0.04] & \text{for } r - g < 0.04 \end{cases} \end{aligned} \quad (16)$$

The function reduces to the standard formulation (Eq. 13) when $r - g \geq 0.04$ /year, but remains non-negative as the growth rate rises and $r - g$ falls below zero. The parameter α governs the price/earnings ratio under conditions of rapid growth and is estimated from the data. The expected growth in profit g is estimated from the history of revenue growth (not net income), using the standard TREND function (Sterman 2000, Ch. 16).

The other input to the EPV of profit is Expected Net Income. We assume that investors use a weighted average of recent actual profits and an estimate of

what profit would be if the firm were able to achieve a certain return on sales:

$$\begin{aligned} \text{Expected Net Income} &= w \times \text{Recent Net Income} + (1 - w) \\ &\quad \times \text{Expected Steady State Net Income} \end{aligned} \quad (17)$$

where w is the weight on actual net income. We assume that investors give a new startup a honeymoon period T_H after their startup date T_S , during which they view actual profitability as unrepresentative of future profits, so the weight on recent net income is initially zero. As the honeymoon ends, the weight on actual net income gradually rises to one (using a third-order information delay, denoted SMOOTH3):

$$w = \text{SMOOTH3}(w^*, \tau_{\text{NI}}) \quad (18)$$

$$w^* = \begin{cases} 0 & \text{for } t < T_s + T_h \\ 1 & \text{for } t \geq T_s + T_h \end{cases} \quad (19)$$

where τ_{NI} is the time constant for the adjustment of the weight on actual net income from 0 to 1.

Recent net income is modeled by adaptive expectations (exponential smoothing) to capture reporting delays and expectation updating among analysts and the capital markets. Expected Steady State Net Income is based on recent sales and an estimate of the steady-state return on sales:

$$\begin{aligned} \text{Expected Steady State Net Income} &= \text{Expected Long Run Return on Sales} \\ &\quad \times \text{Recent Sales Revenue} \end{aligned} \quad (20)$$

Recent sales is formed from actual sales by exponential smoothing. Expected long-run return on sales is modeled by adaptive expectations (using a third-order information delay), and adjusts gradually from an initial value to the average return on sales achieved in the firm's market segment (where the return on sales of each firm are weighted by market share):

$$\begin{aligned} \text{Expected Long Run Return on Sales} \\ &= \text{SMOOTH3}(\text{Indicated Industry Return on Sales}, \tau_{\text{ROS}}) \end{aligned} \quad (21)$$

$$\begin{aligned} \text{Indicated Long Run Return on Sales} \\ &= \begin{cases} \text{Indicated Expected Return on Sales} & \text{for } t \leq T_{\text{ROS}} \\ \text{Industry Average Return on Sales} & \text{for } t > T_{\text{ROS}} \end{cases} \end{aligned} \quad (22)$$

$$\begin{aligned} \text{Industry Average Return on Sales} &= \sum_{j=1}^n \text{Market Share}_j \times \text{Return on Sales}_j \\ & \quad (23) \end{aligned}$$

where τ_{ROS} is the time over which investor expectations about the long-run return on sales adjust to actual results for the industry, and T_{ROS} is the date at which investors start adjusting their expectations from their priors to actual results.

In essence, we assume investors give startups a honeymoon period during which they value the firm using an estimate of profit based on revenue and an assumed return on sales rather than actual profit. Once the honeymoon period ends, valuations revert to the traditional model based on actual net income and expected growth. A firm's valuation can fall if it does not achieve profitability by the end of the honeymoon period even if revenue growth remains high. In addition, the estimate of return on sales used during the honeymoon can change. After a certain date, expected return on sales adjusts to the actual average for the market segment to which the firm belongs. Every startup receives the same honeymoon period, but later entrants may find that investors have accumulated enough experience to adjust their estimates of steady-state return on sales to actual results. If industry return on sales is low (because many players simultaneously operate in the red to pursue GBF strategies), valuations may collapse even before the honeymoon ends.

Figure 3 shows a partial model test of the valuation subsystem, calibrated using revenue and profitability data for Amazon.com.⁶ From 1997 (when Amazon.com went public) through the peak of its valuation (around 2000) the dramatic rise in valuation is driven by strong revenue growth (approaching 100%/year). Valuations rise despite Amazon.com's large losses—almost \$2 billion/year at annual rates in the last quarter of 2000—because the simulated investors grant Amazon a honeymoon in which they believe that return on sales will eventually be high (after Amazon achieves the scale and scope economies and other advantages of the GBF strategy that should ensure market dominance). After 2000, expected revenue growth falls, raising the growth-adjusted discount factor from its low of about 0.015/year to about 0.029 by the end of 2001 (corresponding to a drop from a peak price/expected earnings multiple of 67 to 35). Expectations for profitability also begin to fall starting around 2000 as investors begin to adjust expectations towards actual results. Even so, by the end of 2001 there is still a large residue of hope (the weight on actual profit has risen only to about 36%). However, the expected return on sales also falls after 2000 as investors begin to recognize that the segment as a whole has consistently lost money. The drop in expected growth and implosion of unrealistic profit expectations cause the collapse of simulated market value after 2000.

Base case: the online book market

Total U.S. book sales were estimated to be \$26 billion in 1996 and growing at a few percent per year. The book market was one of the first markets for online

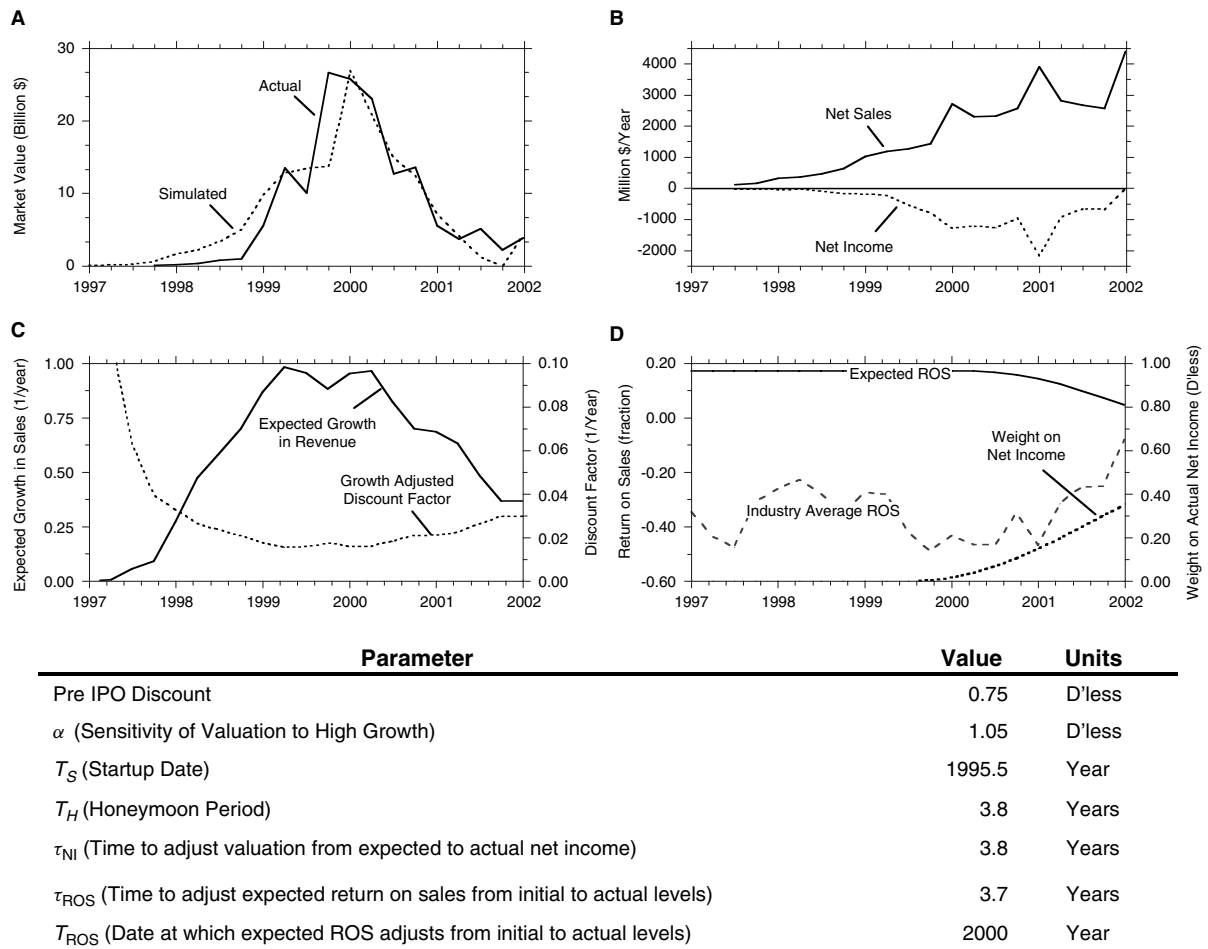


Fig. 3. Partial model test of market valuation subsystem: Amazon.com

retailing to develop. Amazon.com, a pure-play online retailer, was launched in July 1995 and quickly dominated the market. Amazon soon added music (June 1998), video and gifts (November 1998), personal electronics, and toys to its product selection. Revenue grew from \$15.7 million in 1996 to \$147.8 million in 1997 to \$1,639.8 million in 1999 (a compound growth rate of 155%/year). Amazon's market capitalization peaked close to \$30 billion, despite steadily growing losses through the end of 2001. After 2000, the stock price fell dramatically, putting strong pressure on Amazon.com management to turn a profit. After massive cost cutting, particularly in marketing, Amazon.com was able to achieve a slim profit of \$5 million on revenue of \$1.12 billion for the 4th quarter of 2001.

