**Network Goods (Theory)**

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**Abstract**

Network effects arise where current users of a good gain when additional users adopt it (classic examples are telephones and faxes). The effects create multiple equilibria and fierce competition between incompatible networks; users’ expectations are crucial in determining which network succeeds. Early choices, such as the QWERTY typewriter keyboard, lock in the market; new entry, especially against established networks with proprietary technology, is often nearly impossible. Incompatible networks can induce efficient ‘competition for the market’, but more often create biases and inefficiencies. Policymakers should scrutinize markets where firms deliberately choose incompatibility.

**Keywords**

Compatible products; Competition for the market; Competition policy; Coordination; Entry; Excess early power; Excess inertia; Excess momentum; Herding; Indirect network effects; Intellectual property; Lock-in; Market share; Microsoft; Multiple equilibria; Network effects; Network externality; Penetration pricing; Pre-announcements; Product variety; Proprietary technology; QWERTY; Standards; Switching costs; Tipping

**JEL Classifications**

L13

Direct network effects arise if each user’s payoff from the adoption of a good, and his incentive to adopt it, increase as more others adopt it; that is, if adoption by different users is complementary. For example, telecommunications users gain directly from more widespread adoption, and telecommunications networks with more users are also more attractive to non-users contemplating adoption.

Indirect network effects arise if adoption is complementary because of its effect on a related market. For example, users of hardware may gain when other users join them, not because of any direct benefit, but because it encourages the provision of more and better software.

Extensive case studies and more formal econometric evidence document significant network effects in many areas including, for example, telecommunications, radio and television, computer hardware and software, applications software and operating systems (including Microsoft’s),...
Coordination through contingent contracts is possible in theory (see, for example, Dybvig and Spatt 1983; Segal 1999), but seems uncommon in practice.

When adoption is sequential, we see early instability and later lock-in (see, for example, Arthur 1989) – this corresponds to the multiple equilibria that arise with simultaneous adoption. Because early adoptions influence later ones, long-term behaviour is determined largely by early events, whether accidental or strategic. In theory, at least, fully sequential adoption achieves the efficient outcome if it is best for all adopters, but more generally early adopters’ preferences count for more than later adopters’ preferences: this is ‘excess early power’. Note that ‘excess early power’ does not depend on ‘excess inertia’, that is, on incompatible transitions being too hard given ex post incompatibility. (Both ‘excess inertia’, and its opposite, ‘excess momentum’, are theoretically possible; see Farrell and Saloner 1985.)

Firms promoting incompatible networks compete to win the pivotal early adopters, and so achieve ex post dominance and monopoly rents. Strategies such as penetration pricing and pre-announcements (see, for example, Farrell and Saloner 1986) are common. History, and especially market share, matter because an installed base both directly means a firm offers more network benefits and boosts expectations about its future sales. Such ‘Schumpeterian’ competition ‘for the market’ can neutralize (or even overturn) excess early power if promoters of networks that will be more efficient later on set lower penetration prices in anticipation of this (see Katz and Shapiro 1986a). More commonly, though, late developers struggle while networks that are preferred by early pivotal customers thrive.

So early preferences and early information are likely to be excessively important in determining long-term outcomes. For example, whether or not the Dvorak typewriter keyboard is really much better than QWERTY (as David 1985, contends), there clearly was a chance in the 1800s that a keyboard superior to QWERTY would later be developed, and it is not clear what could have persuaded early generations of typists to wait, or to adopt diverse keyboards, if that was socially
desirable. So it seems unlikely that the market gave a very good test of whether or not waiting was efficient. (Liebowitz and Margolis 1990, and Liebowitz 2002, contest both the details of the QWERTY example and the claim that network effects are significant more generally, but at least the second view is probably a minority one.)

Despite the possibility of competition for the market passing \textit{ex post} rents through to earlier buyers, incompatibility often reduces efficiency and harms consumers in several ways.

