P E R S P E C T I V E S

PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

Endogenous Sunk Costs, Quality Competition and Welfare: A Technical Note

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One of the most common mistakes when analyzing markets is to view competition as uni-dimesional—that is, firms compete only on price. In reality, competition occurs along *many dimensions* beyond price including, very commonly, quality. While it is always nice when consumers get generous scoopings of both low prices and increased quality and innovation, in many cases there are trade-offs to consider. Quality is costly, for instance, and may lead to higher prices. Also, modern economic models of industry structure indicate that in some cases quality competition may raise the fixed and sunk costs of a firm's participation in an industry and, in turn, increase equilibrium industry concentration. From a welfare perspective, the reduced well being of consumers from higher prices due to higher concentration (at least under some assumptions of competitive interaction) is offset, to some extent, by consumers' higher willingness-to-pay for better or more enhanced services.

In this PERSPECTIVE, we show that even though competition in quality with escalating levels of sunk costs may raise industry concentration, consumers may very well benefit from such expenditures despite the potential for higher concentration and, in turn, an attenuation of price competition (under certain assumptions). This result has significant public policy relevance for competition in communications markets, where sunk costs are prevalent and quality competition is a primary instrument of rivalry.

Equilibrium Industry Concentration

The number of firms that can supply a given market is not infinite, and while public policy may have some influence at the margins, it is mostly the underlying supply-side and demand-side conditions of the market that establishes how many firms can profitably compete in a market. That sustainable number of rivals is known as the equilibrium number of firms, sometimes referred to as N^* ("N-star").

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An excellent presentation of these ideas is provided in John Sutton's seminal treatise, *Sunk Costs and Market Structure* (1991).[1] For the layperson, an accessible treatment is provided in our paper, *Competition After Unbundling: Entry, Industry Structure and Convergence* (2007).[2]

Increasingly, the concept of equilibrium industry structure is making inroads at the Federal Communications Commission ("FCC"),[3] though the agency's use of the theory is sometimes inconsistent[4] and sometimes incorrect.[5]

Both theory and econometric evidence show that the equilibrium number of firms in any market is a function mainly of market size, the fixed and sunk costs of entry, and the intensity of price competition. Under some simplifying assumptions, the predicted equilibrium number of firms in a market is determined by the formula:

$$N^* = \sqrt{\frac{\phi S}{\sigma}} \qquad (1)$$

where S is market size; σ is the fixed/sunk cost of entry; and ϕ is a parameter measuring the intensity of price competition, where larger values of ϕ indicate less intense competition.

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Expression (1) shows clearly that for a market of a given size, the larger are fixed and sunk costs, the fewer firms exist in equilibrium. Likewise, fewer firms survive in equilibrium as price competition intensifies (ϕ gets smaller), holding market size and sunk costs constant. This latter result presents an interesting twist on the standard textbook view that more firms imply more price competition. In the presence of fixed and sunk costs, high concentration may indicate intense price competition, rather than the lack of it, since intense price competition tends to drive down price-cost margins and thus the profit necessary to finance the large sunk costs of market entry.

Another important result implied by Expression (1) is that as market size grows, other things remain constant, the equilibrium number of firms rises. As detailed in Sutton's text, and discussed in our paper *Changing Industry Structure: The Economics of Entry and Price Competition*, this is true only if the level of sunk cost is determined exogenously.[6] By "exogenous" we mean that entry costs are determined solely by the technology of production (e.g., plant size, start-up working capital, and so forth), so that the firm has little discretion in choosing the level of σ. Limiting the focus of equilibrium industry structure to the causal influence of exogenous sunk cost may, in some cases, present a misleading picture of the extent of industry fragmentation in the long run.

