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Still Powerful

The Internet's Hidden Order

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Source:

- In spite of a correction in the Internet sector over the past six months, the relationship between rank and market value of online firms continues to exhibit power law behavior.
- This winner-take-all market capitalization distribution supports the notion that competition on the web has some unique characteristics. For example, large firms can grow as quickly as small firms and the positive reinforcing nature of the medium provides leaders with a source of competitive advantage.
- We would continue to focus on the companies with customers, capital and viable long-term business models.

Executive Summary

Despite the Internet's apparent complexity, hidden order exists. Studies demonstrate that Web pages are distributed among sites according to a universal power law. Power laws are distribution functions for measurable quantities—like how many earthquakes there are of a particular size, or the number of cities within a given range of populations. The number of web pages adheres to a remarkable stable regularity. Roughly described, it says that many sites have few pages, and few sites have many pages.¹

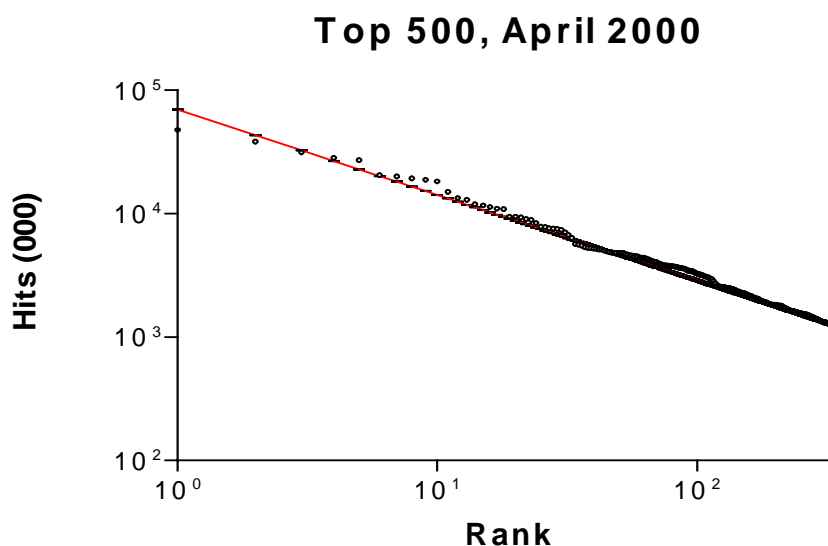
The distribution of web pages is not the only online phenomenon that adheres to a power law. The distribution of visitors per site follows a power law as well: many sites have very few users, and a few sites have very many users. Although intuitive, the precise nature of these two regularities carries profound implications. Online firms that depend on the ability to attract and monetize users face significant challenges. The observed power laws suggest a low probability that newly established sites will attract a significant number of users.² In fact, from January 1999 to April 2000, 20 out of the top 25 companies in the MediaMetrix "Top Properties" ranking remained in the top 25.³

We first explored power laws and the Internet in late 1999.⁴ In spite of a sharp correction in the prices of Internet stocks over the last six months, the relationship between rank and the market value of online firms are still best expressed with a power law. This winner-take-all distribution continues to support the notion that competition on the web has unique characteristics. Not only can large firms grow as quickly as small firms, but the positive reinforcing nature of the medium translates into a source of sustainable competitive advantage. This report explores some of the factors that might contribute to the observed distribution.

Powerful Web

Let there be no mistake. Activity on the web is highly concentrated. To show the breakdown of web site popularity, we ranked n web sites on the horizontal axis—as determined by the number of unique users—and plotted pageviews on the vertical axis, using MediaMetrix data for the top 500 domains in April 2000. The result is a straight line when using a double logarithmic scale. The data show that the top 5%, or 25 sites, account for 31% of the total volume of traffic.⁵ This is consistent with broader studies of the web that show the percentage of total volume accounted for by the top sites is extremely large. That is, one tenth of one percent of the total, or the top 119 sites, account for 32% of the total volume of site traffic.⁶ Very few web sites get large, and very few web sites get a lot of user traffic.

