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Networks and compatibility: Implications for antitrust

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Abstract

In this paper we draw crucial parallels between the concepts of compatibility and networks and the more traditional concepts of complementarity and vertical relationships. We also develop the important distinctions between 'two-way networks' and 'one-way networks'. We then apply our framework to a number of current antitrust issues.

Key words: Networks; Compatibility; Antitrust; Complementarity

JEL classification: L13; L40

1. Introduction[1]

Networks are a frequent phenomenon in modern economies. Telephones, railroads, roads, ATMs, and electricity are common examples. In this paper we make the distinction between 'two-way networks' and 'one-way networks' and show the important differences between these two general types of networks. We also show that vertical relationships are inherent in networks. Further, we indicate that compatibility – an essential element in networks – is equivalent to the more general concept of complementarity. We are thus able to draw on a significant body of economic and legal thought concerning vertical relationships and complementarity in order to analyze antitrust issues in this area.

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[1] This paper draws heavily on Economides and White (1993), where further discussion can be found.

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2. Network externalities and compatibility

2.1. Two-way networks

We begin with the simplest possible 'star' network: a central switch S with *n* spokes (SA, SB, S, C, etc.). See Fig. 1. If this is a telephone network, the customers are located at A, B, C, etc., and the goods (or services) are phone calls ASB, BSA, ASC, CSA, etc. Each good (e.g., ASB) is composed of two complementary components (AS and SB), each of which could be described as 'access to the switch'.

We now offer a number of important observations: First, *all* components (AS, BS, etc.) are *complementary* to each other; therefore, *any two* of them can be combined (connected) to make a demanded composite good (such as ASB). Second, these components are complementary even though (in individual specification terms) they are very similar goods. Third, there is reciprocity or reversibility: Both ASB and BSA are feasible *but different* (though technologically very similar) since the spokes (AS, BS, etc.) can be traveled in both directions. Fourth, customers tend to be identified with a specific component. Fifth, composite goods that share one component, such as ASB and ASC, are not necessarily close substitutes. Sixth, there are *network externalities*: The addition of a new spoke to an *n*-spoke network creates 2*n* new potential goods.[2] The externality involves the creation of new goods for each old customer; it is an *economy of scope in consumption.* Note that *the externality affects directly the utility function of each customer.*[3] Seventh, compatibility among the components is essential for the network to function. Compatibility may be automatic for certain goods (e.g., sugar always dissolves in coffee), but for high technology products compatibility often has to be achieved by explicit or implicit agreements on crucial *technical standards.*

Most *two-way networks* (e.g., telephone, railroads, roads, Minitel) embody the features just discussed. Some complicated networks, however, may have only partial compatibility for some services and incomplete symmetry of the externality.

A slightly more complex network is portrayed in Fig. 2. A 'gateway' (S_AS_B) connects two separate switches (S_A and S_B), which are the central nodes of two separate star networks. All components (A_1S_A, A_2S_A, etc.) are still complementary to each other. However, only components that are connected to the same central node (e.g., A_iS_A and A_jS_A) can be connected directly to make a composite good ($A_iS_AA_j$). Components connected to different nodes (e.g., A_iS_A and B_jS_A) are complementary but require gateway S_AS_B to create

[2] See Rohlfs (1974).

[3] There may be other secondary (indirect) effects through the markets (such as price changes), but this is not necessary or essential.

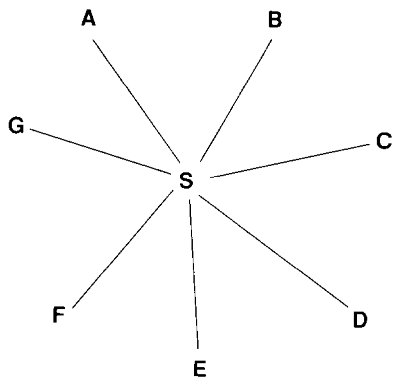

Fig. 1

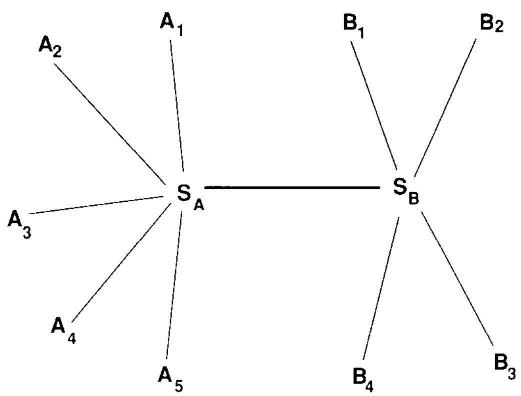

Fig. 2

the demanded composite good $A_iS_AS_BB_j$. We now have two types of externalities: '*Local network externalities*' (in the same star) are immediate (as before); '*long distance network externalities*' require the gateway (S_AS_B).