Quality Competition and Endogenous Sunk Costs

In some industries, the firms in the market may influence the level of entry cost which, in turn, will influence the equilibrium number of firms as determined by the level of exogenous sunk costs. Sutton (1991) describes such costs as "endogenous" sunk costs. Endogenous sunk costs are those that arise from the behavior of incumbent firms competing in the industry, such as costs from quality competition (e.g., vertical product differentiation), advertising, investments in research and development (which increase consumers' willingness to pay), and even strategic entry deterrence. As market size grows, the potential profitability of incurring such endogenous sunk costs rises. From Expression (1), allowing σ to rise with S,

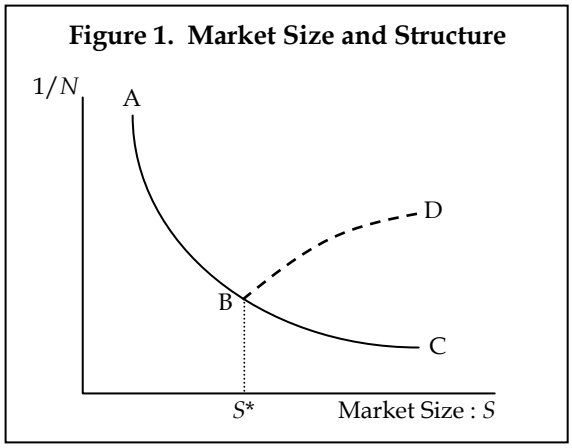
the relationship between market size and the number of firms becomes muddy. Since equilibrium industry structure is a function of both market size sunk costs, increases in market size together with increases in endogenous sunk costs in excess of the exogenous sunk costs of market entry may not result in a larger N^*, and in fact may result in a smaller N^*.

The intuition is illustrated in Figure 1. On the vertical axis is a measure of market concentration ($1/N$), where concentration falls as the number of firms increases. Market size (total expenditures) is measured along the horizontal axis. With only exogenous sunk costs, Expression (1) indicates that the number of firms in equilibrium rises monotonically (always) with market size and market concentration falls. This relationship is illustrated by the curve segment ABC.

Adding endogenous sunk costs to the mix, however, changes things considerably. Once market size reaches some critical value, labeled S^*, the incumbent firms begin to intensify competition in quality by escalating investment expenditures in R&D, advertising, and activities that will raise consumers' willingness to pay and attract customers away from firms offering lower quality products. Such investment in sunk costs activities creates endogenous entry barriers to new entrants. Such entry barriers are, however, the consequence of intensifying rivalry, not an exogenously-determined barrier to entry. If the increased endogenous sunk cost investments are large enough, then concentration begins to *rise*. This relationship is illustrated by the curve segment ABD. For market size below S^*, Expression (1) holds; after S^*, it does not.

Whether or not growth in endogenous sunk costs become significant enough to alter market concentration in a significant way is an empirical question. For firms to incur endogenous sunk costs, it must be profitable to do so. Thus, consumers must respond favorably to such costs, say by increasing their willingness to pay for quality improvements or responding to advertising which will have a similar effect on the demand for a firm's output. Sutton (1991) presents several empirical tests of the theory, as do other studies.[7]

Figure 1. Market Size and Structure



High concentration, particularly in large markets, invariably attracts the attention of policymakers and regulators. A theoretical expectation that an increase in market size may result in higher, rather than lower, concentration invites the question: Is the higher concentration resulting from quality competition necessarily good or bad for consumers and economic welfare? It certainly can be bad for economic welfare if regulation encourages endogenous sunk cost investments in an effort to deter entry, as in the case of "level playing field" laws.[8] However, endogenous sunk costs may also be a consequence of quality competition (or some other factor increasing consumers' willingness-to-pay), and quality has value to consumers. The welfare consequence of higher concentration driven by quality competition is an interesting question, and we provide a way to address it.

Consumer Welfare and Endogenous Sunk Costs

Since our interest in this topic is drawn from Sutton's *Sunk Costs and Market Structure*, we look there to begin our analysis.[9] Specifically, the

analysis that follows pertains to the theoretical example in Section 3.2 of Sutton's book.[10] We leave it to the reader to review the details of the Sutton's model in that section.

In Section 3.2, Sutton utilizes a Cobb-Douglas specification for modeling consumer utility. This choice implies that the representative consumer chooses a good that maximizes the ratio of quality (u) to price (p).[11] The quality-to-price ratio (u/p) can, therefore, be used as a simple index of consumer welfare. This metric is superior to alternatives such as aggregate utility since it does not automatically scale when market size is increased due to either an increase in the number of consumers or consumer income.

