Chapter 8

SHOULD BUYERS TRY TO SHAPE IT-MARKETS THROUGH NON-MARKET (COLLECTIVE) ACTION?

Antecedents of a Transaction Cost Theory of Network Effects

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Abstract: This paper develops a transaction cost theoretic model of network effects and applies it to assessing the chances of user groups to influence the range of technological choices available on the market. The theoretical basis of the model is formulated by a number of empirically refutable propositions which overcome some conceptual and empirical difficulties encountered by the traditional interpretation of network effects as (positive) network externalities. The main difference between our model and modelling network effects as network externalities is that network effects are seen as caused by the costs of purchasing/marketing new technology, i.e. transaction costs, rather than by the benefits of using new technology. A preliminary application of the model suggests that a user group's ability to function as a conduit for information exchange and knowledge sharing can significantly improve the chances of replacing an established technology by a new, potentially superior one. This, however, would call for a rather different type of user group than exists today.

Key words: Standardization, Collective Action, New Technology, IT-Procurement

1. INTRODUCTION

As information technology (IT) increasingly permeates all kinds of business operations, firms' dependence on IT suppliers increases too. This would be of no concern if IT markets were perfectly elastic, not only in terms of quantity supplied but also in terms of responsiveness to new requirements as they arise. However, the fact that user groups frequently try to actively influence IT vendors' product policies indicates that this cannot be taken for granted. It seems that users, at least partially, have to retreat to means of collective action in order to induce suppliers of new technology to incorporate users' demands in their products (Lundvall 1990, Saloner 1990).

From a theoretical point of view the idea of perfectly responsive technology supply markets has also been questioned. Beginning with the 1985 paper by Katz and Shapiro, a huge literature has emerged on the possibility of "market failure" in technology supply markets. This literature evolved around the concept of "positive network externalities" (PNE). PNE stand for a situation in which—the telephone network being the archetypal case example—the benefit one consumer derives from using a product increases with the number of other consumers of the same product (Arthur 1996). Moreover, the PNE concept has been extended to capture so-called indirect network externalities which are said to exist in systems markets (where different products form elements of a system which is useful only in its entirety) and to geographical networks such as distribution and service networks (cf. Church et al. 2003 for a recent discussion of this extension).

A large part of the literature is concerned with a phenomenon which is called "network tipping." Network tipping means that in markets characterized by positive network externalities, one product tends to capture the whole market. Since this need not be due to some intrinsic superiority if positive network externalities are present, there is a certain likelihood that inferior products, or rather products which do not accurately reflect users' requirements, dominate a market. Since this effect results from the uncoordinated behaviour of users who each make their decisions without regard of their decisions' effects upon other (potential) users thereby creating an externality, collective action might indeed prove the only way to increase responsiveness of technology supply markets to users' needs.

However, the established interpretation of network effects as network *externalities* does not provide for an explanation for how users can influence technology supply markets through non-market (collective) action except by collectively committing to buy a certain technology which is a rather unlikely course of action. An alternative explanation will be provided in this paper by giving network effects a different interpretation which focuses on the costs of purchasing/marketing a product rather than the benefits of its use, i.e. on transaction costs.

In the next section we will briefly recapitulate the literature on network externalities as it is relevant to the focus of this paper. In section 3 several problems resulting from interpreting network effects as network externalities will be identified. In section 4 we will discuss antecedents of a transaction cost theoretic model of network effects and provide some empirically refutable propositions. In section 5 the model is applied to analyzing the way users of technological products can influence the range of choice available to them on IT markets. The concluding section summarizes the results and discusses some possible normative implications of our model with regard to the organization of user groups.

2. THE ESTABLISHED INTERPRETATION OF NETWORK EFFECTS

The classical formulation of the PNE concept has been provided by Katz and Shapiro (1985, 1986).[3] They also introduced the distinction between direct and indirect network externalities. Their major findings are (1) that network products will be supplied in a smaller quantity than is socially optimal (because consumers ignore the positive externality they exert on other consumers) and (2) that there is a strong tipping tendency if two "networks" are competing leading to consumers being "locked in" by the winning network. This latter effect, however, may be reduced by consumer heterogeneity and product differentiation. Reflecting on the emerging literature, Katz and Shapiro later (1994) conclude that there is no general theoretical support for an "excess inertia problem" when two systems are competing, meaning that the emergence of new technology need not be prevented by an existing network and its accompanying positive network externalities if that would be socially optimal. Indeed, they find that there can be "excess momentum" as well meaning that consumers may be too eager to adopt a new technology thus creating a bandwagon which leaves users of the old technology "stranded".