Figure 1
Power Laws



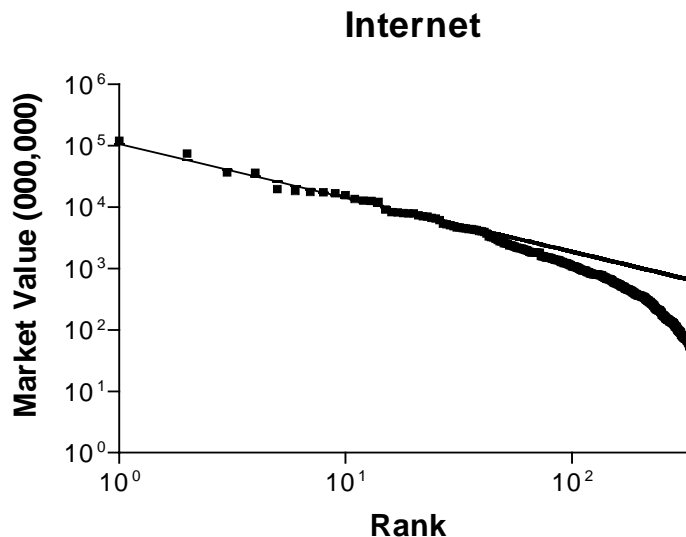
Source: MediaMetrix and CSFB analysis.

A logarithmic plot of rank versus frequency, a straight line with slope near unity, (as seen in Figure 1) is known as Zipf's law. This regularity has been observed in diverse realms, including the magnitude and frequency of earthquakes, rank and city sizes, and the distribution of words in a language. Extremities are apparent when Zipf distributions are plotted on a linear scale. A few elements score very high, a medium number of elements get middle-of-the-road scores, and an enormous number of elements score very low (the long tail of the distribution which hugs the x-axis).

Power laws are unusual. They are special situations. Gaussian, or normal, distributions are much more common in nature than power law distributions. For example, the velocity of gas molecules in a room, the length of new born babies, and the distribution of market capitalizations for the broader stock market all follow Gaussian distributions. One common trait of Gaussian systems is independence. To use gas molecules as an illustration, the velocity of any given molecule will not explicitly depend on the velocity of the other molecules. Even when the molecules collide, there is only a small degree of interaction.

In contrast, power laws occur when there is a high degree of interaction. The canonical example is a forest fire. The probability that a given tree in the forest will burn is highly dependent on weather or not other trees in the forest are burning and the location of a tree relative to its neighbors. The underlying “network” position of the trees determines whether or not the blaze dies out, is confined to a small area, or becomes a full-blown conflagration. This complexity gives rise to power law distributions in the sizes of forest fires. The concentration of hits on the web also translates into a concentration of market value. Implicit in this observation is that the most frequently used sites generally have the best opportunity to create viable business models. What’s interesting is that the valuations of Internet companies, despite a pronounced downturn in the segment over the last six months, still conform to a power law. This can be seen in Figure 2.

Figure 2
Internet Market Capitalization Power Law



Source: CSFB analysis

This analysis provides compelling evidence that the market continues to value Internet companies correctly on a relative basis. It is important to note that these data remain mute on the issue of absolute valuations. Contrary to popular perception, there is some discernible order to Internet valuations. The question is whether this order is unique to Internet stocks. Do other industries exhibit the same characteristics, where a disproportionate share of the total market capitalization resides in a handful of firms? We analyzed forty-six sectors from eighteen different industry classifications in an attempt to answer this question. This broad survey revealed that nine sectors exhibited strong power law characteristics. They are displayed in the Appendix.

The Strong Get Stronger

While no pure Internet brand is reinforced by the benefit of a physical presence, many particular characteristics of the online medium allow those companies that are already ahead to stay ahead. One example noted in Absolute Power is that new sites tend to link to already-popular sites in a bid for increased traffic. Such a reinforcing link structure is reconfirmed in a number of subsequent studies of the web.