Amazon.com's largest competitor, barnesandnoble.com, the online division of the leading brick-and-mortar retailer Barnes & Noble, went online 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, trailing Amazon.com by eight to one. The firm lost \$64 million on revenue of \$320 million in 2000, and saw its stock price fall from the IPO level of about \$23/share to less than \$2/share by 2001. Other players in the book market are significantly smaller than either Amazon.com or barnesandnoble.com.

The base-case simulation involves competition among three companies. Company 1 is an Amazon.com-like online-only retailer with aggressive marketing, excellent customer service aspirations, and moderate pricing. Company 2 is also an online-only retailer, but with a low-price, low-service strategy—it represents the aggregate of most other online entrants. Company 3 represents the online division of a brick-and-mortar retailer like barnesandnoble.com; it enters the market two years later than companies 1 and 2, but with significant resources in terms of product selection, brand equity, cash, and warehousing infrastructure. To focus on the elements of the GBF strategy, and consistent with the behavior of the main players in the online book market, we assume that prices are set by unit costs and a constant markup. Table 1 summarizes the initial conditions and strategies for the three firms in the base case.

The base-case simulation was calibrated to match the characteristics of the online book market and to track the historical development of Amazon.com. Parameters that affected behavior beyond 2001 were adjusted to eventually yield a small profit margin. The base-case calibration captures multiple sources of increasing returns. In terms of *economies of scale*, the model assumes that product selection, inventory levels and warehousing, server requirements, customer support requirements, and general and administrative expenses all benefit from economies of scale, captured by power laws of the form:

$$R = D_0(D/D_0)^e \quad (24)$$

where R is the resource level required to meet a demand for service D , for example, the level of server investment required to meet the demand on the website. The smaller the exponent e , the stronger the scale economy effect; the smaller the reference value D_0 , the earlier these economies set in.⁷ In terms of *learning effects*, we assume that rookie engineers are only 15% as productive as experienced engineers, and that it takes two years to reach full productivity. We assume customer support personnel reach full productivity in six months, from an initial level of 25%. Finally, *network externality* effects are assumed in the diffusion of site popularity (word of mouth), user generated content, and site attractiveness.

These capabilities and infrastructure, however, develop slowly and also decay over time. The acquisition delays for tangible resources—e.g., real estate,

Table 1. Model parameters for the online book market

	Company 1	Company 2	Company 3
Summary	Amazon.com-like online-only retailer. Aggressive marketing, high-service, medium price strategy.	Online-only retailer. Low-price, low-service strategy.	barnesandnoble.com-like online subsidy of brick-and-mortar company. Late start with significant assets.
<i>Initial conditions</i>			
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	10,000 SQF	150,000 SQF
Initial Experienced Emps.	5 Eng., 5 CSRs	5 Eng., 5 CSRs	5 Eng., 5 CSRs
Initial Server Infrastructure	\$50,000	\$50,000	\$50,000
IPO date	1997.5	1997.5	1999
Initial shares outstanding	10 million	10 million	10 million
Initial % Founder Ownership	40%	40%	40%
<i>Company strategy</i>			
Minimum Marketing Spending	\$1 million/year	\$1 million/year	\$1 million/year
Target Marketing Spending as % of revenue	Initially 17.5%, decreasing to 10% by the time sales reach 60% of expected market size.	Initially 15%, decreasing to 10% by the time sales reach 60% of expected market size.	Initially 17.5%, decreasing to 10% by the time sales reach 60% of expected market size.
Desired Product Selection	7 million SKU	2 million SKU	5 million SKU
Desired Time for Fulfillment	2 days	4 days	2 days
Target Gross Margin	20%	20%	20%
Editorial budget	\$1 million/year	\$1 million/year	\$2 million/year
User-generated content	Enabled	Enabled	Enabled

warehouses, servers, personnel, and inventories—are explicit. Intangible assets—e.g., brand equity and site content—are modeled as the accumulation of expenditures for these items (marketing and content development) and customers' contribution to them, for example, brand equity generated by word of mouth and content contributed by users (e.g., user product reviews). Intangible assets are assumed to have a short useful life.

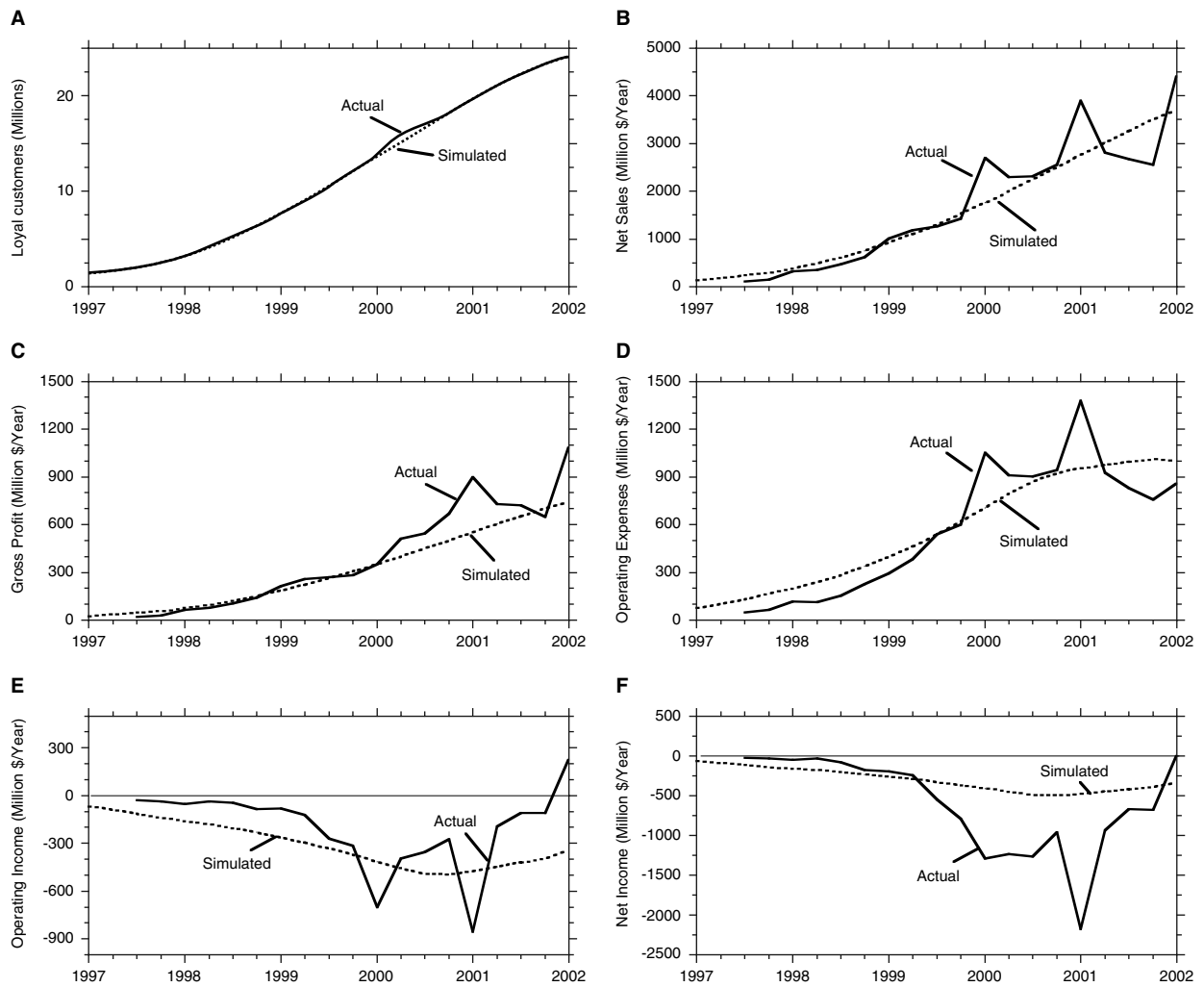


Fig. 4. Base case—historical comparison to Amazon.com

Figure 4 compares model behavior against the history of Amazon.com. In contrast to the partial model test of the valuation subsystem (Figure 3), this simulation is not driven by any exogenous data. The model adequately tracks the behavior of customer acquisition, net sales, gross profit, and operating expenses. It does not capture the seasonality of Amazon.com's market, where the fourth quarter represents, on average, nearly 40% of annual sales and operating expenses. Operating income, being the difference of two large numbers (gross profit – operating expenses) is not tracked as closely. The simulation, however, captures the overall trend and magnitude

of Amazon.com's operating losses and reflects the major shift away from GBF and towards profitability during 2001. The model does not accurately track net income from mid 1999 through mid 2001 when Amazon.com realized losses from investments it made in other Internet ventures during the peak of the speculative bubble. Our model excludes these side investments, and hence underestimates losses for that period.