Farrell and Saloner (1985, 1986) use a game theoretic setting in order to explore the possible lock-in effect in more detail. As Katz and Shapiro they find evidence of possible excess inertia as well as of excess momentum whereby they focus on the question whether communication among supplying firms might eliminate these problems which, they find, is not the case although it might reduce them. In addition to Katz and Shapiro, Farrell and Saloner explicitly distinguish between two types of network externalities which are responsible for excess inertia and excess momentum respectively, namely those users of the existing technology exert on users of the new technology and those users of the new technology exert on users of the existing technology. Besen and Saloner (1994), also reflecting on the emerging literature, emphasize the "strong tipping tendency" in markets

3 "There are many products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good." (Katz and Shapiro 1985, p. 424).

characterized by network externalities. Moreover, they stress that it is the *expected* network size rather than the *existing* network size which matters. This point is made by Economides (1996) as well. Krugman (1991) demonstrates under which conditions the expected network size rather then the existing network size determines the competitive outcome. He finds that if either of the following conditions are fulfilled it is rather the existing network size which determines competitive outcomes: future flows of costs and benefits are strongly discounted; switching to the new technology takes a long time; external economies of scale (i.e., indirect network effects) are low.

Gandal and colleagues have conducted a number of empirical studies which seek to provide an empirical basis for the notion of positive network externalities (Gandal 1994, 1995, Dranove and Gandal 1999). As put forward there, the argumentation mainly rests on the empirically validated observation that users are willing to pay a premium for products which are compatible with a dominant standard. It is then concluded that, since compatibility with a dominant standard increases the potential market for suppliers of complementary products, indirect network effects are present because the increased market size for complementary products will increase the variety of complementary products on offer which is what is valued by consumers. Moreover, a two-way positive feed-back effect between the sales of complementary products has been found (such as CDs and CD-players; cf. Gandal et al. 1997).

However, there is a number of models which demonstrate that a similar effect can be constructed without the assumption of positive network effects in so-called "mix-and-match" markets, i.e. in markets where complementary products must be assembled to form systems by users. The reasons put forward differ. Economides (1989) argues that in a regime of compatibility profits (and prices) are higher than under incompatibility because price elasticity are greater in the latter case (a similar line of argument can be found in Matutes and Regibeau 1988). As a consequence, vendors have strong incentives to provide compatible products which, following a similar logic as above, increases variety of complements on offer and thus creates an equivalent to indirect network externalities. Desruelle et al. (1996) base their model on fixed costs which lead to external economies of scale in systems markets (Langlois 1992) which they interpret as a type of network effect. When the production of some components of a systems good is characterized by economies of scale due to the existence of fixed costs, the number of components supplied will increase with the number of users implying a higher variety of components, i.e. more components are available as the "network" increases in size which is valued by consumers.

The most prominent critique of the PNE concept has been put forward by Liebowitz and Margolis (1990, 1994, 1995, 1996, 1998). Their criticism rests basically on three arguments. Their first argument is that the distinction between direct and indirect network externalities is a crucial one and should not be blurred. Specifically, they point out that indirect network externalities resemble pecuniary externalities which are not socially harmful because they represent a transfer of wealth between producers and consumers (cf. Church et al. (2002) for a response to that critique). This leads to their second main criticism which holds that most effects described by using the PNE concept can be derived with traditional models of natural monopoly as well. Third and finally, they claim that another crucial distinction is missing in most PNE-based models, namely that between remediable network effects and those which are not. Only the former can be called true network externalities. They demonstrate that the circumstances under which true network externalities (as opposed to network effects which are not remediable) emerge are extremely rare and that all cases which are commonly used to demonstrate the existence of positive network externalities do not fall into this category.

3. WEAKNESSES OF THE ESTABLISHED INTERPRETATION OF NETWORK EFFECTS

Apart from the criticism voiced by Liebowitz and Margolis there are three other weaknesses in the established interpretation of network effects. The first is empirical. If the value of a network product increases with the size of the network (i.e. the number of buyers of that product) and if this implies a tendency toward network tipping, we would expect to find a number of examples where suppliers increase prices as the network is growing provided the network is proprietary, i.e. network externalities can be internalized by some suppliers. The empirical evidence put forward thus far does not clarify this point. Although it has been demonstrated that buyers are willing to pay a premium for compatibility (as mentioned above; see section 2) the conclusion that this is due to an increased network size is speculative. It could well be that buyers are only concerned with maintaining the value of their past and planned investments without considering the (expected) increase in the variety of complementary products resulting from an increase in network size through achieving (horizontal) compatibility between competing network products.

