SHARED OWNERSHIP AND PRICING IN A NETWORK SWITCH

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Abstract

We observe that many wholesale switches in ATM networks are jointly owned by their members and that this tends to occur more frequently when the wholesale industry is highly concentrated. We also observe that network switches are "natural monopolies," their costs being largely fixed and their demand exhibiting substantial network externalities. Motivated by these observations, we model the competition for members between wholesale switches and the role joint ownership can play in attracting members. The model analyzes both the adoption decision (which network a bank chooses to join) and the subsequent pricing of switch and ATM services. We compare competition between two solely owned switches with competition between one solely owned and one jointly owned switch. Our analysis shows that a more concentrated structure results under the latter and that *retail prices* are higher. This calls into question the leniency of antitrust policy toward jointly owned structures.

1. Introduction

In many financial service networks ownership of the "network switch," that is, the central device that acts as a routing, coordinating, and communicating agent to the network's members (or nodes), is shared jointly by a large number of the members of the network. Notably, 3 of the 10 largest regional shared automated teller machine (ATM) networks in the United States are operated essentially as cooperatives, while several of the remaining ones are owned by a group that generates the lion's share of the network's activity. The two largest securities depositories and settlement networks, Depository Trust Company and the Participants Trust Company, are owned by members. The two largest credit card corporations, Visa and Mastercard, are owned by member banks. In another industry, the railroad express or "fast-freight" companies of the 1850s and 60s, which handled the movement of freight across the lines of several companies, were supplanted in the late 1860s by "cooperative fast-freight lines" owned by the trunk lines themselves.[1]

The fact that many of these (wholesale) network switches are jointly owned by the downstream (retail) users of the services of the switch is a puzzle. Why would firms that compete in the product market "join forces" in the input market? The backward integration aspect of this is not unusual. There are many examples, for instance electricity generators and coal mines or paper mills and forestry, in which downstream firms own (or have long-term contracts with) upstream firms. There is also a well-known motivation, namely, the avoidance of double marginalization. But the contracting arrangement includes usually one downstream and one upstream firm, not a whole group of downstream firms jointly owning one upstream firm.

A related puzzle is the positive correlation between joint ownership and monopoly power upstream. Over the last 15 years there has been considerable consolidation in U.S. ATM networks. In 1982 there were more than 170 major regional networks in the U.S., whereas in 1993 we find only 50 of any significant size. Over the same period, the joint ownership arrangement gained popularity, and at this point many of the largest networks are jointly owned by member banks (see evidence section below). Thus, monopoly and joint ownership were correlated over time. But they are also correlated at one point in time: If we consider different regions of the country, joint ownership appears usually when the network switch is either a monopoly or has a substantial market share. The question that arises then is, what is the link between monopoly power and joint ownership?

This paper tries to address these issues by focusing on two features of network industries. The first is the vertical

1. See George Rogers Taylor and Irene D. Neu, *The American Railroad Network 1861-1890*, Harvard University Press, 1956, Chapter 8.

structure of production: firms in the downstream industry (e.g., banks) serve end-users (bank customers), and buy network (or "switch") services from upstream firms. Second, the upstream industry exhibits economies of scale on the production side, the cost of operating a switch being largely fixed. It also exhibits network externalities on the demand side. For ATM networks, these are due to economies of ubiquity; the greater the number of banks in an area that deploy affiliated ATMs, the more convenient (and more highly valued) are the services a consumer receives from the network. In the securities depositories, the more other firms that participate in a depository, the more convenient will be the settlement of trades in securities. Therefore, the upstream industry is a "natural monopoly." Of course, if monopoly power is not granted to it by a decree, it remains to be seen whether competition will lead to monopoly (or to greater concentration). It also remains to be seen what role joint ownership plays in the monopolization process.

In addition to these questions, this paper considers the exploitation of monopoly power, a policy concern of the antitrust authorities. Historically it was felt that joint ownership would come in response to monopoly pricing of switch services and that it would lower their prices.[2] As Charles Rule (1985), then acting assistant attorney general for the antitrust division of the Department of Justice, put it: "the likelihood of the direct exercise of market power in interbank switching... is lessened to the extent that ownership and control of the system is more diffuse, and to the extent that the system is operated on a not-for-profit basis. Indeed, the incentive to exercise monopoly power is substantially reduced if the proportions of equity ownership of system participants approximate their respective shares of system usage." Thus, it was felt that joint ownership was already an institution that coped with the monopoly pricing problem and that further supervision was unnecessary. This sentiment guided the antitrust authorities in their evaluation of ATM networks, inducing lenient antitrust policy. Our analysis calls into question this logic.