The most comprehensive study of the web to date reveals some interesting insights into its macroscopic structure. Researchers at IBM's Almaden Research Center in San Jose, California examined over 200 million pages and 1.5 billion links (roughly one-fifth of the estimated current web). They found that the web's connectivity resembles a bow tie. On the left side of the bow tie is what they dub, the "newbies." This group of sites, consisting of 43 million pages (or 21% of the total), are relatively new to the scene. They link to the center, or what is called the "Strongly Connected Component" (SCC). However, these established players—with over 56 million pages—do not link back to the newbies. Sites in the SCC consist of portals and many of the top corporate sites in the MediaMetrix data. On the right hand side of the bow are the "introverts." This group includes a lot of lesser-known e-commerce sites. Although the SCC is linked to these introverts, the introverts do not provide links back to the strongly connected center.⁷

Most search engines rely on so-called "crawlers." Crawlers work by indexing a web page, jumping to other pages linked to it, then indexing those, and so on. The Almaden study contradicts earlier suggestions that any two web pages are connected by a relatively small number of hyperlinks. In order to give wide breadth of coverage in the future, search engines will have to crawl from a greater diversity of starting points than they do today.⁸ Until this occurs, they will continue to channel traffic to the most popular and entrenched web sites—without any reciprocity for the "newbies." With only a fraction of the growing web appearing in most search queries, traffic patterns to the existing strongly connected sites is positively reinforced.

Advertising Spiral

So how does this translate into economic value? One example of the value concentration is advertising. Advertisers aren't taking any chances with the "new" medium: about 95% of web advertising is spent on 1% of all ad-supported web sites. And while the *absolute* number of web sites receiving online ad revenues continues to grow, the *percentage* share of ad dollars being spent at the top 50 sites continues to rise.

Figure 3
Publisher's Share of Total Web Ad Revenues

	<u>1998</u>	<u>1999</u>	<u>2000</u>
Top 10 Sites	72%	74%	76%
Top 25 Sites	85%	87%	89%
Top 50 Sites	92%	95%	95%

Source: eMarketer estimates

Although this profile may change as advertisers shift their dollars away from portals and towards more highly targeted vertical web sites, advertisers continue to gravitate toward high traffic sites.

Web Competition

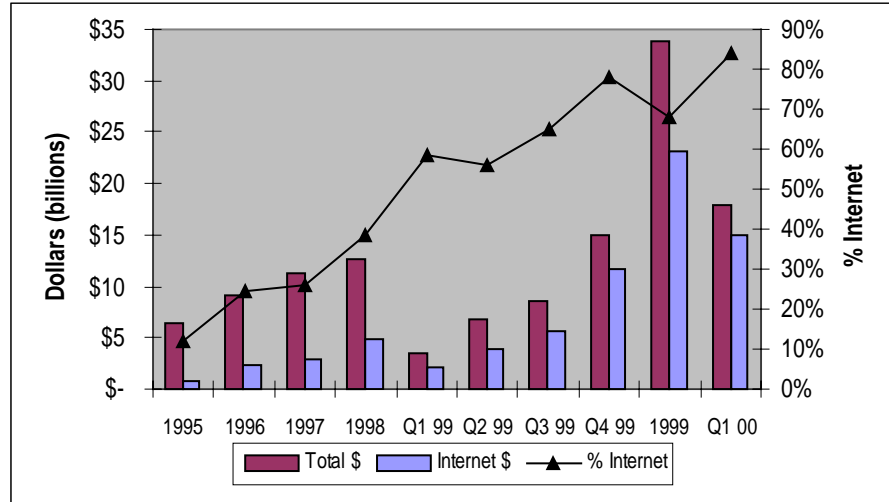
Models that try to explain the characteristics of electronic markets—where a few sites thrive while most are driven to the verge of extinction—conclude that sudden transitions occur. As the competition between web sites heats up, a profound shift can take place from an environment where many sites simultaneously thrive to a winner-take-most market where a handful of sites attract most users. This is attributable to a nonlinear interaction among sites, which effectively reduces the growth rate of some sites due to extreme competitive pressure from others.⁹

With firms spending enormous sums to sustain growth, it's easy to see that it's possible to reach a critical spending point where funding dries up (in tandem with the business fundamentals). This phenomenon can occur even with only two competing sites, and is comparable to the "principle of mutual exclusion" in ecology. Two predators of the same prey cannot coexist in equilibrium when competitive predation is very strong.¹⁰

Once the fixed development cost of operating a web site is spent, it's relatively inexpensive to scale capacity to meet increased demand. So as web sites proliferate, focus on aggregate demand becomes the order of the day. Unfortunately, many web company "predators" are competing for the attention and resources of the same consumer "prey."

Conclusion

**Figure 4
Trailing Venture Capital Money Flows**



Source: VentureOne Corp. & CSFB analysis.