The second weakness concerns the actual mechanism through which positive network externalities are supposed to increase the benefit of buyers. This lack of clarity also contributes to some confusion surrounding the concepts of lock-in and self-fulfilling prophecy respectively. If positive network externalities are assumed to arise due to the requirements of interacting with existing components of a system, i.e. through compatibility features, it is the existing size of a network which would be decisive. Then, it might be said that buyers are locked in because they cannot change to a newer (possibly better) technology if this is incompatible with existing components. In this case, buyers are not concerned with the future size of the network and, by implication, with the variety of components offered in the future.

However, if the latter is their true concern, any expectation of network size can be self-fulfilling if the future is not discounted too strongly, network effects (i.e. external economies) are not too weak and the adoption of the network does not take too long time as Krugman (1991) has demonstrated. In this case, the concept of lock-in (or path dependency) cannot be reasonably applied. In fact, we would expect to see the opposite: frequent adoption and rapid diffusion of new technologies.

Third and finally, indirect or "virtual" network effects sometimes seem to result from the combined effects of decisions concerning the degree of modularity and the degree of compatibility respectively. These concepts, however, need to be clearly separated.

Modularity designates an approach which decomposes a system into modules that can be mixed and matched as needed (Clark 1995). This, of course, requires that modules have common interfaces which allow for a measure of freedom in combining them, i.e. they need to be vertically and horizontally compatible to some extent.[4] Increased modularization of a system allows for increased levels of specialization and thus increased levels of economies of scale. If different firms (i.e. entities of ownership) specialize on these different modules, economies of scale become external.

It might be argued that an increased degree of modularity leads to increased variety of complements because (external) economies of scale imply lower prices as the network grows (if components are supplied competitively) which would make the network actually grow, given a normal demand curve. Thus, virtual network effects may emerge as the market for complements grows as well implying an increased number of different complements offered, i.e. an increased variety of complements (cf. Desruelle et al. 1996 for a similar argument). It is probably because of this implied virtual network effect that Economides claims that although the

[4] Vertical compatibility means that two complementary products can be combined without additional cost; horizontal compatibility means that two substitute components can be combined with the same complementary product without additional cost (cf. Economides 1991).

"mix-and-match literature" does not assume a priori the existence of positive network externalities, "it is clear that demand in mix-and-match models exhibits network externalities" (Economides 1996, p. 16).

A similar effect, however, may occur as a result of decisions about horizontal compatibility. If two firms offering substitute components agree on horizontal compatibility, they effectively increase the network size from the perspective of suppliers of complementary products, thus creating another indirect network effect (as would be the case if Microsoft and Apple agreed to making their operating systems compatible). This link between compatibility and indirect network effects has lead scholars to analyze the incentives of firms to offer their products under a "regime of compatibility" rather than as a proprietary system (which is accordingly called a "regime of incompatibility"; cf. Matutes and Regibeau 1988; Economides 1989).

Thus, although the decisions about the degree of modularity and about the degree of horizontal compatibility can have the same effect (a type of virtual network effect), the mechanisms accounting for these effects are quite different. Therefore, it seems desirable to model these mechanisms directly rather than to assume a chain of causal effects leading to some identical looking indirect effects which are treated as one and the same phenomenon.

To summarize, the problems of establishing an empirical basis for the PNE concept seem to stem from a lack of clarity in distinguishing between two sets of phenomena. First, it must be decided in which way buyers are said to benefit from increases in network size which will determine if the current network size (the installed base) or rather the expected network size is decisive for their buying decisions. Second, indirect network effects may be a result of either increased horizontal compatibility or increased modularization of systems. These two phenomena should be clearly separated for either a positive theory of network effects and a normative theory of regulation or, as in this paper, buyer behaviour.

4. A TRANSACTION COST THEORETIC INTERPRETATION OF NETWORK EFFECTS

In order to tackle the problems mentioned in the previous section it is necessary to adopt a more substantial approach toward new technology which goes beyond stylized examples such as the telephone network or the introduction of video recorders. First of all, it must be defined what is meant by "new technology". If Microsoft brings a new version of its operation system *Windows* to market, can we call this an introduction of new technology? Certainly, the introduction of a new version of an operating system differs fundamentally from the introduction of a large-scale system such as the telephone network.

Next, the distinctions which have been identified above as necessary need to be made and operationalized in order to incorporate them in a model of network effects.

Finally, it must be clearly stated how costs and benefits depend upon various factors for both, suppliers and buyers. These factors should include the phenomenon of network size in an appropriate specification. This statement should be such as to facilitate empirical validation or refutation.

