Who will win?
Does Quality Win?

COMPETING AGAINST AN ENTRENCHED MARKET LEADER IN HIGH-TECH MARKETS

Gerard J. Tellis, Eden Yin and Rakesh Niraj

In recent years, with some early entrants to a market commanding huge market shares, critics have wondered whether the best quality products win in the market place. Early entrants can gain a position of wide-spread acceptance among users. The fact that a critical mass already uses the product might prompt new consumers to snowball onto this early choice leading to consumer lock-in. Many economists fear that such “network effects” may enable inferior products to defend their entrenched positions even against higher quality alternatives. This article tests the validity of this premise in 19 high-tech markets including hardware, software, and services. Results indicate that contrary to the above fear, healthy market evolution occurs in most cases without regulatory intervention. Better quality entrants gain market dominance within three to five years of entry. The findings also show that it makes sense to invest in developing high quality products even if the market seems dominated by an entrenched industry leader and that network effects even increase market efficiency in some cases.

**Contradictory conclusions on market evolution**

Microsoft Windows, Internet Explorer, Oracle relational databases. These high-tech innovations have survived numerous challenges and dominate their respective categories. The antitrust litigation against Microsoft in the US and the European Union in the 1990s suggested great concern about whether the dominance of Microsoft was based on superior quality or abuse of market power. The question arises if market forces support inefficient products of established firms even with the entry of superior alternatives. For example, did Internet Explorer win in the market because it was superior or because of Microsoft’s monopoly power? If so, should these potential problems be the focus of antitrust policy? Or can we rely on the efficiency of free markets to pick the best products even when some firms dominate their markets?

**Network or quality, what prevails?**

So called “network effects” may play an important role in hindering healthy market evolution. Such effects refer to the tendency of consumers to choose products depending on what other consumers do so. Technically, network effects can be explained as an increase in a consumer’s utility from a product when the number of other users of that product rises. Examples would be the popularity and continual use of Facebook or Word. As a result, consumers may decide to buy and use a product not because it is superior but because their friends and colleagues use it. If most consumers in the market follow this rule of thumb, economists fear that such effects may lead to consumer inertia and lock-in in favor of established inferior products even when newer superior ones exist. Paul Krugman, winner of the Nobel Memorial Prize in

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Economics in 2008, for instance, doubts that “markets invariably lead the economy to a unique best solution”. Instead, he asserts, “the outcome of market competition often depends crucially on historical accidents”. A technology that by chance gains an early lead in adoption may eventually corner the market of potential adopters, with the other technologies locked out even though the latter are superior.

Contrary to this position, scattered empirical research suggests that markets do respond to quality. Superior quality brands do command higher prices, market share, and profits. The key question is, does this also hold in modern markets in the presence of network effects. That is, when a large number of consumers choose brands based on which brand prior consumers chose, does the whole market converge on an inferior quality product?

Explaining the contradictions

The resolution to this problem depends critically on two conditions. First, is quality distinguishable prior to purchase? Second, are at least a small segment of consumers informed on quality? If consumers cannot distinguish the quality of the products prior to purchase, or if all consumers are uninformed on quality, then network effects are likely to dominate the market. As a result, markets will be inefficient, and a brand that first enters the market, will dominate the market even in the presence of superior, later entrants.

On the other hand, if quality is distinguishable prior to purchase and even a small segment of consumers are informed on quality, then superior quality brands can win. How will this happen? Each period, these informed consumers will evaluate the brands in the market and will choose the best quality brands. Those who cannot evaluate quality will consult prior buyers of the brands. At least some of them will be informed consumers and would have chosen the best quality brands in the market. So every period, the set of new consumers who choose the best quality brands will increase. As further new consumers consult these informed consumers, more of them will choose the better quality brands and the market will converge on the best quality brands.

The above argument is a hypothetical one depending on certain conditions. What actually happens in practice depends on the actual number of informed consumers in the market. This is an empirical issue.

To empirically sort out whether inferior or better brands actually prevailed in the market, we conducted a study of 19 individual products and services within the personal computer industry in the 80s and 90s. The next section describes the procedure of getting the relevant measures as well as the analyses conducted to answer the open research questions.

MARKET EVOLUTION IN THE PERSONAL COMPUTER INDUSTRY

Market characteristic and relevant variables

The personal computer products and services markets were selected for the analysis since these are supposed to exhibit strong network effects. Thus, they would generally favor the received wisdom of the superiority of network effects over those of quality. A total of 19 hardware and software products as well as some services were included in the sample. Different platforms, such as PC and Mac, were treated as different product markets. However, the two PC operating platforms, DOS and Windows, which emerged sequentially, were defined as representing one market. In most of these markets, there were usually two or three major competitors at any given time, usually with one dominant brand that often kept changing. Different product categories were tracked for between 4 and 17 years. Table 1 (page 12) provides a list of included product categories as well as some summary statistics like number of brands in each category, the time period and the evolution of market leadership.
The key variables used in the analysis include market share, quality and network effects. Relative prices and market growth were also considered in some analyses.