The last two years has witnessed unprecedented investment by venture capital firms. The fourth quarter of 1999 put an exclamation point on the full year, as \$14.9 billion was spent on new business opportunities. This *quarterly* total was higher than any *annual* amount in the history of U.S. venture capital. Picking up where 1999 left off, venture backed firms raised \$17.8 billion in the first quarter of the new century. Of the totals dollars allocated, 84% went to Internet related ventures. We register our skepticism today, as we did six months ago, regarding the ability of most online firms to survive the unforgiving rule of the power law.

Since the beginning of the second quarter there has been a marked change in perception of Internet businesses. Investors are now focusing on a new acronym: P2P—the path to profitability. With some high-profile firms at 52-week lows and others closing their doors altogether, investors must remember the inherent advantage of today’s market leaders. They have the customers. They have the capital. And they benefit directly from the self-reinforcing nature of the web.

Appendix

Complements

We analyzed forty-six sectors from eighteen different industries for possible power law trends. Data are from Factset industry classifications. This broad survey shows that nine of these industries show strong power law characteristics (see Figure 5). In every industry studied we find that the largest companies best follow a power law. We show the relative size of this subset of companies in the first column. The second column gives a measure of how much each industry is dominated by its largest companies, and the third column quantifies how well the companies are fit by a power law (smaller numbers closer to zero correspond to better fits). Here we employ the standard statistical practice of taking the square root of the mean squared residuals as a goodness of fit test.

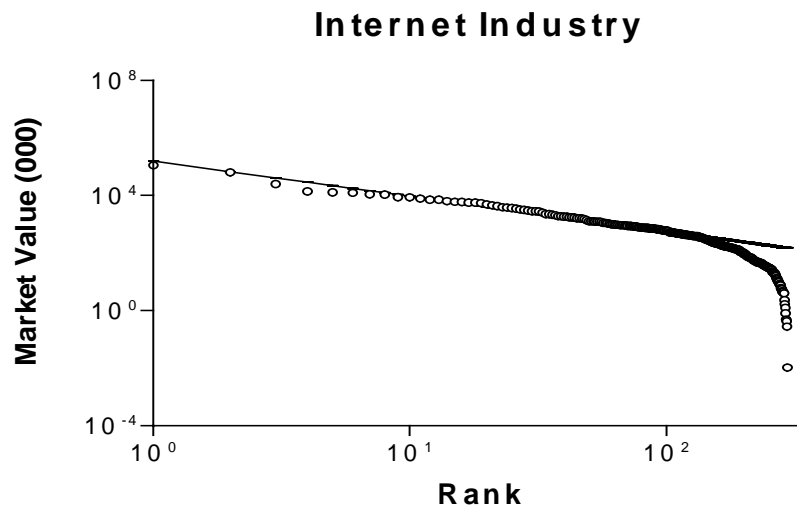
Figure 5
Power Law Sectors

Industry	Portion Following Power Law	Market Share Held By Companies in Top 5%	RMS of Residuals in Power Law Fit
Internet	47%	64%	0.152
Biotech	46%	64%	0.094
Savings & Loan	45%	66%	0.091
Telecom Equipment	39%	86%	0.209
Specialty Chemicals	35%	40%	0.121
Semiconductors	28%	64%	0.137
Restaurants	19%	85%	0.214
Software	17%	85%	0.126
Apparel	16%	67%	0.127

Source: CSFB analysis

To further illustrate the procedure used to establish the results in Figure 5, we present the Internet industry results in greater detail.

