

## Commentary: High-Technology Industries and Market Structure

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Hal Varian does an excellent job of surveying economic models related to high-technology markets. He covers two distinct aspects: how advances in technology affect marketing and market structure in other industries (such as retailing), and how the market structure of technology industries is altered by the presence of network effects, customer lock-in, economies of scale, etc. My comments will address primarily what conclusions we should draw from the analysis he presents.

First, I agree with the paper's assessment that advances in information technology have revolutionized and will continue to revolutionize the way that products are marketed, distributed, and sold in many industries. The opportunities for product customization and individualized marketing and pricing are greatly enhanced by today's information systems and the Internet. As the paper makes clear, models often predict two conflicting effects. First, consumers gain because (i) firms are better able to customize products that satisfy heterogeneous wants and (ii) because improved pricing tends to raise total consumption and can intensify competition. Second, consumers tend to lose due to the "surplus extraction effect": Firms are able to charge higher prices to those who have less elastic demands. The surplus extraction effect leads to increased revenues for firms. These revenues cover the cost of the information systems and increase profits. However, this is not the end of the story. In the long run, we expect that profits will be

competed away, typically through lower prices to consumers or through enhanced incentives for product development and innovation. This will offset the surplus extraction effect and increases the probability that consumers will benefit.

While the paper and the underlying literature argue that the effect of information technology on consumer welfare is ambiguous, I am much more optimistic. The paradigm I have in mind is that markets are competitive (at least from an *ex-ante* perspective) and provide firms with a normal rate of return. In such a world, technological change will not increase aggregate profitability of firms. Consumers will gain if the technological improvement enhances efficiency (even if this shows up initially as higher profits), as long as the means through which profits are competed away are relatively efficient (for example, through lower prices to consumers). While it is possible that technological changes can reduce rather than improve efficiency, and it is possible that profits can be competed away in inefficient ways, firms and consumers have incentives to find better ways to use technology and to compete. In fact, the ability for technical improvement to reduce efficiency is not unique to models of information technology. The economics literature is replete with models of emiserating effects of growth and trade, whereby technological improvement or free trade reduces rather than increases welfare. Yet, experience indicates that such perverse effects are common in theory but rare in fact. I suspect that technological improvements in marketing will yield similar results; yes, they could be bad but rarely are. Some of the gains may be unmeasured in terms of improved variety or convenience, but I suspect that even just on price dimensions, outcomes will be better rather than worse. So long as we avoid inefficient technologies or methods of competition, consumers must gain from *ex-ante* competition. Given the incentives of firms and individuals to find efficient methods and reject inefficient ones, I suspect that this form of competition will be the norm.

Hal Varian's paper also does an excellent job of covering a wide range of issues that affect market structure in technology markets. I agree that there are many forces that tend to lead to more concentrated

markets (at least as conventionally measured). Yet, market structure is not an end in itself, nor is it even a useful benchmark for judging welfare—which is what really matters. We care instead about actual market outcomes in terms of prices, output, and technological improvement. In my judgment, many of the forces that lead to greater concentration do so precisely because they enhance competition and/or make outcomes with greater concentration more efficient.

For example, network effects, through which a product becomes more attractive to an individual consumer when more individuals use the same product, have two primary effects. They make the demand for any one firm's product more elastic (because attracting one customer will bring in additional customers) and they make outcomes with more concentration more efficient—a concentrated market exploits the gains from a large network. Elastic demand lowers equilibrium prices by increasing the incentive for firms to cut price. This makes it more difficult to support multiple producers, particularly when network effects are combined with large fixed costs and low marginal costs. In isolation, this effect works toward more competitive outcomes (i.e. low prices) even though it leads to markets that look less competitive to observers who focus on market structure. The tension is between equilibria with a single firm (which may maximize the benefits from the network) and equilibria with a few firms (which sacrifices some network gains for greater ex-post competition and product variety).

The prototypical network industry with very large network effects is dominated by a single large producer whose large share of the market raises consumer demand for its product, while small customer bases for competitors limit their ability to succeed. From an efficiency standpoint, this is not all bad because the large market generates real efficiency for the dominant firm and its customer base. This is particularly true when network effects are as important (on the margin) with large customer bases as they are when customer bases are small. Under such conditions, productive efficiency is generally enhanced by increased concentration. One potential criticism of highly concentrated network markets is that potential competitors may only offer

weak competition for the dominant firm, leading to high prices. Also, it may be difficult to displace inefficient incumbents.

