Network Effects and Market Outcomes

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INTRODUCTION

Network effects occur when to an economic agent (e.g., a consumer of a firm), the utility of using a product or technology becomes larger as its network of users grows in size (Farrell & Saloner, 1985; Katz & Shapiro, 1985). The network effect may set in motion a positive feedback loop that will cause a product or technology to become more prevalent in the market.

The presence of network effects may have large consequences for market outcomes (i.e., factors such as the speed of diffusion of products and technologies, the dynamics of the market shares of different competing products or technologies, and the predictability of market outcomes) (Arthur, 1989, 1996).

BACKGROUND

Theory and existing research suggest that the presence of network effects in a market has important implications for the outcomes of the competitive process in the market (Arthur, 1989; Farrell et al., 1985, 1986; Katz & Shapiro, 1985, 1986). Based on this theory we can identify the following characteristics of markets in which network effects are present (Den Hartigh, 2005):

- Battles for the technological standard (i.e., competition between multiple technology networks)
- Competition takes place between networks, rather then between products
- Multiple possible equilibria (i.e., these markets will show winner-take-all situations with very asymmetric distribution of market shares)
- Customer lock-in on technological standards (i.e., when the cost of switching to another technology—even though it may be technically superior—is too large for the switch to take place)
- Unpredictability of market behavior, e.g., excess inertia (i.e., stalemates in the market, or excess momentum, i.e., explosive growth, in the adoption of technologies)
- Path dependence (i.e., disproportional influences of historical small events and of factors of chance)
- The possibility of market imperfections (i.e., it is not assured that the "best" technology will prevail)

These characteristics are discussed next.

MAIN FOCUS OF THE ARTICLE

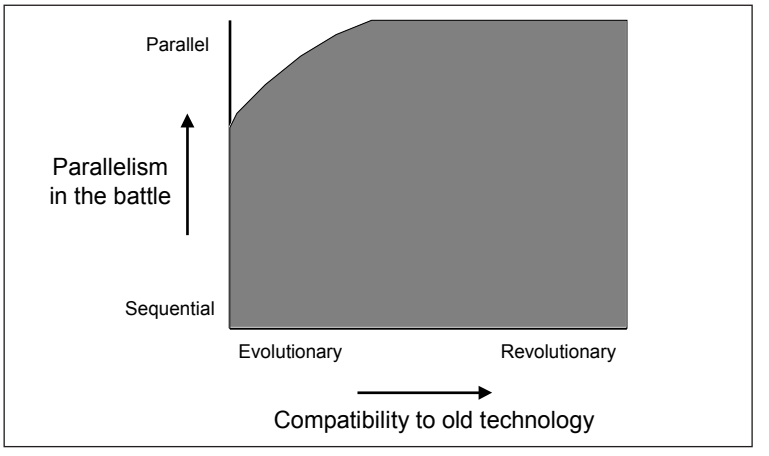
Technology Battles

In general, the market structure will take the form of a competition between different technologies, generally referred to as a "technology battle." Such a technology battle may take different forms that can be distinguished on two dimensions (see Figure 1). On the first dimension, a technology battle may either be parallel (i.e., a competition between two or more equivalent technologies) (see Farrell et al., 1985, 1986), or sequential (i.e., a competition between an old (i.e., existing, incumbent) and a new technology (see Arthur, 1989; David, 1985; Katz et al., 1985, 1986). On the second dimension, a technology battle may either be evolutionary (i.e., when the new technology is backward compatible) or revolutionary (i.e., when the new technology is not backward compatible) (see Shapiro & Varian (1999). Based on these two dimensions, many different kinds of technology battles are possible. Of course, in completely parallel battles there is no old technology and there is nothing for the new technologies to be backward compatible to, hence the blank part in the upper left-hand corner of Figure 1.

Arthur (1989) mentions four properties of such technology battles:

1. The market will eventually be dominated by one of the technologies, which means that there are multiple possible equilibria in the market and it is ex ante unpredictable which equilibrium will

Figure 1. Dimensions of technology battles



be selected; this is called *non-predictability* or *winner-take-all.*

2. The winning technology will be *locked in*; this is called *inflexibility.*
3. It is possible that a sub-optimal technology will be selected; this is called *market inefficiency.*
4. The end result may be determined by historical small events; this is called *path dependence* or *non-ergodicity.*

More properties have been added by others (e.g., *excess inertia*) (Farrell et al., 1985, 1986), *excess momentum* (Katz et al., 1986), and *competition on the network level* (Den Hartigh & Langerak, 2001). These properties will be discussed next. Although many of these issues are still debated, it has become clear from both the theoretical and the empirical body of research that the presence of network effects and social interactions effects in markets can have severe consequences for adoption and diffusion of technologies and thereby also for the adoption and diffusion of products based on these technologies.

Competition at Network Level

A first consequence of the occurrence of network and social interaction effects, implicit in most theoretical and empirical literature, but seldom explicitly mentioned, is that competition shifts from the product level to the network level (Den Hartigh et al., 2001). As a result of this shift, features like high product quality, low prices, ownership or patents, or exclusive rights on technology are just an "entrance fee" for competitive success. The network dimensions of competition, such as the availability of complementary products, compatibility of these products, size of the network or *installed base* and customer expectations with regard to network growth, are more important for competitive dominance (Shapiro et al., 1999). In other words, competition takes place on both the product and the network level. However, many firms have not yet incorporated both levels into their competitive strategy. For example, in the battle for the home video standard between *VHS* and *Betamax*, *Sony* still competed on technical product quality and exclusive rights on technology.[1] In contrast *JVC*, the first supplier of the *VHS* system, took network effects into account. By providing licenses for *VHS* technology to other suppliers and by strongly stimulating the availability of complementary products (i.e., video movies), *JVC* created a strong network effect around the *VHS* system that still dominates the home video market today.

The network dimension of competition may become so important that any possible market inefficiencies at the product level may hardly matter. Customers might be prepared to accept lower quality on the product level if compensated by advantages on the network level. For example, in the home video market, the *VHS* technology's image quality was supposed to be inferior to that of *Betamax* (i.e., at the product level), yet customers favored *VHS* because *VHS-compatible* movies were more widely available at video rental shops (i.e., at the network level). Suppliers often try to win the battle on the network level at the expense of losses on the product level. For example, both *Microsoft* and *Netscape* have been striving to dominate the Internet