Quality is defined as the composite of a brand’s attributes, on each of which consumers prefer more to less (e.g. reliability, performance, and convenience). Networks refer to the proportion of prior users of a brand. Efficiency of markets is measured as the best quality brand (after adjusting for prices) emerges with the largest market share. Other factors such as price, advertising, distribution, and market growth might also play a role in these markets, but for most analyses they seemed uncritical in assessing the role of network versus quality. Wherever possible, price data was also collected and controlled for.

The Art of Collecting Data that Does Not Exist
The main challenges of collecting the data needed were the long time period and the qualitative and scattered characteristic of some key variables. The majority of the market share data was taken from IDC (International Data Corporation) and partly from Dataquest. However, even these firms did not have complete or adequate data on a number of categories. In those instances where the data was not available from any syndicated source, other archival sources were used to complement the data.

The quality measure was based on the ratings or reviews in the three most respected and widely circulated computer magazines: PC Magazine, PC/Computing, and PC World plus the leading magazine for Mac products, Macworld. However, since many of the magazines published reviews without numerical ratings, a content analysis of the reviews was necessary to arrive at numerical ratings. First, a set of terms was collected that reviewers often use to describe these products. Then these terms were grouped into five levels expressing increasing quality. Two specifically trained raters analyzed all reviews independently for content and converted the result into a numerical score based on the prevalence of such terms in the review (intercoder reliability 87%).

In creating a measure for network effects, the repurchase cycle for all markets in the sample was estimated to be about three years. This assessment is based on personal experience, interviews with some senior IT managers, and interviews with some consumers. The information collected indicated that software and hardware is typically upgraded or repurchased within three years. Thus, the relevant network size was measured using the accumulated market share of a brand in the past three years.

Though pricing was not an explicit part of the study, pricing information was necessary as a control variable. The price data was scattered around each issue of magazines in either the articles/features or the ads. Two graduate students located all relevant pricing data for the brands in the sample. Then all the price data was compiled into a meaningful format by brand and averaged per year.

A series of different analyses investigated the personal computer market using the described variables. Some of the key analyses and conclusions of the study are presented below.

EFFICIENCY, QUALITY AND NETWORK EFFECTS IN THE PERSONAL COMPUTER INDUSTRY
If network effects were dominant, an early entrant would dominate a market and one would not see changes in market leadership. So a test of network effects was an answer to this question:

Were Changes in Market Leadership Observed Over the Years?
Indeed, fairly frequent changes in market leadership were observed in the sample. Market leadership rarely rests with a single brand. In a categorical analysis all switches from being sub-dominant to being dominant in either market share or quality were compared pair-wise.

> In 17 of the 19 markets, at least one switch in market share leadership occurs during an average period of 9.3 years sampled for these markets.
> The average duration of market leadership ranges from 5.5 years in operating systems to as short as 2 years in web browser. Across all categories examined in this exercise, the average duration for market leadership is only 3.8 years.
> Further, in 10 of these markets, there are multiple switches in market share.
> Overall, a total of 34 switches in market share across all the markets were observed.

A simple graphical analysis of markets reveals the same picture: market shares are in a state of constant flux. This observation does not support the existence of simple markets where consumers care only about the network or randomly choose products ignoring network as well as quality. Figure 1 (page 12) gives an overview of these results.
TABLE 1:
Switches in Quality, Market Shares and Market Share Leadership

<table>
<thead>
<tr>
<th>Markets</th>
<th>Number of Brands</th>
<th>Switches in Quality</th>
<th>Switches in Market Share</th>
<th>Years Taken to Become Market Leader After Quality Switch</th>
<th>Total Years</th>
<th>Switches in Market Share Leadership</th>
<th>Duration of Market Share Leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spreadsheet</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>14</td>
<td>Lotus, Excel</td>
<td>7</td>
</tr>
<tr>
<td>Internet Service Provider</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>Prodigy, CompuServe, AOL</td>
<td>4.2</td>
</tr>
<tr>
<td>Personal Finance</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>Managing Your Money, Quicken</td>
<td>5.5</td>
</tr>
<tr>
<td>Web Browser</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>Mosaic, Netscape, Explorer</td>
<td>2</td>
</tr>
<tr>
<td>Desktop Publishing (Mac)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td>PageMaker, QuarkExpress</td>
<td>4.5</td>
</tr>
<tr>
<td>Desktop Publishing (High-end)</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>10</td>
<td>Ventura, PageMaker, QuarkExpress</td>
<td>3.3</td>
</tr>
<tr>
<td>Desktop Publishing (Low-end)</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>No quality switch due to data censoring</td>
<td>7</td>
<td>First Pub, Express Pub, MS Publisher</td>
<td>2.3</td>
</tr>
<tr>
<td>Presentation Graphics</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>Freelance, Harvard, PowerPoint</td>
<td>4</td>
</tr>
<tr>
<td>Operating Systems (PC)</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>11</td>
<td>DOS, Windows</td>
<td>5.5</td>
</tr>
<tr>
<td>Operating Systems (Network)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>NewWare, Windows NT</td>
<td>2.5</td>
</tr>
<tr>
<td>Word Processor (Mac)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>MacWord, MacWrite</td>
<td>6</td>
</tr>
</tbody>
</table>