The following discussion will address each of these issues in turn. The results of this discussion will then be combined in a simple model.

4.1 The meaning of "new technology"

The analytical problem of clarifying the meaning of the term "new technology" rests on the observation that what might look like a radical innovation or technological revolution from a macroscopic point of view appears to be an evolutionary process of incremental innovation from a microscopic point of view (Schumpeter 1939, p. 227).[5] In order to avoid that difficulty the term "new technology" will be defined with respect to interaction properties between vendors and buyers of new technology rather than with respect to some properties of the technology itself.

Any technological artifact ("machine"), i.e. any physical artificial product incorporating technological knowledge, must embody a number of trade-off decisions concerning various performance and cost characteristics (Dosi 1982). This is clearly true for design quality vs. cost considerations. However, different performance characteristics must also be traded off against one another. For example, when IBM introduced its System/360 together with software automating systems operations (the operating system OS/360) in 1964, it assumed that users valued the comfort of having an operating system more than accompanying reductions in processing speed (Fisher et al. 1983, p. 118).

Thus in order to appropriately assess the value of a certain machine, users must be informed about the kind of trade-off decisions embodied in the new technology. This knowledge is both costly to acquire – for buyers – and to communicate – for vendors – and thus constitutes part of the overall transaction costs. We call the trade-off decisions embodied in a technological artifact *trade-off positions.*

[5] "... there is as little contradiction between them [the macroscopic and the microscopic point of view] as there is between calling the contour of a forest discontinuous for some and smooth for other purposes." (Schumpeter 1939, p. 227).

The term *new technology* can then be defined as follows. Whenever the existing knowledge of users is not appropriate to evaluate a machine's trade-off positions but must be newly acquired, the machine represents an instance of new technology. In contrast, if the performance characteristics of a machine are improved without changing its trade-off positions, users can rely upon the existing evaluation knowledge to assess its price/performance characteristics.[6]

4.2 Two types of transaction costs

From this definition of new technology follows that any firm offering new technology on the market must communicate knowledge about how to assess its new product properly or rely on potential buyers acquiring that knowledge by themselves, i.e. without the help of vendors.

In addition to these "vertical" transaction costs, there is a second type of transaction costs which needs to be considered when analyzing the special case of IT markets. IT markets are increasingly characterized by systems competition, meaning that the products offered by IT vendors are but components of a system which has to be assembled by the buyer or a buyer's agent (cf. Matutes and Regibeau 1988; Economides 1989; Desruelle et al. 1996; Church et al., 2002). A firm offering new technology on a market characterized by systems competition (systems markets) has not only to communicate new evaluation knowledge to buyers but also has to persuade other firms to offer complementary products. This requirement constitutes a second type of transaction costs for vendors offering information technology.

IT vendors can mitigate that effect by providing backward compatibility with regard to older components. However, this typically will sacrifice some of the advantages of the new technology. Therefore, vendors must balance the advantages of the "uncompromised" new technology against the demand for backward compatibility.

Distinguishing between these two types of transaction costs provides for the possibility of identifying two types of network effects which are linked to the size of the existing network and the size of the expected network respectively.

[6] This definition of *new technology* bears some resemblance with the notion of "Techno-Economic Paradigms" (TEP) which has been proposed by Andersen (1991). The TEP concept is itself an extension of Dosi's (1982) Technological Paradigms which has been modified to describe the interface between developers and users of new technology across a market interface. Accordingly, improvements of performance characteristics without changing embodied trade-off positions correspond to Dosi's/Anderson's concept of "normal technological progress."

Knowledge necessary for evaluating new technology properly can travel along the network of existing users by direct exchange (e.g. word of mouth on conferences). Thus, transaction costs resulting from the need to communicate evaluation knowledge to potential buyers will depend upon the size of the existing network (i.e., the number of past and current buyers).

In contrast, the difficulty of persuading potential developers of complementary products to actually offer the latter on the market will correspond to the perceived future size of the relevant market. The theoretical basis for this proposition is that the costs of developing new technology are largely fixed implying that economies of scale dominate the calculus of potential suppliers of complements. Thus, the second type of transaction costs will depend upon the expected network size.

The roles of the existing and the expected network size in the decisions of users and vendors of new technology can be summarized by the following two propositions.

> Proposition 1. The transaction costs (for vendors and/or buyers) resulting from communicating/acquiring knowledge necessary for potential buyers to accurately value new technology directly depend upon the number of past and current buyers of products incorporating that technology.