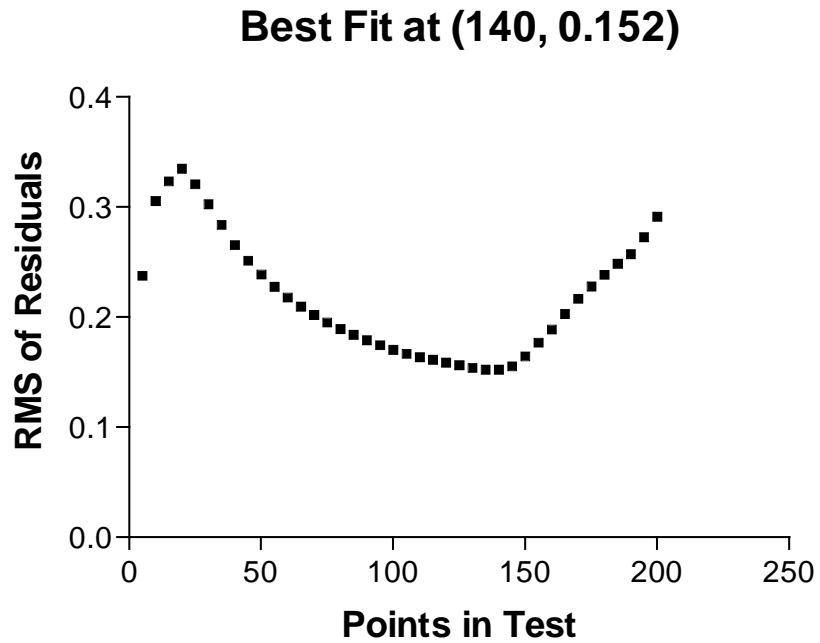
Figure 6
Internet Services Industry



Source: CSFB analysis

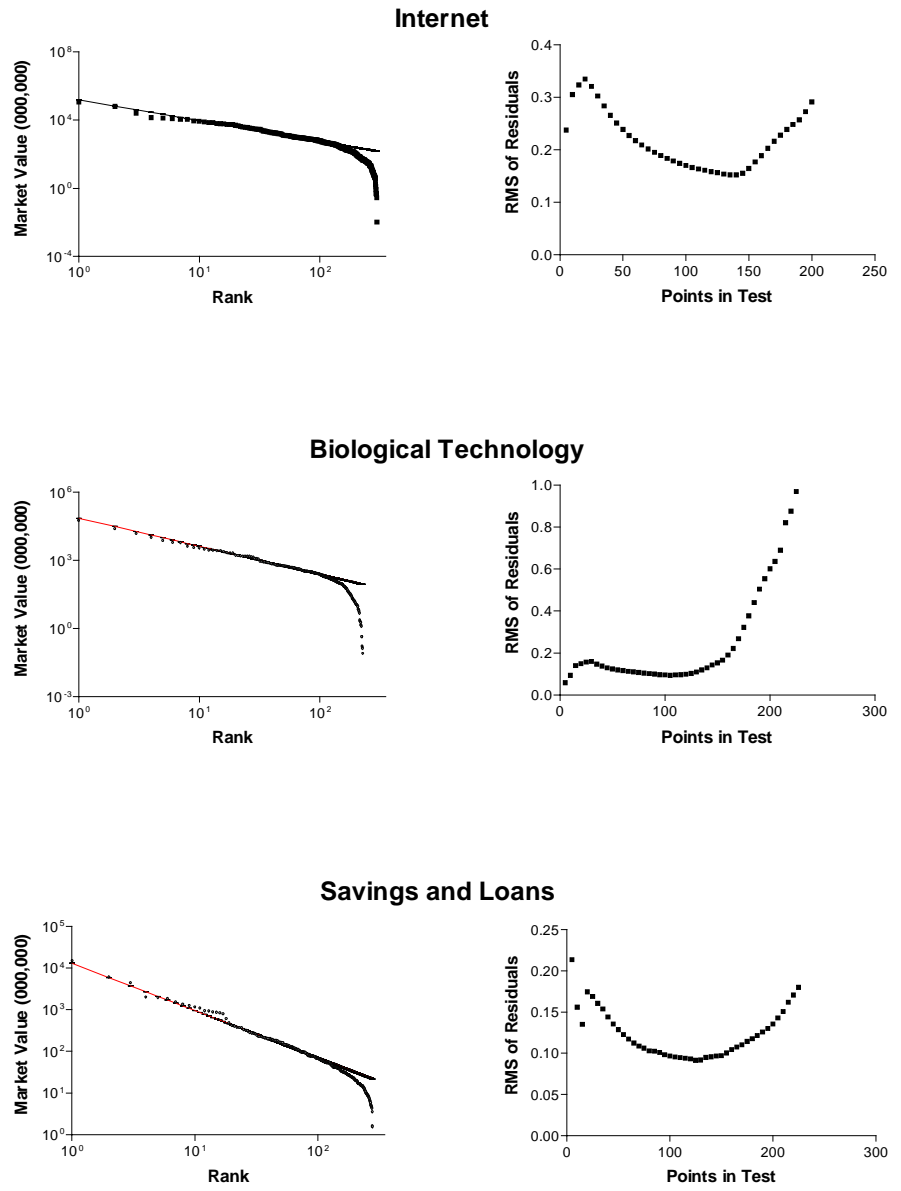
Figure 6 contains the market value (in thousands) for each of the 297 companies in the Internet industry. As a function of rank, the top 140 companies (47%) closely follow the fit line. Figure 6 demonstrates how the fit line was chosen. Each point is the result of a power law fit to a portion of the total industry. When more than 140 companies are included in the fit, the RMS values begin to systematically increase which indicates divergence from power law behavior. Therefore the fit line in Figure 5 is chosen to best fit the top 140 companies.