We will address these issues in a model of network creation and subsequent pricing of both switch services and ATM services. The essence of the model is to compare concentration and pricing under two solely owned switches vs. one

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2.In an early analysis of the industry, Rule (1985) suggested that large retail banks resist joining systems owned by rivals because of concerns that the owners will exploit their market power against the non-owners. However, switches need not be owned by rivals in the same market. Several ATM switches are owned by data processing firms, for example. Some ATM networks span several local banking markets, so that, even if the switch is owned by banks, it need not be owned by in-market rivals. Nonetheless, fear of monopolization by a network switch might be a valid concern of potential members, whether or not the owner is a rival. One hypothesis that might then be advanced (and that Rule seems to suggest) is that joint ownership creates an incentive to refrain from exploiting monopoly power, thereby enhancing the ability of such a network to attract membership. This would tend to create an advantage for the joint ownership structure, which might then prevail in competition with a solely owned alterative.

solely owned and one jointly owned switch. This approach is motivated by the fact that in most regions there are not more than two competing switches and that they are organized either as solely owned ventures (e.g., by a data processing firm or one of the region's largest banks), or as a joint venture with regional banks having ownership shares[3].

We show that for a given level of concentration, the exercise of monopoly power over *retail customers* is the same. More interestingly, we show that the upstream industry is more concentrated under one joint ownership switch and that the resultant retail pricing is more monopolistic. These results are the theoretical counterpart of the positive correlation between network monopoly structure and joint ownership, and they provide a basis for policy evaluation.

The remainder of the paper is organized as follows. In the next section we present cursory evidence of the evolution of the ATM industry, the degree of concentration across different regions of the U.S., and the extent of joint ownership. In section 3 we lay out the model and derive the results. Section 4 concludes.

2. The Extent of Shared Ownership and Market Control in Regional ATM Networks

Here we discuss evidence, presented in Appendix 1, on the extent of "shared ownership" of regional ATM networks in the U.S. First, we point out that there has been a reduction in the number of networks that were owned by a single bank or by a nonbank corporation over time. Next, using data for 1993, we conclude that shared ownership is common for the nation's largest regional ATM networks.[4]

The regional ATM networks sometimes started in a single city (for example, the MAC system in Philadelphia), and in other cases were started across a region (as in the case of the Pulse system in Texas). Most of these networks are the sole regional network in some of the local markets they serve (typically, the national networks are higher cost alternatives for the banks). The larger the network is in number of transactions, the more likely it is to be the dominant system in its local markets.

The decline of solely owned networks is especially noticeable among those ranked as the largest regional networks,

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3.In the model joint ownership is treated as a network switch which reverts all its profits to its users, i.e., to member banks. More generally, joint ownership includes the possibility of a network switch owned (at least partially) by non-(downstream) market participants, although that case is less relevant from an empirical standpoint.

4.Shared ownership is a qualitative concept, and so we will examine the three criteria advanced by Charles Rule, discussed in the introduction: the diffusion of ownership shares by retail member banks, the non-profit structure of the network and finally, if ownership is concentrated, the extent to which a large share of system usage is generated by the owners and their customers.

declining from 5 of the top 10 in 1982, to none of the top 10 in 1993. This increasing predominance of multiple owners is even more pronounced because of the steady consolidation of transactions in the largest networks. In 1982 the top 10 networks had a market share of 10 percent of all ATM regional network transactions, while in 1993 the top 10 had a market share of 80 percent. Hence, over time a decreasing share of the total ATM transactions in the U.S. has been conducted in solely owned networks.

Next we directly focus on the extent of joint ownership among the largest regional ATM networks in 1993.[5] Of the largest 10 regional ATM networks, which had an 80 percent share of ATM network transactions in 1993, 3 are not-for-profit, essentially cooperatives. Of the remaining 7 for-profit networks, 3 have diffuse ownership shares, and we judge that in the remaining 4 networks, the owners' shares of system usage is significant in 3 of them. All are owned as joint ventures of retail members.