2.2. One-way networks

We now consider *one-way networks*: e.g., ATMs, television, electricity networks, retail dealer networks, etc. We again offer some observations. First, in such networks, a combination of any two components does *not* necessarily create a demanded composite good. Essentially, there are *two types of* *components* (type A and type B), and *only* the combination of a component(s) of type A with a component(s) of type B creates a demanded composite good. Accordingly, a one-way network has a structure similar to Figure 2, but only the 'long distance' composite goods (e.g., $A_iS_AS_BS_j$) make sense. The 'local' composite goods (e.g., $A_iS_AA_j$) give no utility and therefore are not demanded. Second, a one-way network lacks reciprocity, since goods $A_iS_AS_BB_j$ and $B_jS_BS_AA_i$ coincide. Third, customers typically are not immediately identified with specific components or nodes. Fourth, a composite good usually is a closer substitute with a good with which it shares a component than with goods with which it doesn't. Fifth, these networks exhibit a variant of consumption economies of scope: Let there originally be m components of type A and n components of type B that can be combined in a 1:1 ratio, so that there are mn composite goods. Then the addition of one more component of type A creates n new composite goods, and the addition of one more component of type B creates m new composite goods. As before, the externality is in the creation of new goods. When customers are identified with components, the one-way network exhibits (in the previous terminology) 'long distance network externalities.' Since this externality arises in the combination of components of *different types*, we call it an '*inter-product network externality*'. When customers are not identified with components, their benefit from the addition of new components is indirect; they are now able to find a variety that is closer to their ideal, and, if new components are provided by new firms, competition may decrease prices.[4] Then we can call *indirect network externalities* the economies of scope that are found in one-way networks. Finally, the achievement of externalities in one-way networks again requires compatibility.

2.3. Vertically related markets

The most important common feature of both types of networks is the property that composite goods are created from complementary components. But this creation of composite goods from complementary components is a feature that is commonly found in most 'vertically related' industries (e.g., upstream-downstream relationships, hardware-software combinations), most of which are usually not considered to be network industries.[5] A typical

[4] Farrell and Saloner (1985) describe this as a 'market-mediated effect.'

[5] It is worth noting, however, that a number of authors who have written about 'network externalities' identify these externalities with vertically related industries. See Farrell and Saloner (1986), Katz and Shapiro (1986, 1992), Church and Gandal (1992), and Economides and Salop (1992).

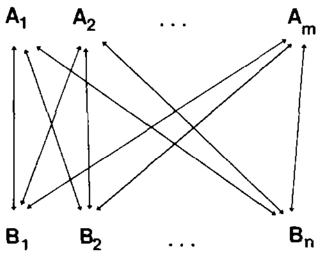

Fig. 3

market with compatible components has *m* varieties of type A and *n* varieties of type B, where the A components are complementary to the B components. Composite goods are created by combining components of different types. See Fig. 3. *These pairs of vertically-related markets are essentially identical (under compatibility) to a one-way network*, as pictured in Fig. 2, with the understanding that goods $A_iS_AA_j$ and $B_iS_BB_j$ are of no value. Composite good A_iB_j in Fig. 3 is the equivalent of good $A_iS_AS_BA_j$ in Fig. 2. Thus, the inter-product and indirect 'network' externalities arise in vertically related markets in the same way as in one-way networks. In most vertically related markets, consumers are not identified with specific components. Accordingly, we expect most network externalities to be of the indirect type. As in one-way networks, a composite good in vertically related markets is usually a closer substitute for a good with which it shares a component than for good with which it does not.

2.4. Compatibility and complementarity

The complementarity between different types of goods is often inevitable because of technical or other features. In many situations, however, complementarity is feasible but not inevitable. Firms have the option of making their products *not* complementary with other components; e.g., a firm has the option of not offering its products through certain channels by *excluding* dealers. When the usefulness of the composite good depends on the technical compatibility between the components, parallel situations arise. Clearly, *compatibility makes complementarity feasible.* But firms may be able to reduce or eliminate the complementarity of their products with other products by introducing various degrees of incompatibility. Thus, *the decision to produce and sell a component that is incompatible with potentially complementary components is tantamount to exclusion.*

2.5. The incentive for compatibility in various ownership structures

Consider an industry where products are produced with known technologies, there is costless coordination, price discrimination cannot be practiced, and there are no cost asymmetries created by any specific compatibility standard. In this case, if a firm does not produce any vertically related components, it has no incentive to create incompatibilities of its products with complementary components. When a firm is vertically integrated, however, the incentive for compatibility depends on the relative sizes of the demands for each combination of complementary components (composite goods).[6]