Figure 7
Internet Services Industry



Source: CSFB analysis

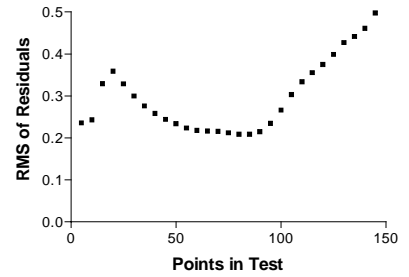
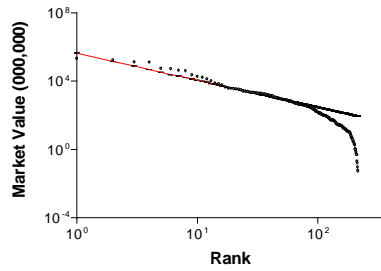
Figure 8
Power Law Segments



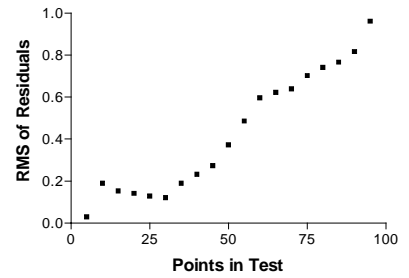
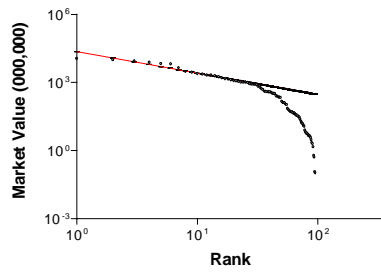
Source: CSFB analysis

Figure 9
Power Law Segments

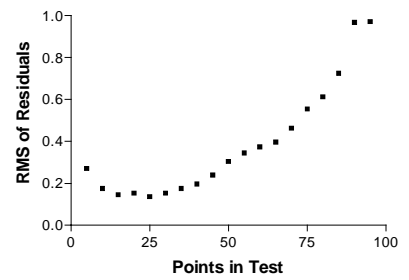
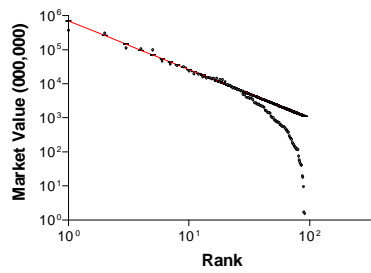
Telecommunication Equipment