Figure 5 extends the base-case simulation through the year 2010. The model produces an outcome with characteristics that resemble the online book market in the U.S. The market produces one dominant player (Company 1), and one struggling player (the click-and-mortar Company 3); smaller firms represented by Company 2 wither away. The GBF strategy pays off for the aggressive first mover (Company 1), which, given our parameterization, eventually turns profitable. Company 3, although viable by 2004, fails to reach the benefits of scale and eventually succumbs to Company 1.⁸ The explanation is found in the large number of positive feedbacks that confer cumulative advantage to the largest player. First, the model captures the growth of an online retailer through investment in three principal attributes that determine attractiveness: brand equity (awareness, reputation, etc.), adequacy of server infrastructure (speed, reliability and security), and adequacy of service infrastructure (access to customer support representatives, fulfillment speed, etc.). Investment in these attributes is driven by revenues, which are in turn increased by the relative attractiveness of the firm, thus creating the reinforcing *Investment* loops that drive the growth of the organization (loops R1–3 in Figure 6A). Additionally, there is a set of loops that help the early market leader extend its lead. A few of these are shown as loops R4–6 in Figure 6A:

- *Stock Market Booster* (R4): Rapid revenue growth drives high stock valuations during the honeymoon period when investors are not troubled by losses. Higher stock prices lower the firm's cost of capital and bring in additional resources. New capital increases spending, which leads to better performance, greater user acquisition and a further increase in revenue.

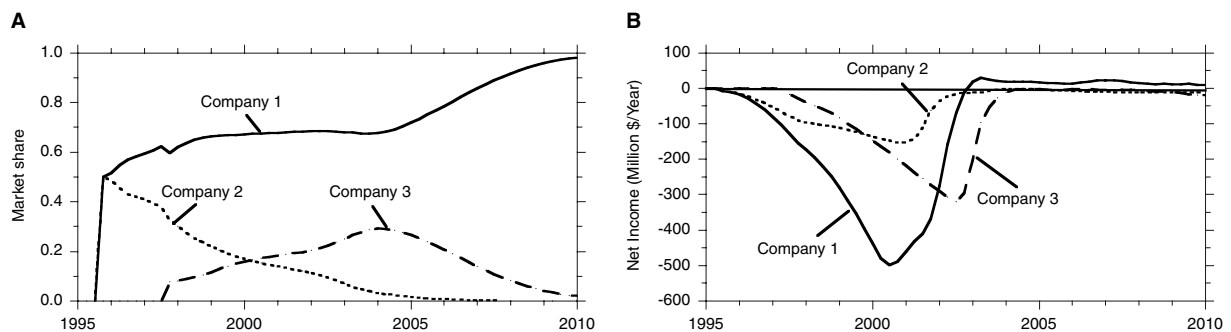


Fig. 5. Online book market

- *User Generated Content* (R5): Many sites, including Amazon.com, solicit user-generated content, for example, user reviews, user-vendors who offer greater product selection, (Amazon.com’s z-shops or e-Bay), and user ratings of outside vendor reliability. The more user-generated content offered by the site, the greater its attractiveness, leading to still more users and more user-generated content (R5). Further, user-generated content boosts attractiveness, increasing both the number of loyal customers and the escalation of customers from occasional to high-volume status.
- *Employee Loyalty* (R6): A higher user base leads to a higher stock price, which increases the value of non-vested employee stock options and reduces the risk of firm failure. Both effects raise the expected present value of total employee compensation. Employee turnover falls, boosting average productivity, which in turn leads to better performance and even more customers.

Under rapid exponential growth, a major challenge for an online retailer is to maintain a balance among the attributes that determine attractiveness.