> Proposition 2. The transaction costs (for vendors and/or suppliers of complementary products) resulting from the need to persuade potential suppliers of complementary products to actually develop them and/or for these suppliers to assess the profitability of developing complementary products directly depend upon the expected total number of buyers of products incorporating that technology over its whole life cycle.

4.3 Degree of standardization and modularization

As shown in section 3, both the degree of standardization (i.e. horizontal compatibility) and the degree of modularization can be related to a kind of network effect. However, this approach involves several causal steps implying an increased degree of "indirectness" which makes empirical evaluation quite problematic.

The direct effects of decisions concerning the degree of standardization and the degree of modularization respectively are quite different.

As pointed out above (see section 3), increased degrees of modularization imply higher levels of (external) economies of scale which translate into lower prices if components are supplied competitively as well as higher product variety (because lower unit costs may make the offering of a new product variety economically feasible). In contrast, increased standardization, on the one hand, increases the degree of competition between vendors of substitute components and, on the other hand, reduces implementation costs for buyers since the likelihood of being able to combine these components with existing or future complementary products without additional cost increases (Bresnahan and Chopra 1990).

Note that by this conceptualization compatibility with (dominant) standards enters the calculus of users on the cost side and not on the benefit side as is usually assumed in the PNE literature (which assumes that users prefer compatibility because of the then larger range of complementary products available; see section 2). However, these two approaches are not contradictory as the one adopted here models variety as ease of integration with existing or future complementary products. This seems plausible because "ex post" compatibility can always be achieved by technical means (adapters, converters) which, however, comes at a cost (which can be saved when standards are available). Thus, the direct effects of increasing the degrees of modularization and compatibility are modelled as cost savings rather then benefit increments.

The roles of standardization and modularization in the decisions of vendors and users of new technology can be summarized by the following two propositions.

> Proposition 3. As the degree of modularization increases, unit costs of supplying (developing, manufacturing and distributing) components decrease which translates into lower prices if components are competitively supplied and higher product variety.

> Proposition 4. As the degree of standardization increases, implementation costs for buyers decrease and competitive intensity for vendors of substitute components increases.

4.4 Outlines of the model

By conceptualizing network effects as cost savings, the question arises how to model the benefit of adopting new technology. For vendors, the benefit of offering new technology on the market is measured by revenues collected. Adopting a Schumpeterian perspective on competition, the main advantage of offering new technology (as opposed to existing technology) consists of creating a temporary monopoly which allows for setting prices close to reservation prices, i.e. the maximum willingness of buyers to pay for the product. Reservation prices, in turn, are determined by net benefits of users (benefit minus costs of using new technology). As substitute products are offered on the market, prices will be driven down toward cost levels. Thus, the only remaining variable in the calculus of buyers and vendors to be determined is the benefit of *using* new technology.

In the PNE literature, a typical way to model the decision calculus of buyers is to distinguish between an "intrinsic value" of a product and the value added through the network effect. The intrinsic value is generally not specially considered and assumed to be distributed according to the requirements of the models used.

Since we have suggested to shift the network effect from the benefit to the (transaction) cost side of the calculus, the intrinsic value of the product remains the only factor on the benefit side of buyers' decision calculus. Rather than proposing hypotheses concerning functional forms for this intrinsic value, we will treat it as a variable in the model.

From the previous discussion it is now possible to specify the foundation of a transaction cost theoretic model of network effects in the following way.

The calculus of buyer *j* of new technology can be represented by the following equation:

$$r_j = b_j - c_j(s) - tc_j(x^i) \quad (1)$$

With:

- r reservation price
- b benefit of using new technology
- c costs of implementing new technology
- s degree of standardization of new technology
- tc transaction costs of acquiring knowledge about trade-off positions embodied in new technology
- x^i size of existing network (installed base)

The calculus of vendor *i* of new technology can be formulated accordingly:

$$\pi_i = \sum r_j - PC_i(m) - TC^c_i(x^i) - TC^s_i(x^e) \quad (2)$$

With:

- π profit of supplying the new technology
- PC production and distribution costs of supplying new technology
- m degree of modularization

TC^c transaction costs of communicating knowledge about trade-off positions embodied in new technology

