Toward a Quantification of the Effects of Microsoft's Conduct

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Microsoft stands accused of an illegal defense of its dominant position in the desktop operating-system market. According to the charge, exclusionary contracts and predatory conduct dealing primarily with the Internet browser prevented the browser from evolving into a rival for Microsoft's operating system, Windows. Earlier, the government negotiated a consent decree with Microsoft limiting exclusionary terms in the company's contracts with computer makers. Our purpose here is to investigate quantification of the effects of the challenged conduct. By how much will the computer purchaser gain from the elimination of artificial barriers to entry in the operating-system business? Or, to put the question the other way around, how much harm did the conduct cause before it was brought under control? We also discuss policies for controlling artificial barriers.

A related more detailed paper, Hall (1999), develops a model to deal with these issues at a more general level. Here we will present a stripped-down version of the model and apply it to Microsoft.

I. Model and Calibration

The personal-computer industry is a symmetric Cournot oligopoly with M sellers. Industry demand is $p = \alpha Q^{-1/\varepsilon}$. Producers incur a fixed cost K and a constant marginal cost c. Microsoft sells them Windows at a per-unit cost of r. Hall (1999) considers two-part pricing, but we restrict attention here to standard one-part pricing. The output of the representative firm is q. Its profit is

$$q[\alpha(Q' + q)^{-1/\varepsilon} - c - r] - K$$

where Q' is the output of all the other firms. The firm proceeds on the Cournot assumption that its own quantity decision does not affect Q'. The Cournot assumption makes sense not because firms ever believe this proposition, but because many markets seem to fit the predictions of the Cournot model.

The first-order condition for profit-maximization of the firm is

$$(1) \qquad -\left(\frac{p}{\varepsilon}\right)\left(\frac{q}{Q}\right) + p - c - r = 0.$$

If there are M identical makers of personal computers, the equilibrium price is

$$(2) \qquad p = \left(\frac{\varepsilon M}{\varepsilon M - 1}\right)(c + r).$$

We will calibrate this model to a rough description of the market for Windows. We take the price of Windows to be $r = \$60$ and the price of a personal computer to be $p = \$1{,}000$. We take the extent of competition in the market to be $M = 11$ identical sellers. We assume an elasticity of demand of $\varepsilon = 2$. In symmetric equilibrium, the share q/Q in equation (1) will be $1/M$, so we can solve the first-order condition for the value of marginal cost, $c = \$895$. Thus computers sell for \$1,000, have a total cost of \$955 including the price of Windows, and have a profit margin of \$45. We take the number of computers sold, Q, to be 600 million over the next five years. Thus each computer maker will earn \$2.5 billion before fixed costs over the five years. We assume that the industry is in a zero-profit equilibrium, so that fixed costs are the same \$2.5 billion. These are both the sunk costs of developing and promoting the computer and the continuing fixed costs of production.

Absent concerns about entry, Microsoft would set the price of Windows to achieve the monopoly personal-computer price,

$$(3) \qquad p = \left(\frac{\varepsilon}{\varepsilon - 1}\right)c = \$1{,}789$$

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which calls for

$$(4) \qquad r = \left(\frac{\varepsilon M - 1}{\varepsilon M}\right) p - c = \$813$$

in our calibration. The conclusion, as Richard Schmalensee stressed in the Microsoft trial, is that the actual price of Windows is far below the monopoly price. Something constrains the price to a much lower level.

The hypothesis we pursue here is that any computer maker can develop a replacement for Windows by incurring a cost D. This cost covers coding a new operating system of the complexity of Windows, promoting it, inducing applications sellers to develop compatible versions, and overcoming any barriers to entry that Microsoft has erected, including illegal ones. Hall (1999) explains why it is interesting to consider self-supply as the threat to Microsoft, rather than the entry of an independent seller of an operating system. In the latter case, Bertrand competition is the likely outcome. Post-entry profit will be zero, so entry will not occur. Drew Fudenberg and Jean Tirole (1999) develop a model to overcome that paradox. With self-supply, a computer maker has a straightforward choice between (i) developing a new operating system and using it or (ii) buying from Microsoft.