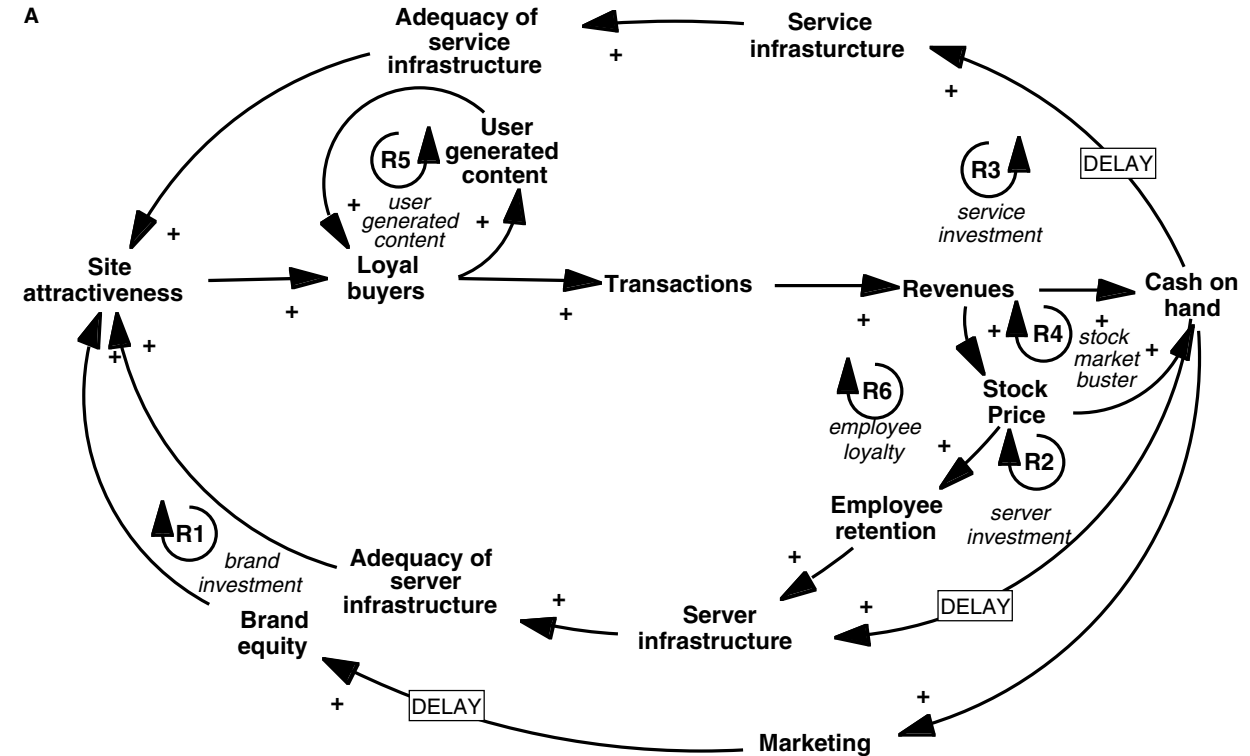


Fig. 6A. Positive feedbacks underlying increasing returns

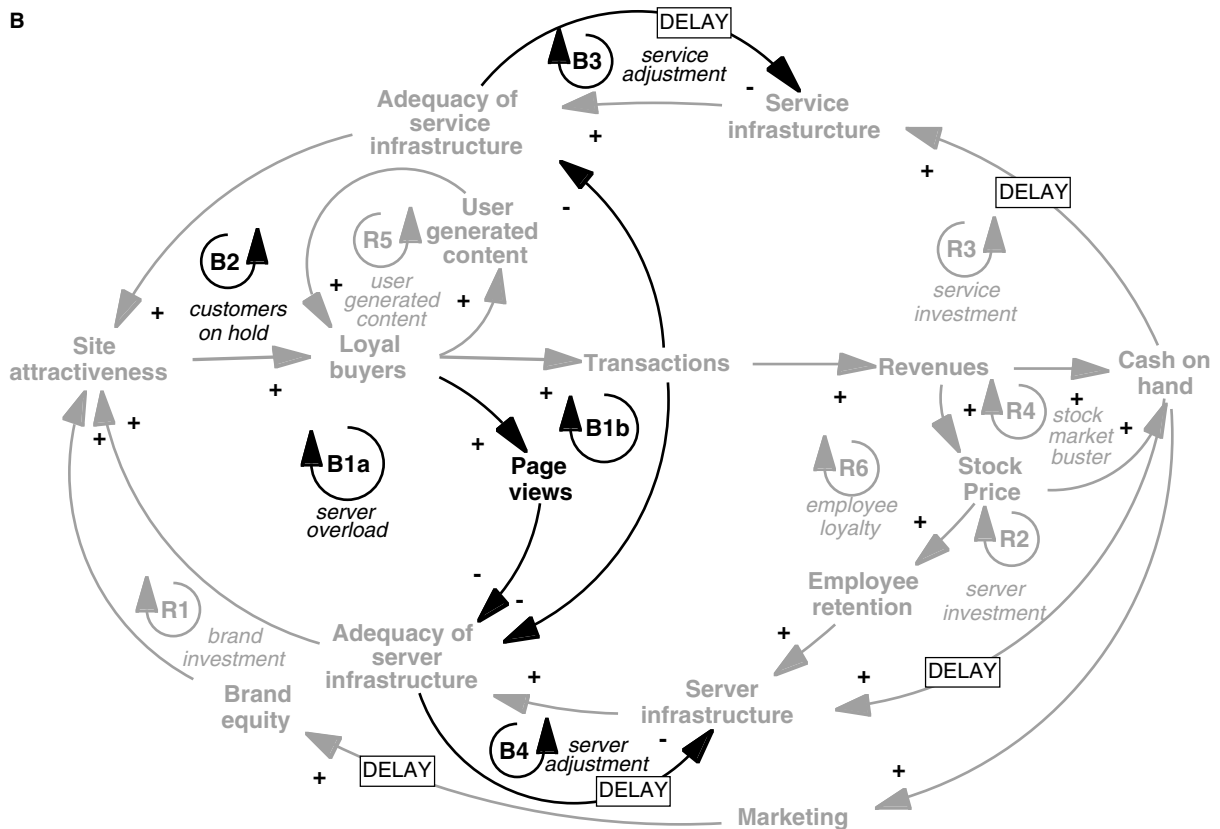


Fig. 6B. Negative feedbacks potentially limiting growth

Failure to develop enough server infrastructure to support the growing number of customer page views and online transactions will erode site performance and limit the growth of the user base (the *Server Overload* loops B1a and B1b in Figure 6B). Insufficient service infrastructure (customer support center, warehouses, product selection, etc.) will cause a poor fulfillment experience, eroding attractiveness and limiting growth (the *Customers on Hold* loop B2). The adjustment of actual service and server infrastructure to the required levels (loops B3 and B4 in figure 6B) takes time, so capacity shortages can limit service quality and constrain growth. Figure 7 shows the perceived quality of customer support for the three companies during the period of most aggressive growth in the simulation (up to the first quarter of 2000). Despite ample funding, the companies cannot develop service infrastructure to keep pace with customer demand. Company 3, although better funded during its initial stage, experiences a steep drop of service quality because at the time it enters the market—two years after the category creators—there already are a large

number of online shoppers willing to switch, generating customer growth much greater than that faced by initial entrants (Figure 7A).

Figure 8 shows how rapid growth contributes to the erosion of service quality. First, rapid hiring leads to a large increase in inexperienced rookie employees, lowering productivity directly and also indirectly as the coaching and mentoring burden on the experienced people mushrooms. Rapid hiring also

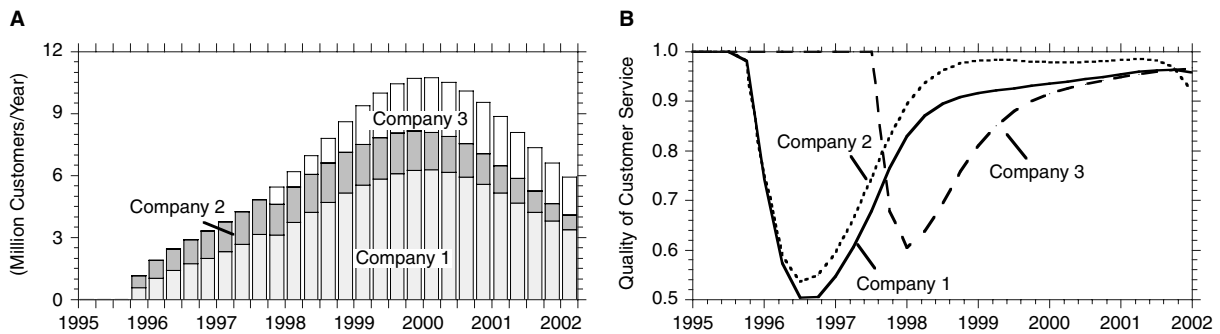


Fig. 7. Effect of growth on service quality

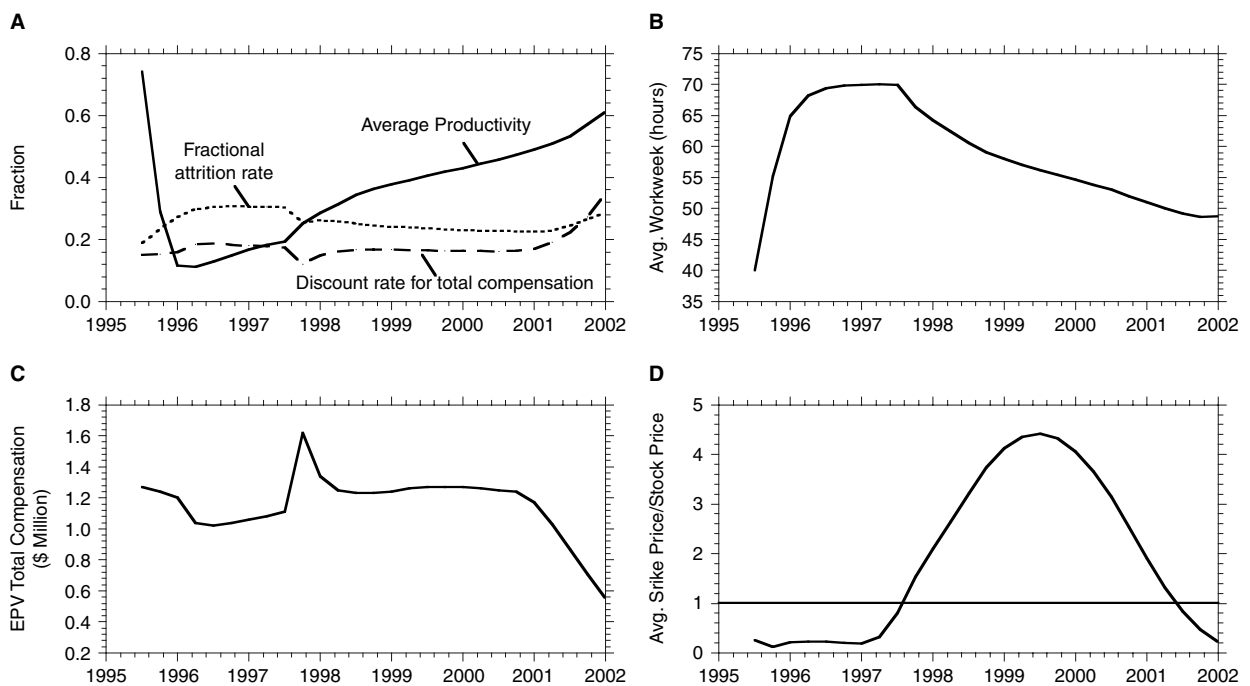


Fig. 8. Effect of growth and market correction on human resources (Company 1)

diverts the time of experienced personnel from customer service to recruiting and hiring. Second, as the demands on the organization grow faster than the experienced staff, the average workweek balloons to nearly 70 hours and remains high for several years. Sustained high workweeks increase employee burnout, lower productivity and attrition, which forces the firm to spend even more time recruiting and hiring and further diluting experience. In addition, the firm experiences low stock prices and poor liquidity prior to going public, leading employees to predict a relatively high probability of firm failure. The discount rate they use to value their compensation (particularly their options) rises, and the low expected compensation also stimulates some attrition before the firm goes public. After the IPO, liquidity improves and the stock price soars, dramatically increasing expected compensation and suppressing employee turnover despite continuing high workweeks. After the bubble bursts, however, expected compensation plummets, both because the stock price collapses, lowering the value of nonvested options, and because the resulting liquidity crisis again raises the discount rate employees use to value their compensation. The result is a second wave of attrition as burned-out employees abandon what they perceive to be a sinking ship.

These phenomena are well documented in the system dynamics literature, including Forrester's (1968) Market Growth model, Sterman's (1988) People Express Management Flight Simulator, and Oliva and Sterman (2001).

Sensitivity and policy analysis

To assess the limits of the GBF strategy we use the model to explore a set of issues challenging the online retailers during the period of aggressive growth. We use the model as calibrated for the book market, varying assumptions about customer and capital market behavior and entry timing to test the sensitivity to different market conditions.

What if the bubble didn't burst?

Most of the business press blamed the collapse of the stock market for the problems in e-commerce. To test this, we varied the length of the honeymoon period to examine the impact of continued unrealistic valuations.

In our formulation, expected profitability is initially determined by expected steady-state return on sales for the industry, gradually shifting to actual income as time passes. As specified in Eqs. 18–19, the total honeymoon period for each firm is the initial honeymoon period (T_H) plus the time to adjust valuation from expected to actual net income (τ_{NI}). Calibration of the valuation subsystem to the Amazon.com case (Figure 3) yielded an average length of the honeymoon period of 7.5 years for the online book market.

