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The economics of standardization: Introduction and overview

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1. Prologue

Instead of trying to give an extensive summary of the various papers included in this special issue, we will briefly discuss the alternative concepts used in modeling network effects and compatibility that characterize these contributions. [1] Section 2 presents this overview. The outline will show that there are issues not covered by this collection although they are of obvious relevance to a comprehensive discussion of the concept of standardization. Section 3 sketches some of these *omissions*. It also mentions some *limitations* which are relevant for our purpose.

2. Modeling of network effects and compatibility

In their review paper, *Carmen Matutes* and *Pierre Regibeau* discuss several concepts of compatibility and network effects. Some of them are, of course, closely related to concepts used in other papers included in this collection. Regarding network effects and externalities, they propose

$$u_i = a_i + b_i N^e$$

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[1] See von Rabenau and Stahl (1974) for an early contribution.

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as a general formulation of the utility of consumer i associated with the network-good i. In this expression, a_i represents the stand-alone value consumer i derives from consuming one unit of the good, N^e is the expected size of the network, and b_i this consumer's valuation of the network effect. Typically, it is assumed that each consumer buys one unit of the good so that N^e is also the expected number of buyers.

An example is given by *Nicholas Economides* who considers the special case where the network externality increases in the willingness to pay for a good, $P(Q; S)$, where S is the expected size of the network and Q the supplied quantity of the good. The network effect pushes the demand outward without changing the slope of the demand function:

$$P(Q; S) = P(Q; 0) + f(S)$$

where $f(S)$ is to be viewed as a measure of the externality. In equilibrium, $Q^* = S^*$ must hold. Since the incumbent monopoly cannot bind itself to supply a quantity larger than the profit-maximizing quantity S^o, it might be profitable for this firm to invite entry of competitors in order to convince the customers that they can expect a network larger than S^o. Thus entry will augment the willingness to pay, compensating the incumbent for giving up its monopoly position.

André de Palma and *Luc Leruth* assume that externalities are related to the total consumption of goods, that is, the number of consumers. If goods are compatible, then the externality of good i (E_i) depends on the number of consumers using i as well as other goods compatible with it. In the case of two goods, we have $E_i = E_i(q_1 + q_2)$ if the goods are compatible and $E_i = E_i(q_i)$ otherwise. To make the analysis tractable, they assume linearity. Furthermore, similar to Mussa and Rosen (1978), consumers have heterogeneous preferences with respect to externalities and the surplus derived by consumer θ from consuming good i is given by

$$S(E_i, p_i; \theta) = \theta E_i - p_i$$

where p_i is the price of good i. [2] The analysis of de Palma and Leruth shows that firms prefer to be compatible when the firms' subjective probabilities to become the larger supplier under incompatibility are close enough. Their welfare analysis demonstrates that, in their model, a duopoly selling compatible network-goods is socially preferable to a monopoly selling a single network-good and the monopoly outcome is preferable to a duopoly with incompatible network-goods.

In the model of *Marie-Hélène Jeanneret* and *Thierry Verdier,* the two products sold on the market are differentiated by their quality (vertical differentiation). Qualities are fixed but compatibility gives rise to differentiated quality mark-ups

[2] As observed by de Palma and Leruth, the surplus function used by Katz and Shapiro (1985) can be rewritten as $S(E_i, p_i; \theta) = \theta - p_i + E_i$ where the externality function E_i is assumed to be concave.

ϵ_i which increase the quality of good i if both suppliers choose to produce compatible goods. The mark-ups may increase or decrease the quality gap between the two products, but it is assumed that it will not be evened out by compatibility. As the quality mark-ups ϵ_i do not depend on the number of buyers, compatibility creates only generic network effects: a consumer of a product may benefit by switching to the other if the price of the latter decreases because the increase in demand leads to economies of scale. Using this conceptual framework Jeanneret and Verdier analyse the implications of trade policy on the incentives for firms to standardize their products. They show that liberalization of trade may well induce the foreign and domestic firms to supply compatible goods.

In *Jay Pil Choi's* paper standardization also focuses on generic network effects. He assumes that users simply add a constant value to the stand-alone value of the alternative technologies if they use identical technologies. What drives his model is the fact the stand-alone value of a specific technology will be revealed only after it has been applied. Thus there is a trade-off between *ex ante* and *ex post* standardization since users can choose an identical technology even before they know its stand-alone value.

Paul David and *Geoffrey Rothwell* elaborate on the following question: how can we define the degree of standardization. In order to find an appropriate answer to this question they pick up an idea suggested in Weitzman (1992, p. 365) for whom "[t]he distance between two species might be derived as a hedonic weighted sum of *distances* between more fundamental micro-characteristics, so that conceptually $d(i, j)$ represents the weighted number of observable 'character-state differences' between species i and j". A high degree of standardization means that this distance is small. David and Rothwell apply this measure to compare the U.S. and the French nuclear power industries. Inasmuch as 'closeness' is evaluated positively (the authors give convincing arguments which support this hypothesis), the French nuclear power industry enjoys generic network effects.