The profit available to such a computer maker is implied by an asymmetric Cournot model where the self-developer has a cost advantage and a correspondingly larger market share. The price in the new equilibrium is

$$(5) \quad p = \left[\frac{\varepsilon(M+1)}{\varepsilon(M+1) - 1}\right] c + \left[\frac{\varepsilon M}{\varepsilon(M+1) - 1}\right] r = \$991.$$

The self-supplier's share of computer sales is

$$(6) \qquad \varepsilon\left(\frac{p - c}{p}\right) = 19.4 \text{ percent.}$$

Industry computer sales rise a bit to 611 million. The self-supplier makes a profit margin of \$991 − \$895 = \$96 per computer and earns a profit of \$96 × 611 million × 19.4 percent − \$2.5 billion fixed costs = \$9.0 billion before development costs.

The idea we pursue is that Microsoft has chosen the price of Windows to make self-supply barely unprofitable. Thus, we infer from the price of Windows that Microsoft believes that it costs \$9 billion to develop an effective rival to Windows. To prevent the loss of its Windows monopoly, Microsoft sets a price of \$60 instead of the monopoly price of \$813. This result is a great victory for virtual competition: not only is the price of Windows brought down to a small fraction of its monopoly price, but the social waste of duplicative investment in operating systems is avoided as well.

We believe that the general range of these calculations is reasonable. The projection that the seller of a computer with an operating system just as good as Windows would capture about 20 percent of the computer market seems about right. If Dell took over the Macintosh operating system it seems likely that it could achieve something like this. The rest of the calculation is mainly the benefit of avoiding paying Microsoft \$60 per machine. For example, avoiding \$60 on each of 120 million machines is \$7.2 billion, not far from our estimate of \$9 billion.

Our understanding is that the coding costs for a Windows rival would run to hundreds of millions of dollars, not billions. Overcoming barriers to entry apparently accounts for most of the cost of creating a serious rival. In addition to the substantial natural barriers defending a network product like Windows, there may be artificial barriers. Judge Thomas Penfield Jackson's *Findings of Fact* condemn a number of Microsoft's practices for blocking the entry of potential rivals.

The model developed earlier has important implications for considering barriers to entry. First, it need not be a goal of competition policy to bring about actual entry. Duplicative investment in operating systems is wasteful. Further, it will always be possible for Microsoft to deter entry by lowering the contract price of Windows, and generally in its interest to do so (see Hall [1999] for further discussion of the second point). But policies that promote entry benefit the consumer by lowering the price of Windows, and of Windows-equipped

computers, even though they cannot result in actual entry.

Competition policy (law enforcement by the Court in the government's case, incentives from the prospect of private cases, or legislation) can lower barriers to entry and reduce the cost of creating an effective rival to Windows. For example, the 1995 Consent Decree prohibits Microsoft from using exclusionary contracts of the type discussed by Phillipe Aghion and Patrick Bolton (1987). It is possible that the current case will result in additional prohibitions or will punish past predatory conduct in a way that will discourage similar conduct in the future. The result should be some reduction in the self-development cost, D. By the earlier analysis, the prices of Windows and computers will be lower in consequence.

Suppose that the remedies lowered D to \$7 billion by removing artificial barriers that would otherwise cost \$2 billion to surmount. The computer price in the presence of a self-developer just able to cover its cost is the root of

$$(7) \qquad \varepsilon\left[\frac{(p-c)^2}{p}\right]\left(\frac{p}{\alpha}\right)^{-\varepsilon} - K = D$$

which is \$981. Then, from equation (5), the associated price of Windows is

$$(8) \quad r = \left[\frac{\varepsilon(M+1)-1}{\varepsilon M}\right]p - \left(\frac{M+1}{M}\right)c$$

$$= \$50.$$

Without the self-developer, the price of computers, from equation (1), is \$989. Recall that Microsoft is seen as lowering the price of Windows just enough to prevent self-development. The effect of the remedy is to lower the price of Windows by \$10 and the price of computers by \$11. Equivalently, the harm to the consumer from the conduct that would have been prevented by the remedy is \$11 per computer. The procedure outlined here could be used to measure the damages to the consumer from the conduct challenged by the government.