Figure 9A shows the effect of the total honeymoon period $T_H + \tau_{NI}$ on the evolution of Company 1's market share, keeping T_H and τ_{NI} equal and holding all other parameters at base case values. Figure 9B shows the steady-state market share for Company 1 as a function of the length of the honeymoon period.⁹ If the honeymoon is too short, the Amazon.com-like firm (Company 1) has no chance to build the resources and scale needed to benefit from the various sources of increasing returns and cannot compete with the better-funded and larger brick-and-clicks Company 3; by 2005 it has all but disappeared. However, if the honeymoon is long enough for Company 1 to win significant market, then Company 1 can outcompete Company 3. The large number of positive feedbacks create a clear discontinuity in the relationship between the length of the honeymoon and long-run success (with our parameters, between 5 and 6 years). A shorter honeymoon results in failure of firm 1; longer honeymoons have an increasing impact on the steady-state market share of the firm.

Figure 9C shows the impact of the honeymoon period on profitability for Company 1. During the honeymoon period, while the firm has ample access to

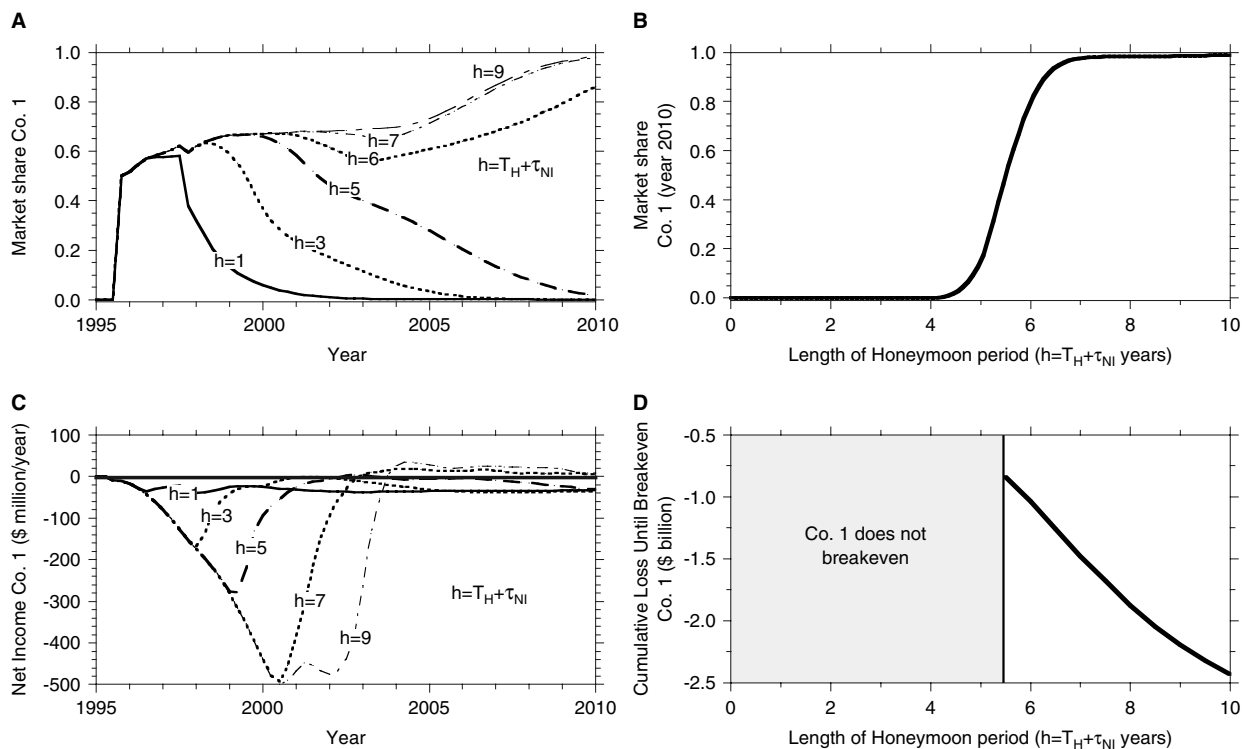


Fig. 9. Sensitivity to length of honeymoon period

inexpensive capital, the firm pursues the GBF strategy by investing aggressively in infrastructure and brand equity, and consequently incurs large losses. Rapid growth is rational for the firm despite large losses as long as the market (perhaps irrationally) rewards the GBF strategy. But, once the honeymoon ends and financial markets become unwilling to invest, the firm quickly suffers a liquidity crisis, forcing it to slow investment and cut expenses, primarily marketing, to staunch losses (Figure 9C). The change in strategy—from get big fast to what Amazon’s Jeff Bezos called “the march to profitability”—is endogenously generated in the model.

Whether the firm eventually becomes profitable depends on whether it is able, during the honeymoon period, to obtain a large enough base of loyal customers to benefit from the various positive feedbacks creating increasing returns. A short honeymoon leads to early death by low liquidity because the firm is forced to stop expanding before scale economies, learning, and network effects become significant (see the simulation with total honeymoon $h = 1$ year in figure 9C). With a short honeymoon the *stock market booster* loop (R4) is weak and low liquidity slows infrastructure investments, further limiting future cash availability—a capital constrained death spiral.

Longer honeymoons, on the other hand, extend the period through which the company can invest in the GBF strategy in the hope of eventual profitability, but entail larger cumulative losses during the growth period. Figure 9D shows the cumulative loss until breakeven as a function of the honeymoon period. A long enough honeymoon does eventually allow the firm to become profitable. However, for most parameter values steady-state profitability pales in comparison to initial losses.

Entry timing

The online book market was one of the first to develop (Amazon.com was incorporated just eight months after the first version of the Netscape browser became available), and, until the entrance of Barnes and Noble, Amazon was the only player with the resources to pursue the GBF strategy and match the growth of the online population. Players in online markets that developed later (pet supplies, groceries, etc.) faced a more difficult task for two reasons.

First, by the time these companies entered, there was a much larger base of Internet-savvy potential shoppers (see Figure 2). GBF-inspired advertising and word-of-mouth then created sudden surges in demand, driving service down. As one infamous example, lingerie maker Victoria’s Secret attempted to launch its online store with a fashion show to be webcast live. Heavy promotion, including expensive Superbowl ads, attracted so many users the site crashed.

Second, the competitive dynamics in these markets became more intense as the venture capital community, in an effort to go ride the dot com rush, funded more companies than the market could sustain. Consider, for example, the pet-supply market. According to the Pet Industry Joint Advisory Council,

total U.S. consumer spending on pet products was approximately \$23 billion in 1997, almost as large as the book market, with an annual growth rate of 9%. Traditionally, demand was filled through specialized retailers, superstores, and grocery stores. In late 1998 and early 1999 venture capitalists received at least a dozen business plans for online pet supply stores (Schibsted 1999). Not all were funded. Nevertheless, several large players entered the market nearly simultaneously, notably Pets.com, Petopia, Petstore and PETsmart, all committed to GBF strategies. Because of the intense competition, many began selling at or even below cost; as they split the market, none could achieve the scale needed to benefit from increasing returns and none of the pure ecommerce players survived. Today PETsmart and PetCo dominate the industry; both depend primarily on their brick-and-mortar stores, not their online divisions.

To explore these dynamics, we used the model as calibrated for the book market, but modified the entry date for the category creators (Companies 1 and 2). The entry date for Company 3 remains fixed (Q2-1997).

Figure 10A shows the effect of the entry date for Companies 1 and 2 on the evolution of Company 1's market share; Figure 10B shows the market share