FIGURE 1:
Share and Quality Flows in the Personal Word Processor Market

In the word processor market, the early leader is WordStar, which dominates the market for a number of years (Wstar-MS). However, from 1984, WordStar’s quality begins a sharp and irreversible decline (Wstar-Q). WordPerfect (WP-Q) surpasses WordStar in quality in 1985 and its market share (WP-MS) rises as its quality rises. However, the market share switch between WordPerfect and WordStar does not occur until four years later, i.e., 1989. WordPerfect’s market share keeps rising and maintains its market leadership until 1993 when it is surpassed by Microsoft Word (Word MS). Microsoft Word’s quality rating (Word-Q) surpasses that of WordPerfect in 1991 and sustains its leadership since then. In contrast, WordPerfect’s quality is consistently inferior to that of Microsoft Word after 1991 and its market share also steadily declines in this time period.
If there are Changes in Market Leadership, are they Related to Quality?

Again, the answer is a clear “yes”. Figure 1 gives an example of the graphical analysis of the word processor market.

The other submarkets show a very similar picture. The market shares of brands appear to rise following the rise in their level of quality. Most switches in quality leadership seem related to and precede switches in market leadership. Hence, quality seems to play an important role in influencing market dynamics. Moreover, these simple graphical plots do not indicate that these markets are perverse. That is, there is no evidence that early market share leaders dominate the market for long or do so if they lose their quality edge for most markets analyzed. Categorical analyses confirmed that out of all the 34 switches in share analyzed, 18% are related to a switch in quality in the same year, 50% are related with a switch in quality in prior years and 20% are related to the sub-dominant brand already having a superior quality to the dominant brand. So, in total, 88% of the switches are related to the switches or superiority in quality of the sub-dominant brands, but only about 12% have no relationships to quality changes. In contrast, when there is no switch in share, we see that quality of the inferior brand mostly stays inferior.

Overall, these results provide strong evidence that a superior quality or a switch in quality of a subdominant brand results in a switch in market share over the dominant brand. A logit analysis further confirms the link between quality and market share switches and finds the strongest effects of quality switches two years prior to the market share switch.

The results indicate that markets are responsive to quality, as is evidenced by the fact that prior switches in quality significantly increases the probability of a market share switch in the immediate subsequent years. To investigate the strength of the quality effect, a hazard analysis of time to market share leadership was also conducted for the data. It shows that the time it takes for the smaller share brand to achieve market leadership is affected positively and significantly by the improvement in quality of the smaller share brand over the larger share brand. The probability of such a switch is much higher when the gap in quality (of the lower share brand over the high share brand) is higher. The leadership duration variable has a negative and significant effect on the probability of market-share switch indicating that a switch in market leadership takes longer in inertial or slow moving markets.

SELECTING APPROPRIATE METHODS TO REVEAL PATTERNS

Logit analysis is a technique which allows the probability of an event occurring or not occurring to be estimated. It predicts a binary outcome (in our case whether there is a switch in market share or not) from a set of independent variables. Only current or previous quality switches were considered as independent variables in this analysis. The relative role of quality and network size differences were not analyzed and differences in product category inertia was also not controlled.

A hazard analysis of time to market share leadership can reveal the relative impact of independent variables on how quickly a high quality brands becomes a market leader. The study modeled time to market leadership as a discrete time hazard process influenced by quality gap and relative network sizes while controlling for leadership duration within the market.

Do Network Effects Inhibit a Healthy Market Evolution?

Here, the answer is “no”. An indication for the presence of strong network effects and a perverse market would be the absence of changes in market leadership. This, as outlined before, was not the case here. Another, softer, indication of market efficiency is whether a subdominant brand becomes a market leader within or beyond the average repurchase cycle.

