

Week 9: Network Externalities

Based in part on Shapiro-Varian Chap. 7 & Tirole Chap. 10.6

0. Where we are in the Syllabus & Topic Discussion

Recall the road-map (aka demand and cost categorization) from a few weeks back:

Cost \ Demand	Homogeneous good	Non-homogeneous (Network Exts., Lock-in, Bundling, Versioning, etc.)
Information goods	a. Oligopoly (Bertrand comp.) b. Perfect Comp. (Entry)	Oligopoly (Competition in Differentiated Products)
Constant Returns to Scale – constant AC	a. Oligopoly (Bertrand comp.) b. Perfect Comp. (Entry)	Oligopoly (Competition in Differentiated Products)
Decreasing AC – Increasing Returns to Scale, large Fixed Costs, etc.	Dominant Firm tending to monopoly	Dominant Firm tending to monopoly

We have so far studied – at some length – i. The Homogeneous good column (although not the dominant firm model which will be studied along with the non-homogeneous good models.) ii. Competition with differentiated products (both horizontal as well as vertical). This week we will study the topic of network externalities – this concept gives rise to vertical differentiation. (and some other consequences).

1. The Concept of Network Externalities

Network Externalities – aka Positive Feedback and aka Demand Side economies of Scale. Refers to the idea that the benefit a user gets from a product depends on how many other users there are of the same product.

One can think of the users as a “network”. Concept does not need an actual network (such as a telephone or cable network). Immediate implication – a product with a larger network is like a “higher quality” good (its implied benefits) and hence consumers will be willing to pay a higher price for that network. Conversely such a network will find it easier to keep out a competing network by pricing “low”.

Examples: auctions (Sotheby’s as well as ebay), software (Microsoft), online (& offline) financial markets (Instinet),

Examples maybe: online book-sellers,

Examples – not: ISPs,

Concept not to be confused with supply-side size advantage stemming from production economies of scale nor with the advantage of larger supplier networks (HMOs with more physicians).

2. The Implications of Network Externalities

- a. S-shaped adoption pattern
- b. Penetration pricing (possibly below cost)
- c. A little advantage can go a long way
- d. Need for standard setting

3. A Model

Monopoly Model: 2 periods. Consumers benefit $\theta s(Q)$ where Q is installed base ($Q=0$ in first period) and θ is distributed uniformly between 0 and 1. Cost is c .

Suppose $s(0) = 0$, i.e., no intrinsic benefit (pure network externalities); can be relaxed.

Duopoly Model: Consumers benefit from firm 1 is benefit $\theta s(Q_1)$ where Q_1 is installed base of firm 1. Similarly for firm 2. (Similarity with vertical differentiation model with $s(Q)$ serving as “quality”)

4. Monopoly Solution

Period 2: If price = p , then consumers buying equal in number those for whom $\theta s(Q) > p$. Hence,

$$\text{Max } [p-c][1-p/s(Q)]$$

Which leads to $2p = c + s(Q)$ – note cost mark-up proportional to benefit from installed base. Profits = $[1/2 s(Q) - c]$

Period 1: If price > 0 , nobody buys. At $p = 0$, everybody buys.

Solution: price = 0 at period zero provided $= [1/2 s(1) - c] > c$. Else, firm sits out the market.

Implications: Penetration pricing – pricing in period zero lower than it would be in the absence of network externalities. Also, pricing below cost. Interpretations for McAfee & Netscape strategies.

There would also be S-shaped adoption in a richer version of the model. For example if benefits are $\theta s(Q) + t$ where t is also randomly distributed in the population and some t 's are negative. Then even at zero price these consumers will not buy but they might buy (say, in the second period) if the installed base is big enough by then. Possible interpretation for adoption pattern in fax machines and wireless phones.

4. Duopoly Solution: Period Two

Vertical differentiation model applies. Recall, market divides at $\theta s(Q_2) - p_2 = \theta s(Q_1) - p_1$, i.e., for the consumer who is indifferent between the two firms, $p_2 - p_1 = \theta[s(Q_2) - s(Q_1)]$. Writing $s(Q_2) - s(Q_1)$ as s , it is easy to see that we now have exactly the vertical differentiation model. In particular, its Nash equilibrium in prices is given by $p_2 = c + 2/3 s$ and $p_1 = c + 1/3 s$. The market shares are $2/3$ and $1/3$. Also profits are directly proportional to s for both firms but higher coefficient applies to firm 2's profits.

Suppose $Q_2 > Q_1$ but not by much. So market shares are essentially 50-50 after period one. But after period 2 these market shares are 66-33 in favor of firm 2. Note the advantage of a little bit of initial advantage. If this model had more periods after the second, the market shares would not change subsequently but the profit difference would be even higher in period three (now that the market share difference is higher).

Similar phenomenon in more general model – bigness begets bigness (or success begets success) as consumers are willing to pay more & more for the larger firm's product. Microsoft? This phenomenon leads eventually towards a monopoly.

5. Duopoly Solution: Period One

Neither firm has any installed base. So the only way to sell is to price at zero. If only one prices at zero, it gets all of the market & in the subsequent period acts like a monopoly (why?). If both price at zero, they share the market & then compete in a non-differentiated market in period two. Hence the payoffs added up over the two periods are:

Firm 1 \ Firm 2	Price = zero	Price > zero
Price = zero	$-0.5c + \pi(0)$,	$-c + \pi(\text{mono.}), 0$

	$-0.5c + \pi(0)$	
Price > zero	$0, -c + \pi(\text{mono.})$	$0, 0$

Where $\pi(0)$ is duopoly profits with zero differentiation in products and $+\pi(\text{mono.})$ is monopoly profits. As long as $-c + \pi(\text{mono.}) > 0$, a firm would prefer to undercut a rival's positive price down to zero. If $-0.5c + \pi(0) < 0$, (as in the vertical differentiation model) then it is better not to match a zero price. Hence one equilibrium is for one firm to drop price down to zero but for the other to not do so. Note we again have a monopoly emerging. If the two firms make a mistake about who is going to stay out, they could both make losses by entering (& competing aggressively). (Online brokerage?)

On the other hand, if $-0.5c + \pi(0) > 0$ then both firms price at zero. Note total profits can be quite low from this penetration pricing (as opposed to a monopoly's) since $-0.5c + \pi(0)$ can be very close to zero.