2.6. Setting technical standards

If coordination to a particular standard is costly, firms may produce incompatible components, even when the demand rewards from compatibility are substantial. However, the incentive for compatibility could be enhanced if coordination to a specific standard puts a competitor at a cost disadvantage.[7] Further, a firm with proprietary information, which may be disclosed in the standard-setting process or in the regime of compatibility, has little incentive to participate in the process.[8]

2.7. Compatibility and ownership structure

It is now well known (and was first demonstrated by Cournot, 1838) that a merger of two vertically related monopolists (e.g., a network depicted in Fig. 3 with $m=n=1$) leads to a reduction in price. Economides and Salop (1992) show that Cournot's result generalizes to two vertically related markets with two varieties in each and complete compatibility (e.g., Fig. 3 with $m=n=2$). In a network setting or in vertically related markets, however, most mergers involve both vertical and horizontal elements, and Economides and Salop (1992) show that such 'mixed' mergers could change prices in *either* direction.

Even in simple networks, the incentive for mergers among the various elements of the network cannot be easily categorized. Small changes in the

[6] See Matutes and Regibeau (1988, 1992) and Economides (1988, 1989, 1991, 1994).

[7] For an analysis of the strategic effects of raising the costs of competitors, see Salop and Scheffman (1983).

[8] Apple has argued that its proprietary design of the operating systems of the Macintosh would be compromised if it disclosed sufficient information to establish compatibility standards. Baumol (1983) discusses an example of a railroad that could be reluctant to interconnect so as not to disclose the identities of its customers.

configuration of the remaining network can change the direction of the incentives of a firm to merge two components of the network, as measured by the difference between the post merger profits and the sum of the individual pre-merger components. Further, gateways can be of no value (and even be a liability) to the existing participants of a network, but be of value to a potential entrant.[9]

3. Networks and antitrust[10] policy

Since the concept of networks and compatibility have strong parallels with the more commonplace concepts of vertical relationships and complementarity, our discussion of three important antitrust topics can draw on much of the existing literature that links these latter concepts with public policy.

3.1. Mergers

Mergers between firms that are vertically related in network industries – either producers of different components in one-way network industries or operators of adjacent two-way networks – have a presumption of beneficial social consequences. All of the usual arguments for the benefits of vertical integration – improved coordination, elimination of double marginalization, elimination of inefficient substitution – apply. In an important respect, *improved coordination is a paraphrase for improved compatibility.* Further, as Carlton and Klamer (1983) point out, such vertical mergers may encourage greater innovation, since an innovator will experience fewer difficulties in reaping the gains of compatibility-linked innovations.

There are, however, well known potential competitive dangers to vertical mergers, which would apply to network industries as well. Vertical mergers may be a means of perfecting a system of price discrimination, with its concomitant ambiguous consequences for social welfare. They may also be a means for quality discrimination, whereby a firm with market power distorts the quality levels provided to some customers so as to be able to charge higher prices to other customers (with likely adverse consequences for social welfare).[11] If the assumptions of constant returns to scale and easy entry are

[9] See Economides and Woroch (1992).

[10] We include here economic regulation that frequently serves as a substitute for antitrust in some industries (e.g., transportation, telecommunications).

[11] See White (1977), Mussa and Rosen (1978), Donnenfeld and White (1990), and Bradburd and Srinagesh (1989).

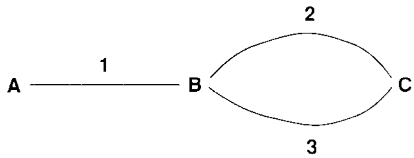

Fig. 4

replaced by increasing returns to scale and/or difficult entry, vertical mergers may be a means of enhancing market power – e.g., by raising rivals' costs or enhancing strategic interactions.[12] Also, if a merger involves both vertical and competing horizontal elements (and if the horizontal elements cannot be easily cured by selling one of the two competing components to a rival or entrant), then difficult judgments concerning enhanced (vertical) efficiency versus enhanced (horizontal) market power may be necessary.

As an example of a complex problem that has vexed the U.S. Interstate Commerce Commission,[13] consider rail links between cities A, B, and C, as in Fig. 4. Link AB is owned by firm 1; firms 2 and 3 each own a separate BC link. Here there are five goods: AB, B2C, B3C, and their combinations AB2C and AB3C. The novel element of this structure is that some components (B2C and B3C) have utility as 'stand alone' goods, as well as components of composite goods AB2C and AB3C. Suppose that the ability of firm 3 to compete in the 'short haul' BC market is affected by its volume of AB3C traffic (because of economies of scale or scope). In this case, a merger between firms 1 and 2 could have anticompetitive effects in the BC market if the merged firm is allowed to favor its B2C subsidiary through price discrimination. If the merged firm is not allowed to price discriminate, it may decide to foreclose B3C rather than to supply AB freight to it at the same price it charges to its subsidiary B2C.

