Toward a Quantification of the Effects of Microsoft’s Conduct

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I. Introduction

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. My 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?

Many observers have been pessimistic about the likely favorable effect of cures put in place so late in the evolution of Windows. Action should have been taken before Microsoft became so dominant, this line of thought holds. There is little chance today of active rivalry in desktop operating systems, it would appear. The network externalities associated with Windows’ presence on every desktop make genuine competition hopeless.

There is also the troublesome question of whether active competition in the operating system is a good idea at all. The investment needed to create a functional duplicate of Windows is socially wasteful, except to the extent that it improves competition. Ideally, virtual, not actual, competition would govern the market. The potential to create a duplicate would discipline the price of Windows, but the duplicate would not actually be sold, so that all users would enjoy the benefits of using a single operating system without having to pay the monopoly price. And virtual competition could stimulate innovation just as effectively.
In a related but longer and more detailed paper, Hall [1999], I have developed a model to deal with these issues at a more general level. Here I will present a stripped-down version of the model and apply it to Microsoft.

II. Model and Calibration

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

$$
\left( Q' + q \right)^{-\frac{1}{\varepsilon}} q - c - r - K
$$

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

$$
-\frac{p}{\varepsilon} \frac{q}{Q} + p - c - r = 0
$$

(2.1)

If there are $M$ identical personal computer makers, the equilibrium price is

$$
p = \frac{\varepsilon M}{\varepsilon M - 1} (c + r)
$$

(2.2)

I will calibrate this model to a rough description of the market for Windows. I take the price of Windows to be $r = $60 and the price of a personal computer to be $p = $1,000. I take the extent of competition in the market to be $M$.
= 11 identical sellers. I assume an elasticity of demand of $\varepsilon = 2$. In symmetric equilibrium, the share $\frac{q}{Q}$ in equation (2.1) will be $\frac{1}{M}$, so I 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. I take the number of computers sold, $Q$, to be a reasonable projection of Windows sales for the next 5 years, 600 million. Thus each computer maker will earn $2.5 billion before fixed costs over the 5 years. I 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,

$$p = \frac{\varepsilon}{\varepsilon - 1} c$$

(2.3)

which calls for

$$r = \frac{\varepsilon M - 1}{\varepsilon M} p - c = $813$$

(2.4)

in my 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 I 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. Fudenberg and Tirole [1999] develop a model to overcome that paradox. With self-supply, a computer maker has a straightforward choice between developing a new operating system and using it, or 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

\[
p = \frac{\varepsilon (M + 1)}{\varepsilon (M + 1) - 1} c + \frac{\varepsilon M}{\varepsilon (M + 1) - 1} r = 991
\]  

(2.5)

The self-supplier’s share of computer sales is

\[
\varepsilon \frac{p - c}{p} = 19.4 \text{ percent}
\]  

(2.6)

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 x 611 million x 19.4 percent - $2.5 billion fixed costs = $9.0 billion before development costs.

The idea I pursue is that Microsoft has chosen the price of Windows to make self-supply barely unprofitable. Thus I 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.

I 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 my estimate of $9 billion.

In principle, the demonstration that there is $7 or $9 billion in profit available from developing an alternative to Windows, and the fact that no major player in the computer business has undertaken to develop an alternative, is dispositive that the development costs are even higher than these numbers. Though the Macintosh operating system comes close to providing a serious alternative, Apple has consistently adhered to a high-margin, low-volume strategy that has kept its share far below potential. And Linux is far from a functional equivalent to Windows, though it might provide the starting point for a serious rival.

My 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 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. As I noted earlier, 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 Aghion and 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

$$
\varepsilon \left( \frac{p-c}{p} \right)^2 \left( \frac{p}{\alpha} \right)^{-\varepsilon} - K = D ,
$$

which is $981$. Then the associated price of Windows is, from equation (2.5),

$$
r = \frac{\varepsilon (M+1) - 1}{\varepsilon M} - \frac{M + 1}{M} c = $50
$$

Without the self-developer, the price of computers, from equation (2.2), 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.

This calculation helps understand some of the disputes between economists for the two sides in the Microsoft trial. Richard Schmalensee concluded that
Windows was sold in a competitive market because the price was so far below the monopoly level. Franklin Fisher found that the market was a monopoly even though limit pricing might constrain the price of Windows. My conclusion combines both of theirs. Virtual competition has a huge depressing effect on the price of Windows. But Microsoft has market power in the sense that improvements to competition—such as the removal of artificial barriers to entry—could lower the price even further. On the one hand, we should recognize the beneficial effect of competition, as Schmalensee proposes. On the other, we should not excuse Microsoft from further review because it is constrained by virtual competition. It could be constrained more.

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 (2.6) is central—it shows the self-supplier’s potential market share. For large $M$, as equation (2.5) shows, the price-cost margin, $\frac{p-c}{p}$ is around $\frac{r}{p}$, 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 one, 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.

III. Concluding Remarks

Microsoft’s ability to extract a price from computer makers for Windows depends, among other things, on how much it would cost the computer maker to
develop an alternative to Windows. The case of self-supply is worth considering because self-supply cannot be discouraged by the threat of Bertrand price-matching, a powerful deterrent to the entry of an independent supplier of an operating system. Microsoft’s price of about $60 for Windows corresponds to a capitalized self-supply cost of roughly $9 billion.

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 5 years. If the creation of those artificial barriers was Microsoft’s only wrongdoing, then the damages owed to past purchasers of computers are a similar number. 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.
References