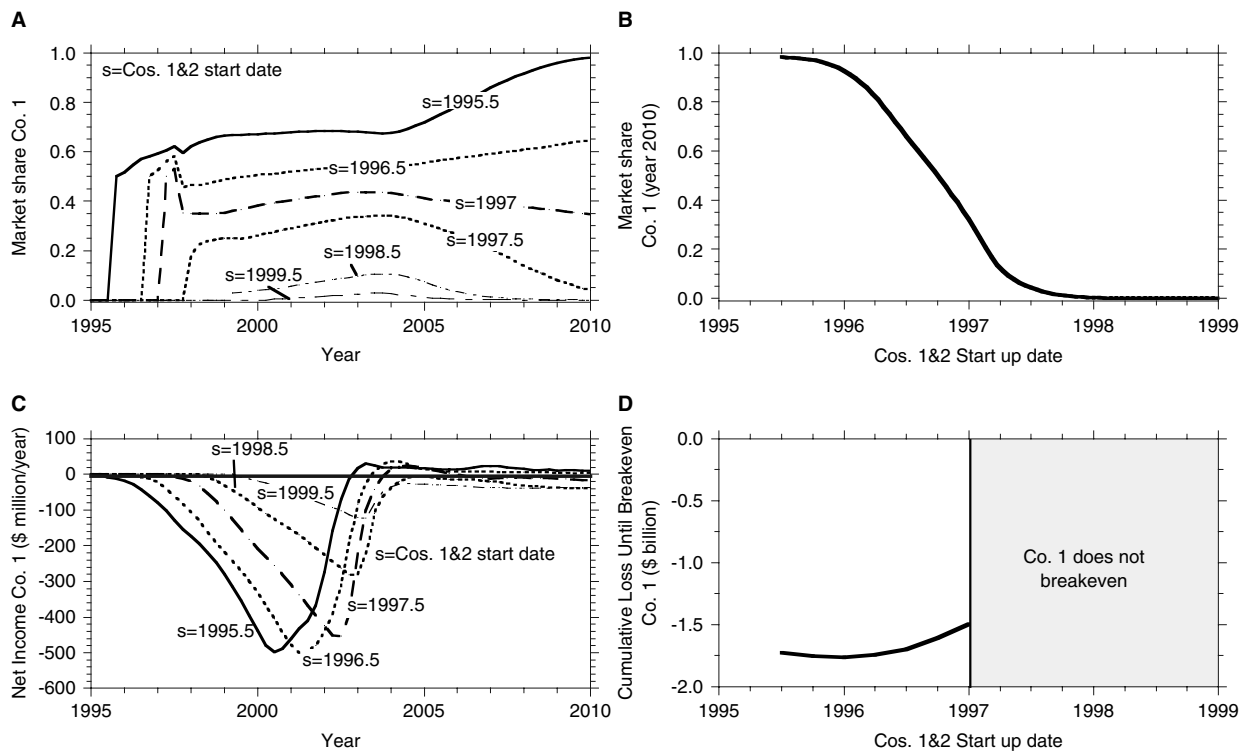


Fig. 10. Sensitivity to Company 1 and 2 start-up date

for Company 1 in 2010 as a function of its entry date. Given the winner-takes-all nature of this market, there is a clear tipping point for market share dominance—market shares greater than 50% after the initial transition period eventually lead to market dominance. The 2010 market share for Company 1 falls steadily as the entry date for companies 1 and 2 is delayed. There are, however, three distinct regions in the relationship. Each region arises from a different mechanism limiting Company 1's acquisition of market share. When the start-up date is prior to the second quarter of 1997, Companies 1 and 2 are category creators (first movers). Company 1 has some time to establish its brand name, debug its operations, and become profitable. Profitability, however, is not enough to ensure market dominance. If Companies 1 and 2 are launched after Q3-1996, but still before Company 3 enters the market (Q2-1997), Company 1 reaches profitability, but it never reaches the 50% market share necessary to tip over the market in its direction; the later but better funded Company 3 takes over the market. Finally, if firms 1 and 2 enter after Company 3 and lose their first mover advantage, Company 1 never becomes profitable and its market share drops to zero.

We did not change the formulation for market valuation in these simulations. The benefit of the honeymoon period, however, is smaller for late entrants as the date to adjust Return on Sales from expected to actual levels was not modified ($T_{ROS} = 2000$), thus limiting the window during which the firms have ready access to capital. Figure 10C illustrates the reduced benefit of the honeymoon period for late entrants as Company 1 is forced to reduce its expenses by 2003, independent of its entry date, because of the reduced availability of external capital. A shorter honeymoon or entry closer to the collapse of the Internet bubble limits cumulative losses (see Figure 10D), but, if the honeymoon is not long enough for the firm to leverage the positive feedbacks leading to increasing returns, the firm never becomes profitable.

Under the assumed conditions, Company 1 manages to turn a profit only if it starts before 1997. The scenario, however, is optimistic as it includes only one minor and two well-funded competitors, while many online markets had up to a dozen well-funded start-ups, further diluting market share and the chance of benefiting from any positive feedbacks that might exist.

Incumbents can use these results to defend their markets from attack. Figure 11 varies the time of entry of the brick-and mortar-incumbent into the online market. The entry delay is measured in years after the category creators enter the market, where the base case was two years (B&N entered the market in summer of 1997, while Amazon.com entered in mid 1995). As in all previous simulations, only Companies 1 and 3 survive for the duration of the simulation. Earlier entry to the online market by the brick-and-mortar incumbent limits the market share and long-run profit of the pure-play leader, even when the financial markets give the online category creators a significant honeymoon period.

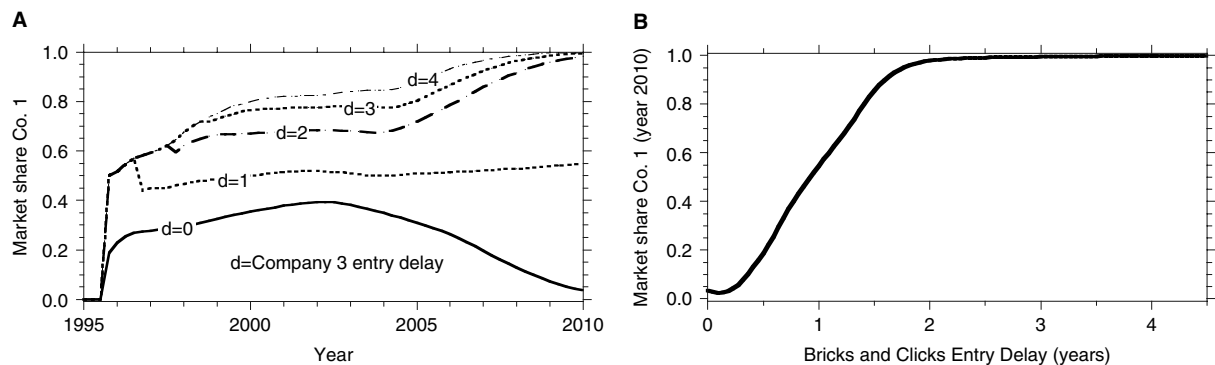


Fig. 11. Sensitivity to Company 3 (bricks and clicks) entry delay

Greater customer sensitivity to service quality

In the simulations so far the sensitivity of customers to quality has been modest, and the first-mover aggressively pursuing the GBF strategy dominates the market. In Figure 12 we assume customers are more concerned with the quality of the online purchasing experience. The simulation is identical to the base case except that:

- The strength of the word-of-mouth referrals driving people from browsers to shoppers is now mediated by the attractiveness of online shopping in the category (the fraction of customers willing to enter the online market is an increasing function of overall online attractiveness; in the base case people experiment with online shopping independent of its attractiveness).
- The maximum rate at which customers are willing to abandon online shopping is increased (the actual abandonment rate depends on the overall attractiveness of online shopping).
- Customer sensitivity to service quality and order fulfillment is increased.¹⁰

Increased customer focus on service quality causes the GBF strategy pursued by Company 1 to fail. Company 1's aggressive strategy still drives the more conservative Company 2 out of business; it reaches nearly 80% market share within two years of launch (Figure 12A). But, as in the base case, Company 1's rapid growth forces its service quality (including order fulfillment) down significantly (Figures 12C and 12D). However, with customers more sensitive to customer service, low quality slows the growth of the customer base (compare Figures 7A and 12F). Slower growth reduces Company 1's market valuation and limits its ability to build advantage through the various positive feedbacks conferring increasing returns. Worse, Company 1's quality-conscious customers switch to Company 3 as soon as it enters the market—Company 1's market share drops more than 20 percentage points in the first quarter