Of the ATM networks ranked from 11 through 20, through which 14 percent of ATM network transactions were conducted, 3 are owned by nonbanks, 3 are owned by single member banks, 1 is owned by a group of only three member banks, and the remaining 3 are owned by a diffuse group of owners. Of the ATM networks ranked from 21 through 50 (through which 6 percent of ATM network transactions were conducted), 5 are owned by nonbanks, 14 by single bank members, 2 by a few banks, and 9 by a large group of banks (in 8 out of those 9 by all members).

To summarize, we first observe that there are several possible outcomes: ownership by a nonbank or by a single bank, as well as by a large group of banks (possibly all banks, as in a not-for-profit). Second, the frequency of ownership as a not-for-profit or as a diffusely owned joint venture is high and has grown through time, especially among the largest networks. Finally, the data suggest that the larger and more dominant ATM networks are more likely to be owned as a joint venture of a large set of members than are the smaller and less dominant ATM networks. This suggests that the markets that are most concentrated (those served by the largest networks) are more likely to be served by shared owner networks. In other words, shared ownership is associated with higher concentration of the market.

3. Model Formulation

3.a. Overview

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5. The *Bank Network News* identified only 50 regional shared networks in the U.S. in 1993, down from more than 170 in 1986 (McAndrews, 1991). Only 0.7 percent as many transactions were conducted in the smallest network identified as compared with the largest one.

We consider two-tier competition in a network industry. There are two upstream firms and n downstream firms. For concreteness we refer to upstream firms as 'switches' (or wholesalers or networks) and to downstream firms as 'banks' (or retailers). Banks sell ATM services to consumers and buy switch services (needed to execute ATM transactions) from wholesalers. At each level all firms are identical and produce a homogeneous service.

We consider short-run and long-run competition. In the short run banks have committed to a switch, take the price of the switch service as given, and compete in quantities. The equilibrium of this game induces a demand curve for switch services, and switches compete in quantities under this demand curve. This two-tier competition determines prices, quantities, and short-run equilibrium profits. In the long run banks will move from a switch with low profits (for the bank) to one with high profits; if profit opportunities in the two switches are the same, no bank will move. This determines how banks are divided between switches in the long run. We show this division for different ownership structures: first, for two solely owned switches, which maximize their own profits; then for one jointly owned switch and one solely owned switch; the jointly owned switch maximizes profits of member banks.[6]

3.b. Consumers

Consumer demand for the end product (ATM services) is modelled as in Katz and Shapiro (1985). Let k and n-k be the number of banks in network 1 and 2, respectively. These numbers are fixed in the short run and are referred to as the industry configuration. Each consumer buys either zero or one unit of the service. Consumers are heterogeneous with respect to their willingness to pay. A type r consumer is willing to pay $r + v(x)$, where r is the 'stand alone' value and $v(x)$ is the network value with $x=k$ or $n-k$. Therefore, the network value that a consumer gets depends on how many banks belong to the same network that his bank is in.[7] We normalize r and v so that $v(0)=0$, and assume $v' \geq 0 \geq v''$. r is uniformly distributed in the population with density = 1 and support $(-\infty, A)$; $A > 0$. Consumers buy the service from the bank that gives them the highest surplus, provided that that surplus is positive; otherwise they don't buy. Thus, a consumer's decision is $\max \{0, r + v(k) - p_i(k), r + v(n-k) - p_j(n-k)\}$, where $p_i(x)$ is the retail price charged by bank i, which belongs to a network serving x banks.

If all banks sell positive quantities, we must have equality of retail prices within a network and equality of quality-

6.The case of two jointly owned switches is not empirically relevant for the ATM industry. It is relevant, however, in the credit card industry, since both Visa and Mastercard are jointly owned by member banks.