However, as I stressed above, any profits accruing to the dominant firm will translate into competition for the network market. As Varian stresses, this shows up as aggressive competition (such as penetration pricing) in order to capture the marketplace. This transfers rents back to consumers and increases consumer welfare. However, it does not eliminate any inefficiency generated by the ex-post high prices (a version of the lock-in effect). But, this is not the end of the story. When these inefficiencies are large, firms can benefit through voluntary licensing, open architectures, etc., which encourage customers to adopt their platform through a commitment to keep ex-post prices low. Through the choice of marketing arrangements (often involving implicit or explicit price discrimination) and technical design, firms have an incentive to reduce the efficiency losses associated with exploiting their dominant position ex post. Once again, the competitive process up front will encourage firms to adopt such efficiency-enhancing mechanisms. Such substitutes for ex-post competition are not perfect, but neither are they unimportant.

Another of the common descriptions of technology markets is that they are characterized by high fixed costs and relatively low marginal costs. Such costs structures typically lead to high concentration. Once again, however, such a market structure is driven by two forces: Low marginal costs lead to low prices, and high fixed costs make a market structure with relatively few firms efficient. Markets with ex-ante competition and high fixed costs typically end up with a small number of firms, with price equal to average cost (but in excess of marginal cost). Such a market structure is economically efficient and is only dominated by outcomes with even greater concentration, (which economize on fixed costs) and/or prices less than average cost (removing marginal consumption distortions). These “superior” outcomes could only be obtained by subsidizing producers and/or restricting entry. Few economists would advocate either.

Markets with high fixed costs and low marginal costs gravitate

toward concentrated structures because concentration is relatively efficient and because of the intense price competition generated by low marginal costs. When the market is too small or fixed costs are too high, the market may only be able to support a single producer. This is the natural monopoly case and it creates special problems. Yet, most technology markets do not look like natural monopolies; they often have several producers even when fixed costs are high. This is certainly true of many hardware markets, applications software markets, and technological infrastructure industries.

One of the places where competition is most difficult to see in operation is the choice of standards. Varian distinguishes between two types of standards: open and proprietary. In their most extreme form, proprietary standards are controlled by a single firm, while open standards are controlled by a consortium of firms or some outside agency. However, the choice between these two types of standards can take place in the marketplace. Some platforms or technologies adopt open standards, while others adopt proprietary ones. Each model has its pros and cons. Proprietary standards suffer from ex-post appropriation and lock-in, while open standards often lack the discipline and incentives generated by the marketplace. In many ways, competition between the Macintosh and the IBM PC, and Windows and Unix represent prime examples. In the hardware arena, the open standards of the PC won out, while in the operating system context the “open” Unix model was far less successful than the more proprietary Windows model. The choice of what types of standards will perform best in a particular market is exceedingly complex, probably more complex than the technical side of producing hardware or software. In my opinion, the choice of which model best serves the needs of consumers is not a job for economists or the courts. It should be left to the marketplace.

Other features of the technology industry also help enhance competition. Rapid technical progress means that firms that have a 10 percent, 20 percent, or even 30 percent disadvantage due to network effects, economies of scale, or lock-in are only one technical leap from displacing a “dominant” incumbent. Likewise, rapid growth of most

technology markets makes competition for share even more intense and limits the exercise of market power as the future losses of market share loom large relative to the gains from charging higher prices today. These forces are evident in the number of dominant incumbents that have been displaced over the years and the low prices charged by firms with dominant shares in an effort to maintain their positions.

In general, I think that Hal Varian has done a fine job of laying out the economic theories that illustrate how technology markets operate. My major concern is what conclusions people draw from the analysis. Hal is careful not to draw conclusions regarding policy or make judgments about market performance, but others may not be (and have not been) so shy. My comments reflect three key points. First, competition is a powerful force that operates at many levels. When ex-post competition is light, ex-ante competition will be more vigorous. Competition also operates on many dimensions: the choice of standards, the choice of contracts (e.g. licensing), competition for the market, and so on. Second, what we should care about is market outcomes and social efficiency, not market concentration. Many forces that lead to more concentrated outcomes do so precisely because they enhance competition and/or make more concentrated outcomes more efficient. Finally, a focus on outcomes leads me to examine what we actually see in technology markets. In my opinion, these markets are incredibly competitive. Even markets with high concentration, such as the PC operating system market, are characterized by remarkably low prices and rapid rates of technical progress and market growth.