Specialty Chemicals

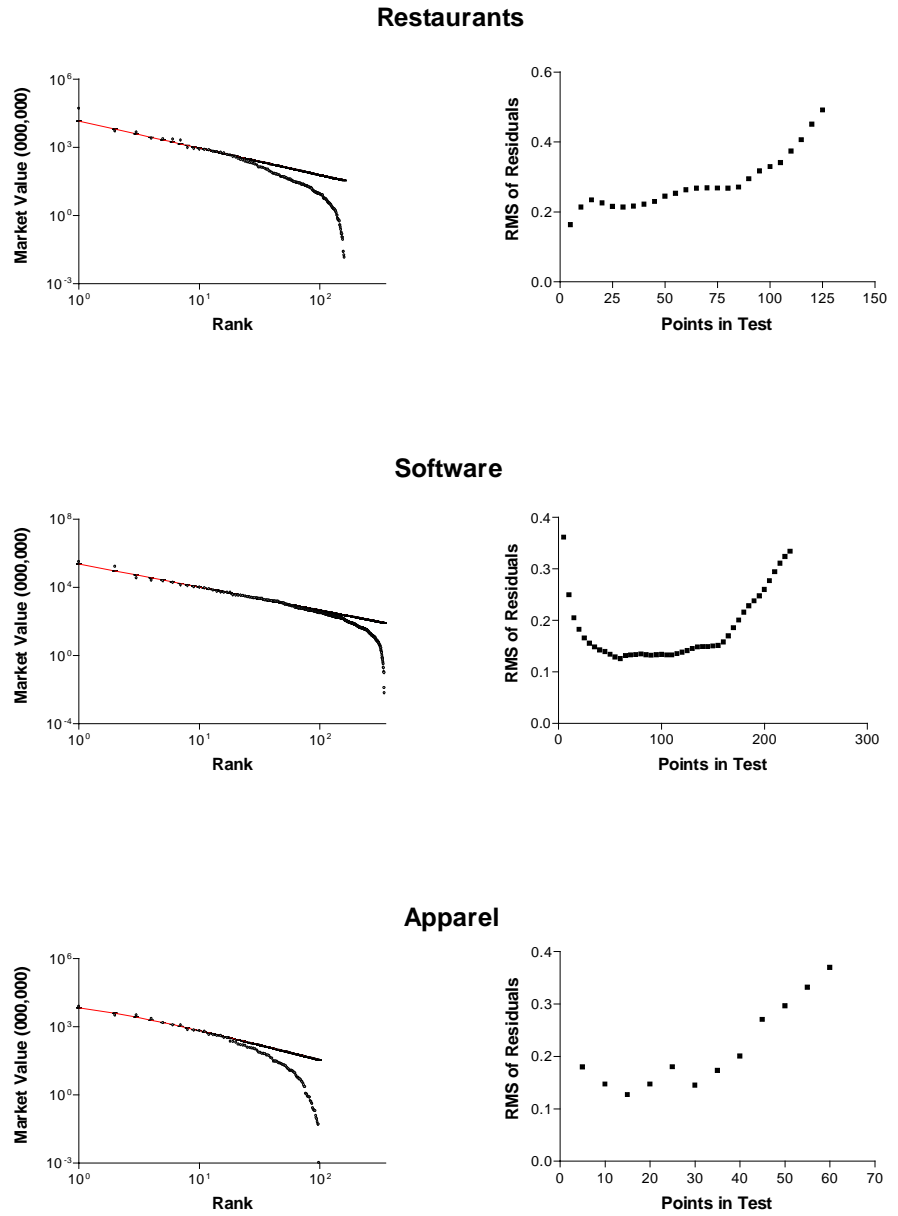


Semiconductors



Source: CSFB analysis

Figure 10
Power Law Segments



Source: CSFB analysis

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¹ This was initially reported in “*Growth Dynamics of the World-Wide Web.*” Huberman, B.A., Adamic, L. *Nature* Vol. 401, September 9, 1999. Since then the results have been reconfirmed in “*Graph Structure in the Web.*” Broder, Andrei et. al. IBM Almaden Research Center, San Jose, CA., June 2000.

² *ibid.* Huberman. It’s important to note that the observed power law behavior was derived from usage logs for all web sites, not usage logs for commercial web sites alone. Corporate strategy can influence the ability to crack the line-up.

³ Six properties were absorbed by competitors that remained in the top 25 in April. The balance of the firms remained in the top 100.

⁴ Michael Mauboussin, Alexander Schay, Stephen Kawaja, “*Absolute Power,*” Credit Suisse First Boston Equity Research, December 21, 1999.

⁵ Although we could find no direct statistical correlation between site traffic and market capitalization, 14 of the top 25 companies in terms of site volume were also in the top 25 in terms of market value.

⁶ “*Growth Dynamics of the World-Wide Web.*” Huberman, B.A., Adamic, L. *Nature* Vol. 401, September 9, 1999

⁷ “*Graph Structure in the Web.*” Broder, Andrei et. al. IBM Almaden Research Center, San Jose, CA., June 2000

⁸ “*Souped Up Search Engines.*” *Nature* Vol. 405, May 11, 2000 www.nature.com

⁹ “*Competitive Dynamics of Web Sites.*” Maurer, Sebastian M., Huberman, Bernardo A. Xerox Palo Alto Research, March 17, 2000.

¹⁰ *Ibid*