The frame of reference in this study is three years, because prior research indicated that repurchase in this product category happens approximately every three years. Categorical analysis showed that, for web browser, Internet service provider, image management software, presentation graphics, and personal finance, it takes less than three years for a sub-dominant brand to become the new market leader after its quality exceeds that of the dominant brand. For products like word processor, spreadsheet, desktop publishing and network operating systems, the time to attain market leadership was usually longer, e.g., four to five years. These results demonstrate that the markets for the first group of products are highly efficient. Superior products quickly
gain market leadership once their quality dominates that of rivals. The markets for the second group of products are also efficient, albeit markets settle down on superior brands more slowly than the repurchase cycle.

The case of the PC operating system seems a notable anomaly. This product category supposedly exhibits strong network effects, but a superior Windows quickly replaces DOS two years after its quality surpasses that of DOS. One reason for this result is that the quality of Windows is so much better than that of DOS. A sufficient quality gap overwhelms the power of network effects. It again shows that quality rules in these markets and network effects cannot protect the incumbent leaders from competition. However, this advantage may have been facilitated by the backward compatibility of Windows to DOS.

These results make intuitive sense because the first group of products is generally believed to exhibit weaker network effects whereas the second group of products is much more influenced by network effects due to their intrinsic communication or sharing-oriented nature. Hazard analysis confirms some influence of network size on switch in market leadership, but the effect of quality is much stronger.

» Time for market leadership by the smaller share brand is affected positively and significantly by the improvement in quality of the smaller share brand over the larger share brand. «

**EFFICIENCY, QUALITY AND NETWORK EFFECTS IN THE PERSONAL COMPUTER INDUSTRY**

**Summary of Results**

- Markets are efficient in general.
- Market leadership changes frequently and market leaders hold sway for an average of a mere 3.8 years.
- Change in market leadership is generally associated with a change in quality the same year or a few years earlier.
- Both network effects and quality are factors in determining market share, but quality seems more important.
- Even in the presence of network effects, the market is not inefficient.
- The presence of network effects enhances the efficiency of the market that derives from a quality conscious segment of consumers.

**A CHALLENGE TO PRIOR “RECEIVED WISDOM”**

Even if this study is limited to one industry and a limited set of key variables, the results have some important implications for business strategy and public policy and challenge some widespread assumptions on market mechanisms. They apply whenever there is an increase in utility of a product for any one user from more users of the product. Examples are the increase in value of a cell phone, email, or a multi-person game to one person as more people own these products.

Is “rush to market” a right mantra to follow?

As previously discussed, high-tech firms spend enormous resources in rushing new products to market in an attempt to outpace their respective competitors. However, the undeniable truth is that many new products fail. One of the major reasons for these failures is the premature product launch undertaken by many high-

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**Box 2**

**Summary of Results**

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- The presence of network effects enhances the efficiency of the market that derives from a quality conscious segment of consumers.
tech managers who rush to market, encouraged by the popular myth of pioneering advantage. The results of this study suggest that superior quality appears to be a very important driver of success and market leadership changes frequently. Thus, companies may need to put a premium on quality rather than on speed to market.

Are network effects a reliable shield for existing leaders?
This study shows that switches in quality consistently result in switches in market share, albeit with a lag of some years. Network effects may delay but do not prevent superior brands taking over the market. On the contrary, even established market leaders, though they enjoy a large network of users, are vulnerable to threats from new entrants that introduce superior alternatives. A network is not a reliable shield on which an existing leader can rely. Constant quality enhancement is an effective way for existing leaders to defend their current positions.

Are network effects responsible for perverse markets?
Network effects have been blamed as the devil that causes market inefficiency, e.g., an inferior product or standard can dominate the market simply because of its large network size. This was not generally observed in this study. In some cases strong networks did slow down the switch in market leadership. However, the study also revealed that networks effects, under certain circumstances, could even make the market more efficient.

If sufficient consumers care about quality, then network effects enhance the role of quality, because other consumers also benefit from the choices of quality-conscious ones. Consequently, the entire market settles on the better products more quickly and at a higher level than it would have in the absence of network effects. In this case, network effects speed the transfer of information from the informed to the uninformed.

Should government act as a substitute for “the invisible hand”?
This study shows that quality drives the success of high-tech giants, even though network effects are present. It seems that markets do settle on the best option while remaining open to better ones. Therefore, high-tech markets are reasonably efficient and rational. Government intervention, which is intended to assume the role of “the invisible hand” in high-tech markets, may be costly and unnecessary.

FURTHER READING

Krugman, Paul (1994), Peddling Prosperity, New York: Norton


KEYWORDS:
Competition, Product Quality, Network Effects, Market Evolution, Market Leadership, Market Efficiency, Computer Industry