Let market concentration be defined as $x = 1/N$, where N is the number of firms. Inserting this measure of concentration into Equation (3) from Sutton (1991: 55) and rearranging yields:

$$x^3 - \left(2 + \frac{\gamma}{2}\right)x^2 + x = \frac{\gamma\sigma - a}{2S} \qquad (2)$$

where a is the cost per advertising message, and γ measures the returns to advertising or other expenditures which increase consumers' willingness-to-pay. Following Sutton, ϕ is assumed to equal 1 in this analysis, which implies Cournot competition in quantities.[12]

Given a set of parameter values (a, σ, γ) and market size (S), this cubic equation yields the equilibrium level of market concentration when firms are in the interior of their profit maximization problem with respect to quality ($u > 1$). If the market size is relatively small, then the firms will be on the quality boundary ($u = 1$) and the equilibrium concentration is given by:

$$x^2 = \frac{\sigma}{S}. \qquad (3)$$

The critical point (S^*, x^*) where the equilibrium concentration switches from (3) to (2) is characterized by the solution to the system:

$$x^2 - \left(2 + \frac{a}{2\sigma}\right)x + 1 = 0 \qquad (4a)$$

and

$$S = \frac{\sigma}{x^2}. \qquad (4b)$$

The above system merely involves a quadratic equation, and is therefore easy to solve. With the critical point (S^*, x^*) calculated, Equation (3) can be used to calculate the equilibrium concentration for any market size, $S \le S^*$. Finally, Equation (2) can be used to calculate the equilibrium concentration for any market size $S > S^*$.

Competition in quality with escalating levels of endogenous sunk costs may produce levels of concentration even higher than expected in their absence, but we show that consumers may very well benefit from such expenditures despite the effects on concentration and likely attenuation of price competition.

After calculating the equilibrium concentration level for a given market size, one can calculate the equilibrium price and quantity in the market. The equilibrium price, assuming Cournot competition in quantities, is given at Sutton (1991: 50), and can be written in terms of concentration:

$$p = \frac{c}{1 - x}, \qquad (5)$$

where c is marginal cost. Whenever $S \leq S^*$, the equilibrium quality is simply equal to one. However, when $S > S^*$, the equilibrium quality level can be calculated using Equation (1) on Sutton (1991: 54). Writing the equation in terms of concentration and substituting in for the fixed cost function (F) yields the following characterization of equilibrium quality:

$$u = \left(\frac{u}{a} Sx(1-x)^2 \right)^{1/\gamma} \quad \text{if} \quad S > S^* \qquad (5)$$

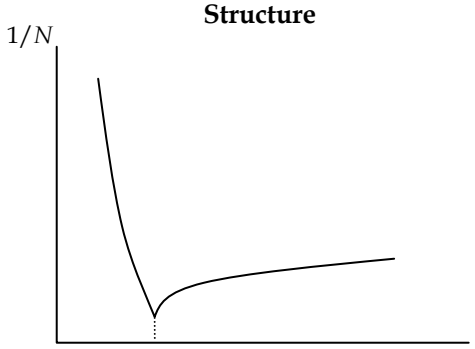
$$u = 1 \qquad \text{if} \qquad S \leq S^*. \qquad (6)$$

Finally, the ratio of the equilibrium quality (u) to market price (p) can now be formed in order to characterize consumer welfare.

... our analysis demonstrates that when higher concentration results from competition in quality with escalating endogenous sunk costs where those costs are incurred to raise willingness-to-pay, consumer welfare rises despite the reduction in the equilibrium number of firms.