Incompatibility means that consumers are faced with either a segmented market with low network benefits, or – if the market does ‘tip’ all the way to one network – with reduced product variety and without the option value from the possibility that a currently inferior technology might later become superior. Product variety is more sustainable if niche products are compatible with the mainstream, and so don’t force users to sacrifice network effects.

These direct costs of poor coordination by adopters may be exacerbated by weaker incentives for vendors to offer good deals. For example, if a firm like Microsoft is widely believed to have the ability to offer the highest quality, it may never bother to do so: the fact that everyone expects Microsoft to recapture the market if it ever lost any one cohort of customers (or lost any one cohort of providers of complementary products) means everyone rationally chooses Microsoft even if it never actually produces high quality or offers a low price (see Katz and Shapiro 1992).

\textit{Ex post} rents are often not fully dissipated by \textit{ex ante} competition, especially if expectations fail to track relative surplus. Worse, the rent dissipation that does occur may be wasteful, such as socially inefficient marketing. At best, \textit{ex ante} competition induces ‘bargain-then-rip-off’ pricing (low to attract business, high to extract surplus) but this distorts buyers’ quantity choices and gives them artificial incentives to be or appear pivotal.

Furthermore, outcomes are biased in favour of a proprietary technology (for example, Microsoft’s) whose single owner has the incentive to market it strategically over ‘open’ unsponsored alternatives (for example, Linux) – see, for example, Katz and Shapiro (1986b). As discussed above, outcomes are also often biased in favour of networks that are more efficient early on, and are generally biased in favour of established firms on whom expectations focus. The last bias implies entry with proprietary network effects is often nearly impossible (and frequently much too hard from the social viewpoint even \textit{given} incompatibility). And this in turn makes it easier to recoup profits after predatory behaviour that eliminates a rival, and so encourages such predation.

So while incompatibility does not necessarily damage competition, it often does, and firms may therefore also dissipate further resources creating and defending incompatibility.

If firms offer compatible products, then consumers don’t need to buy from the same firm to enjoy full network benefits, and (differentiated) products will be better matched with customers. Consumers will be willing to pay more for these benefits, and this may encourage firms to choose compatibility. But compatibility often intensifies competition and nullifies the competitive advantage of a large installed base, whereas proprietary networks tend to make competition all-or-nothing, with the advantage going to large firms, and may completely shut out weaker firms. So large firms and those who are good at steering adopters’ expectations may prefer their products to be incompatible with rivals’ (see, for example, Katz and Shapiro 1985; Bresnahan 2001), and may be able to use their intellectual property to enforce this.

Competition with incompatible network effects is closely related to other forms of competition when market share is important, especially competition when consumers have switching costs (see, for example, Klemperer 1995; Farrell and Klemperer 2007; and the companion-piece to this article, switching costs), and has similar broader implications (for example, for international trade, see Froot and Klemperer 1989).

Because competition ‘for the market’ differs greatly from conventional competition ‘in the market’, and especially because capturing consumers’ and complementors’ expectations can be so profitable, competition policy needs to be vigilant against predatory or exclusionary tactics by
advantaged firms, including deliberately creating incompatibility by misusing intellectual property protection. Thus, for example, the network effect by which more popular operating systems attract more applications software took centre stage in both the US and European Microsoft cases (see, for example, Bresnahan 2001). And because coordination is often important and difficult, institutions such as standards organizations matter, and government procurement policy takes on more significance than usual.

In summary, network effects can involve efficient competition for larger units of business – ‘competition for the market’ – but very often make competition, especially entry, less effective. So I, and others, recommend that public policymakers should have a cautious presumption in favour of compatibility, and should look particularly carefully at markets where incompatibility is strategically chosen rather than inevitable.

Farrell and Klemperer (2007) contains a recent and comprehensive survey of network effects.

See Also

► Network Goods (Empirical Studies)
► Switching Costs

The views expressed here are personal and should not be attributed to the UK Competition Commission or to any of its individual Members other than myself. Furthermore, although some observers thought some of the behaviour discussed warranted regulatory investigation, I do not intend to suggest that any of it violates any applicable rules or laws.

Bibliography