The Cournot model plays an important role in the analysis. It is not material that the actual personal-computer market is assumed to be Cournot. By taking M to infinity, the market could be perfectly competitive instead. Rather, what is key is the role that the self-developer would play in the market after entry. In other words, equation (6) is central: it shows the self-supplier's potential market share. For large M, as equation (5) shows, the price–cost margin, $(p - c)/p$ is around r/p, so the self-supplier earns a margin equal to the price of Windows. The share of the self-supplier is the elasticity of demand multiplied by this margin. There is nothing fundamental about this share (indeed, it can even exceed 1, if the elasticity is high enough). But in the current application, the share of 19 percent seems reasonable. What is important is that the analysis take a reasonable stand on the volume of sales that the self-supplier can achieve.

If the removal of artificial barriers to entry lowered the self-supply cost to \$7 billion, the resulting fall in the price of computers of \$11 each would save computer purchasers about \$6 billion over the next five years. If the creation of those artificial barriers was Microsoft's only wrongdoing, then the damages owed to past purchasers of computers should be based on a similar dollar amount. More aggressive punishment of Microsoft (such as breaking it up into competing entities) that lower shareholder value by more than \$6 billion, may fail the standard of fitting the punishment to the crime.

II. Determinants of Entry Costs and Policies to Restrain Entry Costs

What kinds of developments would raise the cost of self-supply and diminish the effect of virtual competition? One possibility is that Intel and other microprocessor makers might make their chips incompatible with any operating system other than Windows. Then the costs of competing with Windows would include the costs of developing new processors as well as new software.

The openness of the Internet is a factor limiting entry costs at present. Because standards are open and vigorous competition prevails in many Internet inputs, a new operating system faces relatively low costs in supporting Internet functions. If the character of the Internet were to change, so that only computers running Windows provide what consumers think of as an acceptable web-surfing experience, then entry

costs would be higher. The developer of a new operating system would also have to promote an alternative web standard, or at worst, sponsor an entirely new version of the Internet that did not interconnect with the existing Internet.

The availability of popular applications is a key determinant of the cost of entry. At present, Microsoft sells a version of Office for the Macintosh. If Microsoft refused to sell a version of Office for a new operating system, the sponsor would have to incur the costs of developing and promoting an acceptable alternative.

This discussion suggests constraints that could be imposed upon Microsoft in order to retain the benefits of virtual competition. We presume without further discussion that existing rules preventing Microsoft from entering into exclusionary contracts would be retained and strengthened as well. First, Microsoft could be barred from sponsoring any change in microprocessor design that created strong complementarities with Windows.

Second, Microsoft could also be barred from actions that had the effect of making the use of Windows essential for web browsing; or the principle of structural separation could be harnessed by preventing Microsoft from selling Internet services at all, or at least from acquiring existing service providers. A third Internet-related rule would require that Microsoft's web browsers support industry standards as well as any extensions created by Microsoft; and Microsoft could be required to continue to permit rival browsers and other Internet-related software to operate under Windows.

Finally, some type of framework could be developed to provide Office on new operating systems. For example, the developer of a new operating system could be granted the option to pay an independent software developer to convert Microsoft's code to function on the new operating system. Microsoft would earn a royalty on the new version comparable to its profit on the versions Microsoft markets itself.

REFERENCES

Aghion, Phillipe and Bolton, Patrick. "Contracts as a Barrier to Entry." *American Economic Review*, June 1987, *77*(3), pp. 388–401.

Fudenberg, Drew and Tirole, Jean. "Pricing Under the Threat of Entry by a Sole Supplier of a Network Good." Mimeo, Harvard University, 1999.

Hall, Robert E. "Optimal Contracts To Defend Upstream Monopoly." Mimeo, Hoover Institution, Stanford University, 1999.