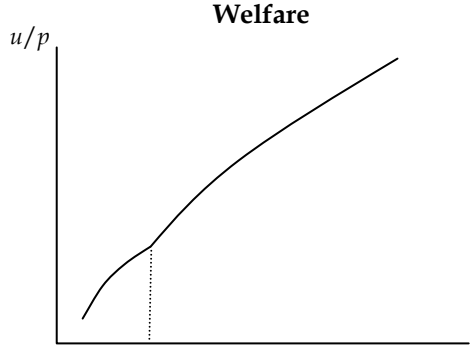
Generally speaking, in a model with fixed costs, one would expect efficiency gains from increased market size. Given the endogenous entry and zero profit condition in Sutton's model, firm welfare cannot rise and hence we would expect the welfare gains to be captured by consumers. Before firms invest in quality (u), an increase in market size simply results in more firms, a lower price level, and hence higher consumer welfare (the range AB in Figure 1).

Figure 2. Simulation: Market Size and Structure



After S^*, firms begin investing in quality, the number of firms slowly falls, and the market price rises, but the rate of increase in quality will generally far outweigh the higher market price. Thus, the consumer welfare ratio (u/p) will continue to rise as market share increases. As an example, we plot the equilibrium concentration and consumer welfare ratio as functions of market size (S) for the following parameter values: a = 300, σ = 101, γ = 2, and c = 1. As shown in Figure 2, the simulation produces the expected size-concentration relationship (see Figure 1) when endogenous sunk costs are positive (with S^* = 1000).

Figure 3. Simulation: Market Size and Welfare



The more interesting result is illustrated in Figure 3. In this figure, the vertical axis measures our metric for consumer welfare (u/p). The figure shows that consumer welfare rises as market size increases, even after the concentration "switch point," which in this

figure is at $S = 1000$. As the figure shows, our analysis demonstrates that when higher concentration results from competition in quality with escalating endogenous sunk costs where those costs are incurred to raise willingness-to-pay, consumer welfare *rises* despite the *reduction* in the equilibrium number of firms.

Conclusion

In this PERSPECTIVE, we show that consumers, under certain conditions, may benefit from higher industry concentration driven by an increase in endogenous sunk costs. This somewhat surprising result has significant policy relevance. In communications markets, for example, supply- and demand-side conditions tend to result in relatively concentrated equilibria, even ignoring endogenous sunk costs. The nature of rivalry in communications markets, however, includes significant endogenous sunk costs, whether from advertising expenditures or quality differentiation. Competition in quality with escalating levels of endogenous sunk costs may produce levels of concentration even higher than expected in their absence, but we show that consumers may very well benefit from such expenditures despite the effects on concentration and likely attenuation of price competition.[13]

NOTES:

[*] **Dr. George S. Ford** is the Chief Economist and **Michael L. Stern** is a Senior Fellow of the Phoenix Center for Advanced Legal and Economic Public Policy Studies. The views expressed in this PERSPECTIVE do not necessarily represent the views of the Phoenix Center, its staff, its Adjunct Follows, or any if its individual Editorial Advisory Board Members. We are grateful to Dr. Jerry B. Duvall, Honorary Chief Economist Emeritus of the Phoenix Center, for encouraging this research and for helpful comments and suggestions, as well as those of T. Randolph Beard, Senior Fellow of the Phoenix Center.

[1] J. Sutton, SUNK COST AND MARKET STRUCTURE (1991).

[2] G.S. Ford, T.M. Koutsky and L.J. Spiwak, *Competition After Unbundling: Entry, Industry Structure and Convergence*, Phoenix Center Policy Paper No. 21 (Jul. 2005), *reprinted in* 59 FED. COMM. L.J. 331 (2007) (and citations therein).

[3] *See, e.g., In the Matter of Implementation of Section 19 of the Cable Television Consumer Protection and Competition Act of 1992, Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming,* FIRST REPORT, FCC 94-235, ___ FCC Rcd. __ (rel. September 28, 1994), Appendix H at ¶¶ 377-383 (discussing how the presence of high sunk costs may have a decisive effect on the evolution of local market structure and the possible trade-offs between the number of actual competitors in any local cable market and the intensity of price competition that might prevail); *In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers,* FCC 03-36, REPORT AND ORDER AND ORDER ON REMAND AND FURTHER NOTICE OF PROPOSED RULEMAKING, ___ FCC Rcd ___ (rel. August 21, 2003) at n. 244; *In the Matter of Special Access Rates for Price Cap Local Exchange Carriers,* FCC 05-18, ORDER AND NOTICE OF PROPOSED RULEMAKING, ___ FCC Rcd ___ (January 31, 2005) at n. 187; *National Broadband Plan, supra* n. __ at 47 ("economies of scale, scope and density that characterize telecommunications networks"); *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services,* FOURTEENTH REPORT, FCC 10-81, __ FCC Rcd __ (rel. May 20, 2010)(hereinafter "*Fourteenth CMRS Report*") *passim*.

