

# **CROSS-MARKET EFFECTS OF NETWORK EXTERNALITIES**

Mark A. Jamison\*  
University of Florida

Draft Date: July 9, 2002

## **Abstract**

I examine how firms that operate in multiple markets in network industries internalize network externalities. Using a Cournot model, I show that operating in multiple markets provide firms an incentive to increase output.

JEL L11, L86

Key words: Networks, Network Externality, Antitrust, Multimarket

---

\* This analysis is from chapter 4 of my dissertation (Jamison, 2001). I would like to thank David Sappington and Sanford Berg for their comments on this analysis. All errors and omissions are my own. Author's address: Public Utility Research Center, 205 Matherly, PO Box 117142, University of Florida, Gainesville, FL 32611-7142, jamisoma@ufl.edu, voice +1.352.392.2929, fax +1.352.392.7796.

## 1. Introduction

The welfare effects of mergers and market concentration have been analyzed extensively. (See, for example, Salant et al. (1983) and Farrell and Shapiro (1990a, 1990b).) Recent papers have extended this work to examine rivalry and market concentration in network industries. (See, for example, Katz and Shapiro (1994) and Crémer et al. (2000).) However, this literature does not examine how network externalities between markets affect firms' output choices. This cross-market effect of network externalities has played an important role in recent merger and antitrust cases in network industries. European Union (EU) regulators placed conditions on the MCI-WorldCom merger because of concerns that the merged company would leverage market dominance in the Internet backbone to capture most of the new growth in Internet access (Ungerer, 2000). The US and the EU have pursued antitrust actions against Microsoft based in part on the theory that Microsoft attempted to leverage its dominance in the market for PC operating systems to dominate other markets. The US Federal Communications Commission (FCC) placed conditions on the merger of AOL and Time Warner because the FCC believed that AOL was dominant in Instant Messaging and could leverage this dominance to control future markets for advanced Instant Messaging-based services.

In this paper, I extend the Katz and Shapiro (1985) model for a network industry to examine the implications of firms serving multiple markets in network industries, perhaps because of mergers. When a single firm serves multiple markets with network externalities, the firm internalizes network externalities and may choose higher levels of output than separate firms would choose. When a firm internalizes network externalities, its extra revenue from an increase in output in market  $A$  reflects not only the effects on price and quantity sold in market  $A$ ,

but also the effects that higher market demands have on prices in other markets in which the firm operates. The higher prices in these other markets provide extra revenue from market  $A$ 's output, providing the firm with an incentive to choose a higher output in market  $A$ . I call this additional revenue from market  $A$ 's output the marginal extra-market revenue.<sup>1</sup>

The analysis proceeds as follows. Section 2 describes the model. Section 3 presents the results. Section 4 is the conclusion.

## 2. The Model

I consider a game in which firms choose output simultaneously in the first stage. These output choices generate market-clearing prices. Lastly, customers choose their preferred network providers.

There are two markets,  $A$  and  $B$ , for a homogeneous network service and  $n$  firms. Customers cannot migrate between markets to buy the service. Each customer buys at most a single unit of output.  $q^{i,m} \geq 0$  will denote the number of customers that firm  $i$  serves in market  $m$ .  $\mathbf{q}^i$  will denote the vector of all  $q^{i,m}$  for a single firm  $i$ ,  $q^m$  will denote the number of customers served by all firms in market  $m$ , and  $\mathbf{q}$  will denote the vector of all outputs of all firms in all markets.

I assume that firms “interconnect” their networks and that networks are perfectly compatible. This ignores the important issue of incentives to lower interconnection quality for rivals (Cr  mer et al., 2000), but that issue is beyond the scope of this paper. In the setting of physical communications networks, this interconnection would be the lines and technical

---

<sup>1</sup> I use the term marginal revenue in the traditional way, i.e., to indicate the effect of a change in output in market  $A$  on the firm's revenues from its sales in market  $A$ . In contrast, marginal extra-market revenue refers to the effect of a change in output in market  $A$  on the firm's revenues from its sales in market  $B$ .

arrangements that allow customers to communicate. In the setting of virtual networks, such as computer software, this interconnection could be interpreted as features that allow customers to benefit from other customers.

In each market, there is a continuum of customers ordered according to the value they place on the network service. The customer that values the service the lowest places a sufficiently low value on the service that this customer would receive a negative surplus even if all other customers purchased the network service and prices were zero. When  $\hat{q}$  customers purchase the network service, the  $q^m$ th customer in market  $m$  has a willingness to pay  $u^i(q^m, \hat{q})$  for firm  $i$ 's service and obtains a net surplus from buying from firm  $i$  at price  $p^{i,m}$  equal to  $u^i(q^m, \hat{q}) - p^{i,m}$ . For a customer not purchasing from firm  $i$ ,  $u^i(q^m, \hat{q}) = 0$ . Customers strictly prefer for more customers to be on the system of networks (reflecting positive network externalities). I assume that, all other things being equal, a customer is indifferent about which other customers are connected to networks and the networks to which these other customers are connected.

Assuming no price discrimination, each customer chooses the firm for which  $u^i(q^m, \hat{q}) - p^{i,m}$  is the greatest. I define the marginal customer to be the customer that, in equilibrium, is indifferent between buying and not buying the network service.<sup>2</sup> At equilibrium, the marginal customer will receive zero net surplus and so will have a value of  $u^i(q^m, \hat{q}) = p^{i,m}$  (Katz and Shapiro, 1985). Because output is homogenous,  $p^{i,m} = p^{j,m}$  for all  $i, j$ , so I denote the price in market  $m$  as  $p^m$ .