3.2. Joint ventures

Where dominant firms are present in one-way network industries, these firms are likely *de facto* to set compatibility standards.[14] In instances where a dominant firm is absent but where compatibility can yield significant social

[12] See, for example, Salinger (1988), Ordover et al. (1990), and Whinston (1990).

[13] For discussions of these railroad merger problems, see Carlton and Klamer (1983), Baumol (1983), Grimm and Harris (1983), McFarland (1985), and Grimm et al. (1992).

[14] This initial conjecture by Braunstein and White (1985) was later demonstrated in formal models by Farrell and Saloner (1986) and Katz and Shapiro (1986).

gains, a coordinating mechanism may be necessary.[15] Regulatory agencies, trade associations, and industry joint ventures can all serve as this mechanism. We will focus primarily on joint ventures.[16]

The beneficial effects of a joint venture to set standards and achieve compatibility are clearly strongest where the member firms are solely in vertical relationships with each other. In such instances the joint venturers' primary interests are to achieve compatibility standards that maximize the efficiency with which their goods or services fit together to provide a composite good or service; anti-competitive consequences are unlikely.[17]

When the joint venturers are competitors (actual or potential) as well as in vertical relationships, the dangers are somewhat greater. The incentives for efficient compatibility are still strong. But anticompetitive tendencies can also be present. First, the joint venture may simply provide the vehicle for blatant horizontal price-fixing. Second, the joint venture may be a vehicle for enhanced implicit coordination among the competitors. Third, the compatibility standards on which the joint venturers agree may favor some firms at the expense of others, and the latter could well be the competitive 'mavericks' of an industry that has otherwise achieved some level of oligopolistic coordination. Further, the joint venture might involve the actual production and pricing of one or more goods or services, with collusive pricing of those goods or services by the joint venture.

Of course, the ability of the joint venturers to succeed in any anti-competitive efforts would be dependent on their ability to exercise market power in their market. In this respect the DOJ-FTC Horizontal Merger Guidelines (1992) provide a useful framework for analyzing the relevant market and the possibilities of non-competitive behavior by the joint venturers.

3.3. *Vertical restrictions*

Decisions by a firm to impose compatibility against some vertically related firms (but not others or against the firm's own vertically related subsidiary) have close analogies with traditional and familiar vertical restraints or

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[15] Economides (1988, 1989, 1991) and Matutes and Regibeau (1988, 1992) provide frictionless models in which non-cooperative oligopolists voluntarily choose compatibility as their profit-maximizing choices. In a world with frictions a coordinating mechanism may be necessary.

[16] Agreements reached through trade associations can be considered as less formal joint ventures; and to the extent that regulatory decisions are influenced by the lobbying of the affected parties, this too might be considered to be a form of joint venture.

[17] One possible anti-competitive consequence might be as follows: If all of the non-competing firms were to recognize some new firm as a potential threat to any (or all) of them, they might adopt a compatibility standard that was more costly for that new firm.

restrictions. Indeed, most of the traditional vertical restraints could be re-interpreted as incompatibility by fiat, rather than incompatibility due to technology (or to technological decision), but the economic effects in either case are likely to be quite similar.

In essence, a decision by a firm to restrict compatibility – and thereby limit the ability of some other 'upstream' or 'downstream' firms to interconnect with the original firm or to have their products (components) be combined with those of the original firm – can be seen as an act of tying (from the perspective of the customer) or of exclusive dealing or refusal to deal[18] (from the perspective of the rival firms).

As we noted above in our discussion of vertical mergers, there are benign and beneficial (efficiency) reasons for firms to want to attain these forms of (partial) vertical integration. But there can also be anticompetitive motives that will increase inefficiency. Accordingly, difficult judgments may be necessary – though a showing of an *absence* of actual or potential market power should be an automatic safe harbor for these practices.

4. Conclusion

In important ways, compatibility and the networks that rely on it can be understood through the lens of complementarity and vertical relationships. There are, however, distinct and interesting differences between two-way and one-way networks. Our linking of compatibility with complementarity provides a framework for analyzing a number of important antitrust issues and showing that, as with most vertical relationships (through merger, integration, or contract), there are strong arguments for the beneficial nature of most compatibility and network arrangements but that, under some circumstances, anti-competitive consequences can arise.

[18] One variant of a refusal to deal is the 'essential facilities doctrine'. See Werden (1988), Ratner (1988), and Reiffen and Kleit (1990).

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