[4] G.S. Ford and L.J. Spiwak, *The Impossible Dream: Forbearance After the Phoenix Order*, PHOENIX CENTER POLICY PERSPECTIVE NO. 10-08 (December 16, 2010)(available at: http://www.phoenix-center.org/perspectives/Perspective10-08Final.pdf).

[5] *See, e.g.,* G.S. Ford and L.J. *Spiwak, Set It and Forget It? Market Power and the Consequences of Premature Deregulation in Telecommunications Markets*, 3 NYU JOURNAL OF LAW AND BUSINESS 675 (2005)(available at: http://www.phoenix-center.org/pcpp/PCPP18.pdf); G. S. Ford, *You're Not Impaired Because You Are Impaired*, PHOENIX CENTER PERSPECTIVE NO. 04-05 (November 2004)(available at: http://www.phoenix-center.org/perspectives/Perspective04-05Final.pdf).

[6] J.B. Duvall and G.S. Ford, *Changing Industry Structure: The Economics of Entry and Price Competition*, PHOENIX CENTER POLICY PAPER NO. 10 (April 2001)(available at: http://www.phoenix-center.org/pcpp/PCPP10Final.pdf) *and reprinted in* 7 TELECOMMUNICATIONS & SPACE JOURNAL 11 (2001).

[7] SUNK COSTS AND MARKET STRUCTURE (1991), *supra* n. 1, Chs. 4-14 and Appendices. *See also* T. Bresnahan and P. Reiss, *Entry and Competition in Concentrated Markets*, 99 JOURNAL OF POLITICAL ECONOMY 977-1009 (1991); T. Bresnahan and S. Greenstein, *Technological Competition and the Structure of the Computer Industry*, 47 JOURNAL OF INDUSTRIAL ECONOMICS 1-40 (1999).

[8] T. W. Hazlett and G. S. Ford, *The Fallacy of Regulatory Symmetry: An Economic Analysis of the "Level Playing Field" in Cable TV Franchising Statutes*, 3 BUSINESS & POLITICS 21-46 (2001).

[9] Sutton, however, declines to make any welfare inferences from his analysis. Sutton, *supra* n. 1 at p. 314 ("No welfare analysis, and so no policy prescriptions, have been offered").

[10] SUNK COSTS AND MARKET STRUCTURE, *supra* n. 1 at pp. 45-64. As with all theoretical analysis, our conclusions are sensitive to the specific functional forms we employ, which are taken directly from Sutton. Whether or not the results, either for concentration or welfare, hold for other functional forms is not addressed in our analysis.

[11] *Id.* at p. 49.

[12] Definitions are provided in SUNK COSTS AND MARKET STRUCTURE, *id.* at 51-2. Larger values of γ correspond to more rapidly diminishing marginal returns to increases in outlays $A(u)$.

NOTES CONTINUED:

[13] While consumer welfare measured in terms of (u/p) may increase notwithstanding increases in industry concentration, it is noted that the metric (u/p) does not reflect the possible welfare effects implied by non-egalitarian distributions of consumer income. Less abstractly, some consumers may become priced out of the market if intense quality competition is accompanied by increasing market price, notwithstanding the increase in consumer benefit implied by higher quality product. All models of vertical product differentiation, including Sutton's, recognize the equivalence of consumer tastes (all consumers prefer higher quality products to lower, price held constant) and the heterogeneity of consumer incomes. *See, e.g.,* A. Shaked and J. Sutton, *Relaxing Price Competition*, 49 REVIEW OF ECONOMIC STUDIES 3-13 (1982). We do not consider, however, the welfare implications of alternative distributions of income in our analysis.