TC^s transaction costs of persuading other firms to supply complementary products for new technology

x^e expected network size

Recognizing that in equation (2) it does not matter whether transaction costs for acquiring/communicating knowledge about trade-off positions embodied in new technology are carried by buyers or vendors, we redefine r and define TC^{cm} as follows:

$$r \equiv b - c(s)$$
$$TC^{cm} \equiv TC^c + tc$$

Which yields:

$$\pi_i = \sum r_j - PC_i(m) - TC^{cm}{}_i(x^i) - TC^s{}_i(x^e) \tag{3}$$

As a firm will offer new technology only if it expects profits to be higher than those of offering existing technology, equation (3) must be compared with the profit of supplying existing technology. Since prices for existing technology will be determined by marginal cost and intensity of competition rather than reservation prices, the profit of supplying existing technology is:

$$\pi^o{}_i = x^{oe} * \{dPC^o{}_i/dx^{oi} + z_i(t)\} - PC^o{}_i(m) - TC^{ocm}{}_i(x^{oi}) - TC^{os}{}_i(x^{oe}) \tag{4}$$

With:

π^o profit of offering existing technology

x^{oe} expected size of the network of existing technology

PC^o production and distribution costs of supplying existing technology

x^{oi} size of installed base of existing technology

z profit margin of existing technology[7]

TC^{ocm} sum of transaction costs of communicating and acquiring knowledge about trade-off positions embodied in existing technology

TC^{os} transaction costs of persuading other firms to supply complementary products for existing technology

[7] We assume that z decreases with time since the longer the product is on the market, the more any proprietary advantage the technology might originally have had will disappear; defining $z(0)$ as the profit margin at the time the new technology is introduced on the market and $z(t') = 0$, the value of t' provides a dynamic measure for the degree of competitive intensity in a given industry.

New technology will only be offered if there is at least one firm for which holds:

$$\pi > \pi^{0} \tag{5}$$

5. HOW BUYERS CAN INFLUENCE PRODUCT DECISIONS OF VENDORS

There are two principal ways in which buyers can try to influence the range of choices of technological alternatives available to them on the market.

First, they can try to take on an active role by specifying their requirements concerning technological products and then communicating these to potential vendors. This approach, however, is likely to meet with serious coordination problems as the mixed results of user groups' attempts at exerting direct influence over product specifications indicate (Burrows 1999). This is because new technology, by its very nature, is still open to change so that buyers likely disagree on the future course of desirable technological development since any one buyer would like to see their special requirements implemented. Thus, reaching consensus on the course of future technological development seems unlikely.

Moreover, buyers need to commit to these specifications in a credible way implying that they would have to shun those vendors whose products do not comply with the required technical specifications. This type of collective commitment is even more difficult to achieve. Consider the example of the up to now biggest effort in forcing vendors of new technology to adopt buyer-defined specifications, the GM initiated and sponsored MAP[8] process. This effort failed due to a lack of degree of coordination on the side of buyers sufficiently large to translate into a credible threat to vendors who are hesitant to adopt these specifications (Besnahan and Chopra 1990, Dankbaar and van Tulder 1992).

Note that this possible course of action is the only way buyers can influence the range of technological options offered on the market if one resorts to the theory of positive network externalities for both of its possible mechanisms, increasing benefits due to an increase in the size of the existing as well as the expected network.

The interpretation of network effects proposed in this paper, however, suggests a second possibility for influencing the course of technological

[8] MAP: Manufacturing Automation Protocol.

development through collective action. If the effect of the existing network size is to facilitate acquisition of knowledge about trade-off positions embodied in new technology, user groups can "artificially" create such an effect even if the existing network of users of the new technology is relatively small. By promoting knowledge about trade-off positions embodied in new technology, they can significantly reduce transaction costs of supplying/purchasing new technology. If user groups could commit to acting as this type of communication platform, the effect may be sufficiently large to trigger the development of new technology which otherwise would not be developed.

In order to explore this idea formally, consider the formulation of a vendor's calculus as developed in section 4.4 for a preliminary analysis. In order to isolate the effects user groups might have on transaction costs of supplying/acquiring new technology, assume the following: (1) Production costs are the same for both, the new and the existing technology; (2) similarly, the ultimate expected network size is identical for both technologies, i.e. $x^e = x^{oe}$; (3) reservation prices are similar for all buyers. Then, inequality (5) reduces to:

$$x^e * r - x^e * \{dPC^o_i/dx^{oi} + z_i(t)\} > TC^{cm}{}_i(x^i) - TC^{ocm}{}_i(x^{oi}) \qquad (6)$$

One way to analyze the decision situation of a user group then consists of expressing the extra benefit which a user derives from deploying new technology as compared to the benefit of deploying existing technology as a function of the existing network disadvantage because this extra benefit provides a source of extra profit for the vendor due to its temporary monopoly situation. If there would be a way of knowing how "artificially," i.e. by collective action of user groups, reducing the network disadvantage impacts upon this extra profits of vendors, user group could assess the likelihood of success of such efforts.