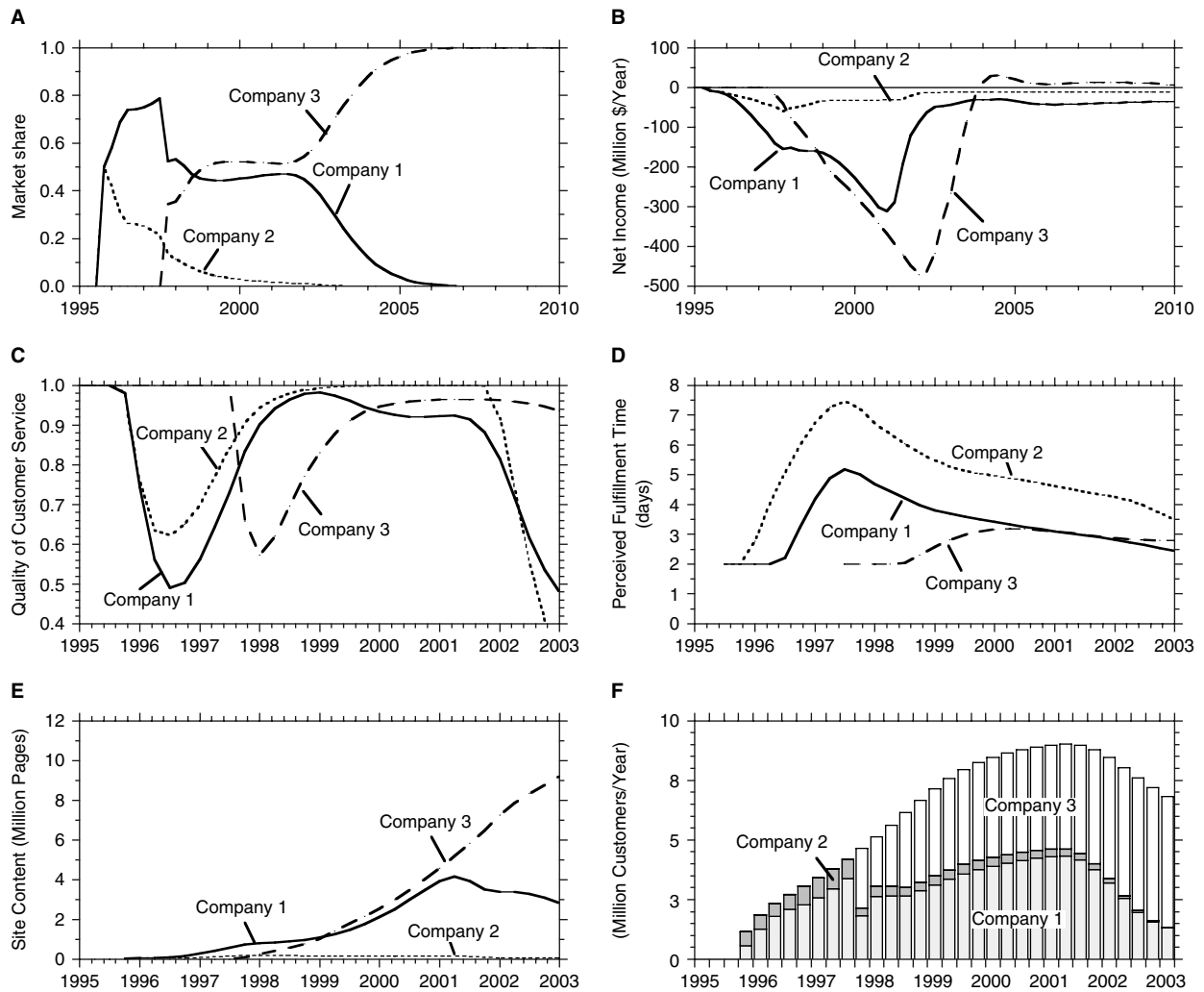


Fig. 12. Increased customer sensitivity to service quality

after the entry of Company 3. The sudden drop in volume further weakens the positive feedbacks Company 1 hopes to use, and its market share continues to fall. By late 2000 the financial markets have soured, and with Company 1's poor revenue growth and continuing losses, its market value, already limited by its lower growth, plummets. Without the ability to raise external capital, investment in service and order fulfillment capability suffer further, and the firm is unable to invest in marketing and content to offset it (Figure 12E). Market share continues to slide; Company 1 effectively exits the market by

2005. Company 3 emerges as the sole remaining online player, achieving steady revenue growth and becoming profitable by about 2004.

Interestingly, the entry of Company 3 accelerates the recovery of Company 1's service quality (compare Figures 7B and 12C), caused by the hordes of unhappy customers defecting from Company 1. This, however, does not save Company 1, as Company 3, with a smaller share of the market, still offers better fulfillment performance (Figure 12D). Given the sensitivity of customers to fulfillment, this advantage helps bring Company 3's share over 50%, at which point it accumulates brand equity and site content faster than Company 1 (Figure 12E). Company 3 is then better able to build the content, brand equity, and other capabilities that drive the positive feedbacks conferring cumulative competitive advantage.

The scenario in Figure 12 shows that the GBF strategy can fail through the erosion of service quality caused by rapid growth. The very growth demanded by the quest to get big fast can drive service quality down as demand outstrips the organization's ability to build service infrastructure, develop experience, and learn. The drop in service quality makes the firm vulnerable to competition and loss of confidence by the capital markets. At the same time, rapid growth creates strong incentives for new competitors to enter. When customers are sufficiently quality conscious, the result can be a rapid death spiral in which the positive feedbacks the firm hopes to use to dominate the market become vicious cycles progressively eroding the firm's capabilities, attractiveness, and demand.

Discussion

The model replicates many outcomes seen in the real world, such as rapid growth and market dominance (Amazon.com), difficulties facing incumbents entering late (barnesandnoble.com) and failure when many players simultaneously pursue GBF strategies (as in the pet supply market). The model captures the interplay of the powerful reinforcing feedbacks that can drive rapid growth for online retailers, and their interaction with limits to growth arising from the availability of capital and the delays in building the capabilities needed to provide quality service.

The GBF strategy requires a delicate balancing act between rapid growth driven by low prices and aggressive marketing on the one hand, and developing the infrastructure required to serve and keep the masses of customers attracted. Our results show that the GBF strategy can work, but only if all of the following conditions hold. First, and most obviously, there must actually be strong reinforcing feedbacks. Far too many dot coms pursued GBF strategies without understanding whether there were in fact any scale economies, learning processes, network effects, or complementary assets that created positive feedbacks that would favor the largest player. Second, even when such reinforcing feedbacks exist, firms must grow long enough for these

loops to become important. Doing so requires substantial access to cheap capital, since the GBF strategy entails rapid growth and low prices so that operating profits and cash flow from operations are significantly negative. The strong dependence of the GBF strategy on positive feedbacks makes it highly vulnerable: the same loops that power the growth and success of the firm can quickly become vicious cycles leading to organizational collapse if low quality or inadequate infrastructure investment begin to constrain growth.

We also examined the challenge faced by a latecomer trying to overtake an early mover. The powerful growth loops in online retailing make it difficult to catch up if one starts late, as *barnesandnoble.com* did in the book market. The positive feedbacks create an incentive for all players to enter quickly. Yet the more new entrants there are, the greater the chance all will fail—none benefit from the positive loops, while competition creates pressure for even greater marketing spending and even lower prices. The result is shakeout, exit, and consolidation, seen in many segments, for example, online pet supplies, where the near-simultaneous entry of over a dozen players, all aggressively pursuing GBF strategies (exemplified by *pets.com*'s infamous 'sock puppet' commercials), forced most to exit within a year or two—ready access to cheap capital and low barriers to entry doomed the GBF strategy to failure.

Our model shows the difficulties of succeeding in e-commerce even when there are positive feedback processes that can lead to cumulative advantage for the market leader. These difficulties arise largely from feedbacks among growth, valuation, service demand, service capacity, and competition. We identify common failure modes arising from excessively rapid growth that causes service quality to fall, from rapid growth outstripping financial resources, to the inability to sustain 'new economy' valuations in the face of extended periods of financial losses driven by rapid growth and low prices. The policy recommendation—balancing investment in different resources so that overall attractiveness remains high, using price to ensure that demand growth does not outstrip the ability to build key organizational capabilities, and ensuring a transition to profitability before the capital markets demand it—sounds simple. But rapid growth and the pressures it creates can degrade the quality of management decision making by forcing a firm's founders and executives to make decisions under severe time pressure. Perlow *et al.* (2002) show compellingly how rapid decision making, by degrading the quality of decisions, creates another set of positive feedbacks that can lead to a death spiral for Internet startups (and by extension, any rapidly growing organization).

Our results highlight the critical role of service quality in success. The GBF strategy requires firms to build a customer base large enough to stimulate the positive loops while maintaining high service quality so that customers remain loyal. Low customer churn limits customer acquisition expense and loyal customers strengthen all the positive feedbacks driving increasing returns, both helping to maintain the investor confidence needed to fund growth. Maintaining high service quality while growing rapidly requires additional

investment, and perhaps deliberate overstaffing, to ensure that the positive loops driving growth do not become vicious cycles leading to a death spiral of declining growth, declining valuations and employee retention, and still greater erosion of service quality (Oliva 2001).

As an example, General Motors developed a system dynamics model to design the growth strategy for its telematics platform, OnStar (Barabba *et al.* 2002). Telematics provides a host of new services to drivers by integrating cell phone, GPS navigation, on-board diagnostics and safety systems, and 24/7 live customer assistance. Like e-commerce, telematics creates an entirely new business and revenue model in an established, mature industry. The modeling identified important positive feedback loops favoring the GBF strategy, and also a variety of negative feedbacks through service quality that might limit growth. The OnStar team used the model to explore these issues and included deliberate overstaffing of their call centers as a key component of their growth strategy. As described by Barabba *et al.*, the system dynamics modeling helped OnStar use a GBF approach to win “80 percent market share of the emerging telematics market” with a market value estimated “at between \$4 and \$10 billion” by 2002, demonstrating the value of explicit dynamic modeling integrating the positive feedbacks driving growth with the negative feedbacks of competition and service quality.

Notes

1. See, e.g., <http://www.itworks.be/dotcomfailures> and <http://www.fuckedcompany.com>; see also Kaplan (2002).
2. See, e.g., funeral.com, farewell.com, and funeraldepot.com, among many others.
3. Dot coms also raised significant capital through their employees, who clamored for stock options rather than salary.
4. A stock option is considered to be underwater when the company’s stock price is less than the exercise price for the option.
5. The full model also provides a structure to capture a valuation premium for the market leader, based on market share and the number of competitors. The leadership premium is designed to capture the additional value investors perceive, based on their belief that market leaders will be better able to earn high profits in the future due to customer lock in and other benefits of increasing returns. In the simulations reported here the premium is set to zero.
6. As described below, we assume entry of two additional e-commerce firms into the book market, one at the same time as Amazon.com and one in mid 1997. However, since Amazon.com dominates the market the industry average ROS is driven largely by Amazon.com’s own results.