Cien-fu Chou and *Oz Shy* analyse markets in which the consumer's value of a specific brand (e.g., hardware) rises with an increase in the variety of supporting services (e.g. software). Two brands are said to be compatible if the supporting services can be applied to both brands. Let S_A and S_B be the surpluses of products A and B, respectively. The utility of consumer z is $(1 - z)S_A$ if he chooses brand A, and zS_B if he chooses brand B. A high value of z expresses a strong preference of the corresponding consumer towards brand B. The analysis indicates that negative network effects are likely to occur when hardware systems are compatible or, in the case of incompatibility, when the degree of substitution between brand specific supporting services is high. If the hardware industry is competitive, then negative network effects cannot arise when the software industry is monopolistically competitive.

Jeffrey Church and *Neil Gandal* analyse the effect of hardware control on software provision. They assume that the consumers' benefit of hardware i is a function of the variety of complementary software products available. The utility

of a consumer located at distance t_i from hardware i (horizontal product differentiation) is

$$u_i = \alpha + N_i^{\beta} - t_i + x$$

where $0 < \beta < 1$. In this expression, the first two terms express the network benefit of consuming N_i varieties of software compatible with hardware i while x represents an outside good. One of the main results of this article is that, if the difference between the monopoly and the duopoly prices is small, the decisions of an incumbent and of a single potential entrant will result in either *de facto* standardization on the technology of the incumbent or incompatible technologies with two suppliers, even though standardization on the technology of the entrant is socially preferable.

Carmen Matutes and *Pierre Regibeau* classify the effects of compatible complementary goods, also discussed in the papers of Chou/Shy and Church/Gandal, as indirect network effects. In their paper, they confront the direct and indirect network concepts of standardization with the 'mix and match' approach. The latter deals with situations where consumers benefit from the use of a system which consists of a fixed set of compatible components. In this context, compatibility means that a consumer can combine components from different producers. [3] This results in a larger variety of goods although each firm's realization of the same component is taken as given. However, the larger the number of varieties, the more likely it is that a specific consumer is able to buy his/her most-preferred version of a system good. The willingness to pay will increase for those consumers who benefit from the mix and match possibility. Note that neither direct nor indirect network effects, as discussed above, are considered here. The utility of consumer does not depend on the choices of other consumers, at least not directly. With reference to mix and match compatibility, Matutes and Regibeau discuss important problems such as entry deterrence and technological progress.

3. Omissions and limitations

There is no paper in this special issue which discusses standards for references, i.e., definitional standards like currency, weights, etc. – with the exception of *Michael Adams'*. It seems that problems of pure coordination do not attract much attention in the profession when the solution of the problem is costless to the agents. For example, from an economist's point of view, little can be said on whether we should drive on the left side or the right side of the street, unless we

[3] This is reminiscent of the Lancaster model where consumers can combine products to produce their most-preferred bundle of characteristics.

consider the costs of switching from left to right (or right to left) because of the installed base created by previous decisions.

Effects of standards for minimal admissible attributes like safety levels are discussed by *Philip Jones* and *John Hudson*. They show that minimum quality standards lower the costs of uncertainty associated with assessing product quality (such as transaction costs of user evaluation or search costs) by reducing the variation in product quality. The truncation of the lower region of variance allows for more efficient signalling of product quality since the variance of the ith signal is inversely related to the degree of standardization. Thus, standardization reduces uncertainty and corresponding costs.

Minimum standards can be related to network externalities inasmuch as they are often designed to save people from the experience of negative network externalities. For instance, there are health standards which prevent us to plunge into epidemic disasters while others are thought to reduce the treatment costs which otherwise the society has to cover. We offer the conjecture that several problems addressed in this volume within the context of positive externalities of standardization carry over to issues of negative externalities. However, this does not mean that the corresponding models and results apply immediately when the values of the two network effects have opposite signs. In this respect, network externality models may be useful to study bandwagon and snob effects in consumer demand theory (Leibenstein, 1950). Yet, conformity can be viewed as a positive network externality while snobbism corresponds to a negative one. This analogy allows one to study the impact of such effects on market equilibrium and welfare (see Navon et al. (1995) for an attempt to integrating).

There is no contribution either dealing with standardization through committee decision making as in Farrell and Saloner (1988) – for a recent paper in this domain, see Goerke and Holler (1995). Several papers, however, mention the possibility of explicit *ex ante* agreements on standards (Choi is an example). In the future, one wishes to see more contributions on this issue because, for practical purposes, standardization through committees is likely to become even more important.

Some of the omissions result from our decision to choose on quality instead of an urge for completeness. As a reaction to the *Call for Papers*, more than forty papers were submitted for publication. However, it was clear from the outset that, depending of the number of pages, no more than ten papers could be published. We very much hope that our policy explains some of the omissions which we have just discussed.

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