For this purpose define:

$$dPC^o/dx^{oi} + z(t) \equiv p$$
$$r \equiv p + tp$$
$$x^{oi} \equiv x^i + nd$$

With:

- *p* market price of existing technology
- *tp* temporary profit of supplying new technology corresponding to the extra benefit of deploying new technology rather than existing technology
- *nd* existing network disadvantage of new technology

Then, inequality (6) becomes:

$$tp > 1/x^e * \{TC^{cm}_i(x^i) - TC^{ocm}_i(x^i + nd)\} \tag{7}$$

In order to further explore this relationship it seems practical to determine a functional form for *TC* and TC^o.[9]

Since the effect of the existing network size on potential buyers consists of providing a communication channel between existing and potential buyers of technological products, it is possible to use diffusion theory for determining a proper functional form. Diffusion theory claims that innovations spread through a population of potential users as a result of a type of "infection mechanism." As potential users learn about new technology from current users, they become "infected" and start to use the technology themselves (cf. Rogers 1983, p. 245). Accordingly, diffusion of innovations follows an S-shaped or "logistic" pattern known from the spread of diseases because initially, when the fraction of current users is still small, the chances of "infecting" new users through direct contact are still high; however, as the share of current users increases the probability of meeting an "uninfected" member of the population begins to decrease because more often than not one current user will meet other current users.

Whereas diffusion theory measures the spread of knowledge in a given population of potential users as a function of time, the underlying mechanism consists of communication between current users and potential users. Only when assuming that current users keep communicating the same "amount of information" per unit of time is it possible to express the spread of knowledge as a function of time. The more direct (and for our purposes the more useful) way of modelling that dependency consists of expressing the spread of knowledge as a function of the number of current users (who, via their communication activity, effect the actual spread of knowledge) which then can also be represented by a logistic functional form.

Because the network effect identified here also depends upon the spread of knowledge about new technology, the "epidemic" growth pattern of diffusion theory must also hold for TC/TC^o. Furthermore, since an existing network of users facilitates communication of evaluation knowledge necessary for making the purchasing decision, transaction costs of communicating that knowledge actually decrease as the network and thus evaluation knowledge grows when seen from the vendor perspective since an ever larger share of the total transaction cost burden will be taken over by the network. Thus, as evaluation knowledge about trade-off positions embodied in new technology travels through the population of potential

[9] As in this expression TC^s does not appear, we drop the superscript *cm* for TC^{cm} and TC^{ocm} from now on.

users, transaction costs of communicating/acquiring that knowledge decrease accordingly. This relationship is depicted in Fig. 1.

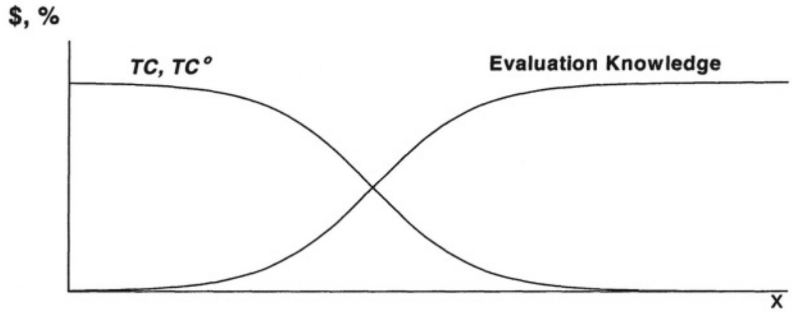

Figure 1. **Deriving *TC* and *TC*^{O}**

According to inequality (7), the extra benefit *tp* of new technology must be bigger than the difference between $TC(x^i)$ and $TC^o(x^i + nd)$ times the reciprocal of the expected network size if the new technology is to be offered on the market. Assuming that *TC* and TC^o have the same form and identical parameters, a function representing inequality (7) – denominated by *F* – can be derived from the shape of TC/TC^o. Starting with an *nd* value of 0, the differential between $TC(x^i)$ and $TC^o(x^i + nd)$ first grows with increasing and then with decreasing rates which gives another logistic pattern for *F* (see Fig. 2). If *F* is constructed for values of *nd* bigger than zero, the part of the curve which exhibits increasing growth rates will be diminished accordingly. As *nd* grows beyond 50% of the population of potential users, *F* begins with decreasing growth rates, i.e. there is no area of increasing growth rates.