7. We assume the following values for economies of scale:

Resource	Reference value (D_0)	Exponent (e)
Product selection	5.5e5 SKUs	1.00
Inventory levels	10e6 items	0.30
Server requirements	2e6 \$ of server infrastructure	0.95
Customer Support requirements	1e6 transactions/year	0.85
G&A expenses	15e6 \$/year	0.80

8. The firm's long-term profitability is determined by the strength of the economies of scale and assumptions about how companies set prices and control expenses as they lose the ability to raise capital from the financial markets. Since there is little empirical data to determine the long-term profitability of a market, we retained throughout our simulations the pricing and resource allocation policies as calibrated during the aggressive growth stage. Consequently, our analysis focuses on the growth stage, and potential failure modes during that stage.
9. As in the base case, Company 2 does not become viable in these simulations and its market share is negligible by 2002. The complement of the values in Figure 9B is the market share for Company 3.
10. The changes to replicate Figure 12 are (base case values in parentheses):
 Maximum Customer Switch Fraction (1/year)= 2 (1)
 Sensitivity of Attractiveness from Fulfillment (dimensionless)= -2.5 (-0.4)
 Sensitivity of Attractiveness from Service (dimensionless)= 2.0 (1.0)
 Switch for Relative Attractiveness on WOM = 1 (0)

References

- Allen L. 1999. *Cashing in on Community*. Report, Forrester Research: Cambridge, MA. September 1999.
- Arthur BW. 1989. Competing technologies, increasing returns, and lock-in by historical events. *Economic Journal* **99**: 116–131.
- . 1994. *Increasing Returns and Path Dependence in the Economy*. University of Michigan Press: Ann Arbor, MI.
- Barabba V, Huber C, Cooke F, Pudar N, Smith J, Paich M. 2002. A multimethod approach for creating new business models: The General Motors OnStar project. *Interfaces* **32**(1): 20–34.
- Balter G, Rasking A, Evans F. 1999. *Traditional Retailing Meets The Internet*. Report, Donaldson, Lufkin & Jenrette Securities Corp: New York. May, 1999.
- Byrne JA. 2000. The fall of a dot-com. *Business Week* 1 May 2000, 150–160.
- Charron C. 1999. *The Content—Commerce Collision*. Report, Forrester Research: Cambridge, MA. March 1999.

- Collins J. 2000. Built to flip. *Fast Company* March 2000, 131.
- Colony GF. 2000. *My view: Hollow.com*. Report, Forrester Research: Cambridge, MA. April, 2000. Available from: <http://www.forrester.com/ER/Marketing/0,1503,183,FF.html>. Accessed May 2003.
- Cooperstein DM. 1999. *Making Net Shoppers Loyal*. Report, Forrester Research: Cambridge, MA. June, 1999.
- Cusumano M, Yoffie D. 1998. *Competing on Internet Time: Lessons from Netscape and its battle with Microsoft*. Free Press: New York.
- Dykema EB. 1999. *Ring up Web Store Costs*. Report, Forrester Research: Cambridge, MA. August, 1999.
- Edgekuffe-Johnson J. 2000. Buffett dismisses spurious net wealth. *Financial Times* 1: May: A1.
- Forrester JW. 1966. Modeling the dynamic processes of corporate growth. *Proceedings of the IBM Scientific Computing Symposium on Simulation Models and Gaming*. IBM Corporation, Yorktown Heights, NY. (pp. 23–42).
- Forrester JW. 1968. Market growth as influenced by capital investment. *Industrial Management Review (MIT)* 9(2): 83–105.
- Frank R. 1995. *The Winner-Take-All Society: How More and More Americans Compete for ever Fewer and Bigger Prizes, Encouraging Economic Waste, Income Inequality, and an Impoverished Cultural Life*. Free Press: New York.
- Fudenberg D, Tirole JJ. 1983. Learning by doing and market performance. *Bell Journal of Economics* 14: 522–530.
- Fudenberg D, Tirole JJ. 1986. *Dynamic Models of Oligopoly*. Harwood: London.
- Hagel J, Armstrong AG. 1997. *Net Gain: Expanding Markets through Virtual Communities*. Harvard Business School Press: Boston.
- Hagen PR. 1999. *Smart Personalization*. Report, Forrester Research: Cambridge, MA. July, 1999.
- Hill G, Hardy Q, Clark D. 1996. Behind the plunge: bloody price wars and strategic errors hammer high tech. *Wall Street Journal* 12 July.
- Kaplan P. 2002. *F'd Companies: Spectacular Dot Com Flameouts*. Simon and Schuster: New York.
- Kary T. 2000. Ouch! Barron's story bites net stocks. *Red Herring* 20 March.
- Larson E. 1999. Free money. *The New Yorker* 11 October: 76–85.
- LaTour Kadison M. 1998. *The Look-to-Buy Imperative*. Report, Forrester Research: Cambridge, MA. April, 1998.
- Lewis M. 1999. *The New New Thing*. W.W. Norton: New York.
- Li C. 1999. *Internet-Advertising Skyrockets*. Report, Forrester Research: Cambridge, MA. August, 1999.
- Lyneis J. 1980. *Corporate Planning and Policy Design: A System Dynamics Approach*. MIT Press: Cambridge, MA.
- Nail J. 1999. *Driving Site Traffic*. Report, Forrester Research: Cambridge, MA. April, 1999.
- Nord O. 1963. *Growth of a New Product: Effects of Capacity Acquisition Policies*. MIT Press: Cambridge, MA.
- NVCA. 2000a. Venture capital investments increase 266% to 22.7B in Q1 2000: Internet-related companies capture the most investments. National Venture Capital Association and Venture Economics, Press Release. 4 May.

-
- NVCA. 2000b. Ventured-backed IPOs account for majority of US IPOs. National Venture Capital Association and Venture Economics, Press Release. 10 April.
- Oliva R. 2001. Tradeoffs in response to work pressure in the service industry. *California Management Review* 43(4): 26–43.
- Oliva R, Sterman JD. 2001. Cutting corners and working overtime: Quality erosion in the service industry. *Management Science* 47(7): 894–914.
- Packer D. 1964. *Resource Acquisition in Corporate Growth*. MIT Press: Cambridge, MA.
- Paich M, Sterman JD. 1993. Boom, bust, and failure to learn in experimental markets. *Management Science* 39(12): 1439–1458.
- Perkins A, Perkins M. 1999. *The Internet Bubble*. Harper Business: New York.
- Perlow L, Okhuysen G, Repenning N. 2002. The speed trap: exploring the relationship between decision making and temporal context. *Academy of Management Journal* 5: 931–955.
- Reuters. 2000. *Shakeout Looming for Many Net Firms* (Special to CNET News.com). 1 April, Available at: <http://www.gwu.edu/~ibus266j/Global%20Int.%20Markets/USA/shakeout.htm>. Accessed May 2003.
- Rothschild M. 1990. *Bionomics*. Henry Holt: New York.
- Sahlman WA, Stevenson HH. 1985. Capital market myopia. *Journal of Business Venturing* 1: 7–30.
- Sawyer J. 2000. *The Demise of Dot Com Retailers*. Report, Forrester Research: Cambridge, MA. April, 2000.
- Schibsted E. 1999. K9 commerce: A bevy of new online pet stores wants to be the pick of the litter. *Business 2.0* 1 August: 29.
- Shreve J. 2000. The paper padlock. *The Standard* 20 March.
- Sood R, Friedman J, Degnan D. 1999. *Goldman, Sachs, Issues & Outlook 2000, eMarkets: B2B and B2C*. Report, Goldman, Sachs & Co.: New York. December, 1999.
- Spence AM. 1981. The learning curve and competition. *Bell Journal of Economics* 12: 49–70.
- Sterman JD. 1988. *People Express management flight simulator: simulation game, briefing book, and simulator guide*. Available from the author at <http://web.mit.edu/jsterman/www>. Accessed May 2003.
- . 1989a. Misperceptions of feedback in dynamic decision making. *Organizational Behavior and Human Decision Processes* 43(3): 301–335.
- . 1989b. Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making experiment. *Management Science* 35(3): 321–339.
- . 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill: Boston.
- Tirole JJ. 1990. *The Theory of Industrial Organization*. MIT Press: Cambridge, MA.
- Trueman B, Wong MHF, Zhang X-J. 2000. The eyeballs have it: searching for the value in Internet stocks. *Journal of Accounting Research* 38(Supp. S2000): 137–162.
- Williams S. 1999. *Post-Web Retail*. Report, Forrester Research: Cambridge, MA. September, 1999.
- Wolff M. 1999. *Burn Rate*. Touchstone: New York.