---

<sup>2</sup> The assumptions that  $u^i = 0$  for the lowest customer type and that marginal costs are strictly positive ensure that there are unserved customers in equilibrium.

I express the inverse demand curve in market  $m$  as  $p^m(q^m, \hat{\mathbf{q}})$  and hereafter suppress the parentheses. Marginal willingness to pay in one market increases with quantity sold in other markets because of positive network externalities, i.e.,  $p_{q^{\hat{m}}}^m > 0$  for  $m \neq \hat{m}$ . To ensure that an internal solution exists for output choices, I make the weak assumption that each firm's marginal revenue in a market declines as output increases in the market and that each firm's residual demand curve intersects its marginal cost curve from above (Dixit, 1986).

Firm  $i$  incurs fixed costs  $K^{i,m} \geq 0$  for each market  $m$  and a constant marginal cost  $c > 0$  of production, which for simplicity I assume is the same for all firms. All fixed costs are assumed to be sunk costs.<sup>3</sup>

Each firm takes its rivals' quantity choices as given when it chooses its own quantity levels. Firm  $i$ 's profit maximization problem can be written as:<sup>4</sup>

$$\begin{aligned} \max_{\mathbf{q}^i} \pi^i &= \sum_{m=A}^B ((p^m - c)q^{i,m} - K^{i,m}) \\ \text{subject to } & q^{i,m} \geq 0 \quad \text{for } m = A, B. \end{aligned} \tag{1}$$

### 3. Analysis of Cross-Market Integration

In this section I consider how firms internalize network externalities across markets. Consider two firms  $i$  and  $j$ . Firm  $j$  operates only in market  $A$ . Firm  $i$  operates in both markets. Proposition 1 provides this paper's primary result.

---

<sup>3</sup> I assume that fixed costs are sufficiently small to allow all firms in the market to receive non-negative profits.

<sup>4</sup> Firm  $i$ 's production in market  $m$  is zero if firm  $i$  does not operate in the market.

**Proposition 1.** Cross-market integration by firm  $i$  leads firm  $i$  to choose a higher output than firm  $j$ .

**Proof.** Consider how firm  $j$  would choose its optimal output. Its first order condition would be:

$$p^A + p_{q^{j,A}}^A q^{j,A} - c = 0. \quad (2)$$

The corresponding first order conditions for firm  $i$  would be:

$$p^A + p_{q^{i,A}}^A q^{i,A} + p_{q^{i,A}}^B q^{i,B} - c = 0 \quad (3)$$

and

$$p^B + p_{q^{i,B}}^B q^{i,B} + p_{q^{i,B}}^A q^{i,A} - c = 0.$$

Subtracting (2) from (3) and noting that  $0 > p_{q^{i,A}}^A = p_{q^{j,A}}^A$  gives:

$$p_{q^{i,A}}^A (q^{i,A} - q^{j,A}) = -p_{q^{i,A}}^B q^{i,B}.$$

Therefore,  $q^{i,A*} > q^{j,A*}$ .  $\square$

When firm  $i$  chooses its profit maximizing outputs, its output choice for market  $A$  reflects the marginal extra-market revenue,  $p_{q^{i,A}}^B q^{i,B}$ , which is strictly positive and represents the portion of network externalities between markets  $A$  and  $B$  that firm  $i$  internalizes when it operates in both markets. If firm  $i$  did not operate in both markets, its output in market  $A$  would create network externalities and higher profits for firms in market  $B$ , but these profits would not directly benefit firm  $i$ . Therefore, firm  $i$  would not consider these profits when choosing its output for market  $A$ . Because the marginal extra-market revenue is strictly positive, firm  $i$  chooses a higher output than firm  $j$ .

#### 4. Conclusion

In this paper, I extend Katz and Shapiro (1985) to examine how cross-market integration affects industry performance in network industries. I find that internalizing network externalities between markets may cause firms that operate in multiple markets to choose higher output than firms that operate in single markets. This implies that mergers that combine firms from different markets may improve industry performance even if the mergers decrease the number of firms in some of the markets. Examination of this issue and interconnection issues are left to other papers.

## REFERENCES

- Cr mer J., P. Rey, and J. Tirole, 2000, Connectivity in the Commercial Internet, *Journal of Industrial Economics* 48, 433-472.
- Dixit, A., 1986, Comparative Statics for Oligopoly, *International Economic Review* 27, 107-122.
- Farrell, J., and C. Shaprio, 1990a, Asset Ownership and Market Structure in Oligopoly, *RAND Journal of Economics* 21, 275-292.
- Farrell, J., and C. Shapiro, 1990b, Horizontal Mergers: An Equilibrium Analysis, *American Economic Review* 80, 107-126.
- Jamison, M. A., 2001, Restructuring in Network Industries: Competition and Mergers in Telecommunications, (Ph.D. Dissertation, University of Florida).
- Katz, M. L., and C. Shapiro, 1985, Network Externalities, Competition, and Compatibility, *American Economic Review* 75, 424-440.
- Katz, M. L., and C. Shapiro, 1994, Systems Competition and Network Effects, *Journal of Economic Perspectives* 8, 93-115.
- Salant, S. W., S. Switzer, and R. J. Reynolds, 1983, Losses from Horizontal Merger: The Effects of an Exogenous Change in Industry Structure on Cournot-Nash Equilibrium, *The Quarterly Journal of Economics* 98, 185-199.



Ungerer, Herbert, 2000, Access Issues Under EU Regulation and Antitrust Law: The Case of Telecommunications and Internet Markets, (Mimeo, Center for Information Policy Research, Harvard University).