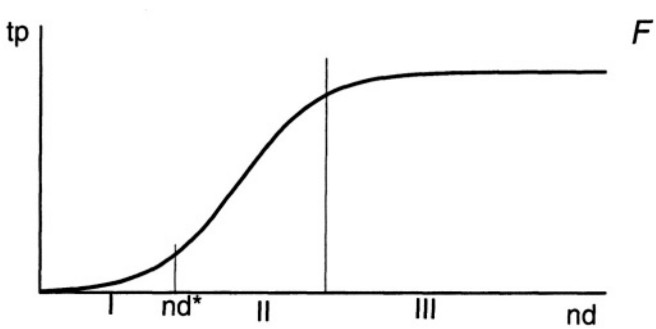

Figure 2. **Phases of Potential User Group Activity**

The logistic pattern of the relationship between the extra benefit of new technology required for triggering its actual supply and its network disadvantage implies that *nd* has a significant effect on *tp* only for intermediate values of *nd* (area II in Fig. 2). If user groups want to facilitate the supply of new technology, the likelihood of success of such action increases significantly if they can create a communication effect larger than *nd**. Thus, users have a means of actively affecting the range of choices offered to them on technology supply markets by *reducing* the degree of a new technology's superiority required to induce vendors to actually develop and supply that technology.[10] From the point of view of positive theory, in turn, the implications of this model can then be summarized by the following proposition:

> Proposition 5: Other things being equal, the frequency with which a new technology seen as superior by buyers replaces entrenched technologies increases with the degree of collective user action aimed at improving the communication flow among users, for example through setting up and running user groups.

6. CONCLUSIONS

Based on a transaction cost theoretic interpretation of network effects, the analysis presented in this paper suggests how users can actively influence the range of technological choices on markets for new technology through collective action other than by collectively committing to only buy products incorporating the new technology. This latter alternative would be the only way for users to affect the course of technological development if one relies on models which interpret network effects as positive network externalities.

[10] Note the difference of this approach to that suggested by Witt (1997) who demonstrated how in a model based on the notion of positive network externalities the likelihood of an entrenched technology to be replaced by a new (possibly superior) one can be expressed as a function of the new technology's superiority: "In principle, there is always a chance of overcoming what appeared ... to be an inescapable "lock-in" situation produced by increasing returns to adoption—if the new variant is sufficiently superior to the established one." (ibid., p. 768). Thus, the cumulated positive externalities of the old technology have either to be compensated by the new technology's superiority and/or by some subsidizing scheme to reach a critical network size in order to be dislodged; in any case, buyers would have no means of affecting the course of technological development other than by developing the new technology themselves or collectively committing to buy (only) products incorporating the new technology.

According to the model presented in this paper, the type of collective user action required for widening the range of technological choices on markets for new technology consists of providing a communication platform for the exchange of technical and economic information about new technology. It has been suggested that the likelihood of success of such action significantly increases if the extend of communication among users exceeds a critical value which can be expressed by the relative disadvantage of the new technology's network size. The model is based on propositions which are formulated in a way allowing for empirical refutation. Moreover, the model predicts that the frequency of instances in which a superior technology (i.e. one regarded as superior by users) replaces an entrenched technology is related to the extend of information exchange among users (other things being equal), a proposition which lends itself to empirical testing as well.

The model presented in this paper also has a rather practical implication. User groups tend to be organized around existing products of specific vendors. This is, in no small part, due to their need of obtaining sufficient financial resources for their own operation and administration which is frequently provided by the vendors. However, such practice rules out the communication effect of user groups which has been described in this paper as facilitating the supply of a greater variety of technologies on IT markets. Achieving this effect requires that user groups comprise users of *different* technologies so that sharing of knowledge regarding their respective economic and technical characteristics becomes possible. Vendors of existing products will normally not have sufficient incentives to incorporate new technologies into their products lest they cannibalize their own revenues. Thus, entrenched technology is most likely replaced by newcomers or rivals (Martin and Mitchell 1998). However, any supplier of a competing product incorporating new technologies would face the daunting task of overcoming the huge communication disadvantage created by the size of the user network of the existing technology (thus increasing the supplier's transaction costs relative to those of the supplier of the existing technology). A user group may help to reduce the magnitude of this disadvantage only if it mixes users of different technologies and, by implication, brands. This, at least, is what the model we have presented in this paper would suggest. Thus, increasing the variety of technologies offered on technology supply markets, which would be one way of increasing the responsiveness of technology supply markets to changing user requirements, would require a different type of user group, one actively managed (and financed) by users formed around *specific types of user requirements* rather than products and brands. However, this conclusion is derived from a hypothetical model of technology supply markets and should be empirically validated before it can be recommended to practitioners as a guideline for action.

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