7.This reflects the fact that the consumer typically cannot use the machine of a network in which her bank does not participate. The larger the number of banks in her bank's network, the less search a consumer must engage in to find a network-affiliated machine.

adjusted prices across networks (because the service is homogeneous). Let p(x) be the common retail price for a network with x members, and let ϕ be the common *hedonic* (or quality-adjusted) price, defined as:

$$\phi \equiv p(k) - v(k) = p(n-k) - v(n-k).$$

Only consumers with $r \geq \phi$ buy a unit of the service. Hence, if banks produce an aggregate quantity of $Q = \sum q_i$, the hedonic price must be $\phi = A-Q$, while individual prices are $p(x) = A+v(x)-Q$, $x = k, n-k$. This determines the demand that banks face. We next show how banks compete under this demand curve.

3.c. Competition at the retail level

Banks use switch services to produce ATM services. We normalize units so that one unit of switch services produces one unit of ATM services, and assume that this is the only variable input that a bank uses. The unit cost of using a switch with x member banks is s(x), which banks take as given. Banks compete in a Cournot fashion with profit functions given by:

$$\pi_i(q;x,s) = q_i[A+v(x)-Q-s(x)], \text{ where } q = (q_1, q_2, ..., q_n) \text{ and } s = (s(x), s(n-x)).$$

The Cournot-Nash equilibrium of this game is:

$$q(x) = 1/(n+1)\{A+(n+1-x)[v(x)-s(x)]-(n-x)[v(n-x)-s(n-x)]\},\ x=k, n-k, \qquad (1)$$

and the equilibrium profit of each bank is:

$$\pi(x) = [q(x)]^2 \qquad (1a)$$

(We suppress bank indices, since the equilibrium is symmetric with all banks in a network earning the same profit.)

3.d. Competition at the wholesale level

Given how banks compete downstream, we can determine a derived demand for switch services upstream. This is done by inverting equation (1), and expressing the demand price that each switch faces as a function of the quantities it and its rival supply[8]:

$$s(x) = A+v(x)-(n-x)q(n-x)-(x+1)q(x). \qquad (2)$$

Now we can analyze Cournot competition between the switches, assuming that switches incur only fixed costs. The strategic variable of a switch with x member banks is xq(x), i.e., the switch decides on the aggregate quantity to sell to banks that use it. We consider two games.

(A) Two solely owned switches:

Here we can write the objective function (net of fixed costs) of a switch with x members as

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8The quantity that switch i supplies to x member banks is xq(x).

$\sigma(x) = xq(x)s(x)$, where $s(x)$ is as in (2); (3)

After some computations, which are worked out in the appendix, it can be shown that the Cournot-Nash equilibrium of this game is:

$$q^*(x) = \frac{2(n-x+1)(A+v(x))-(n-x)(A+v(n-x))}{\Delta}, \tag{4}$$

where $\Delta \equiv 4(x+1)(n-x+1)-x(n-x)$.

The equilibrium profit of each bank is $\pi^*(x) = [q^*(x)]^2$.

(B) One solely owned switch and one jointly owned switch.

Assume switch 1 is owned by member banks, with the objective of maximizing each bank's profits.[9] Then we can write its objective function as

$\sigma_J(x) = (\sigma(x)/x)+\pi(x) = q(x)[A+v(x)-xq(x)-(n-x)q(n-x)]$, where σ comes from (3), and π from (1a).

The objective function of switch 2 remains as in (3) (with $x = n-k$). The Cournot-Nash equilibrium of this game is:

$$q_J^*(x) = \frac{2(n+1-x)(A+v(x))-(n-x)(A+v(n-x))}{\Delta'}, \tag{5}$$

$$q_J^*(n-x) = \frac{2x(A+v(n-x))-x(A+v(x))}{\Delta'}.$$

where $\Delta' \equiv x(3n-3x+4)$.

The equilibrium profit of banks in the solely owned switch is still $\pi^*(n-x) = [q_J^*(n-x)]^2$, whereas the equilibrium profit of banks in the jointly owned switch *exceeds* $[q_J^*(x)]^2$ (as they receive a pro rata share of the switch profit)

3.e. Long-run equilibrium

To this point we took the number of banks belonging to each switch as fixed and given. Now we consider the long-run outcome as banks switch from the low profit network to the high profit one. To analyze this situation in the simplest possible way we let the number of banks be a continuous (rather than integer) variable, and let banks in network 1 switch

9. We have shown that the paper's results remain intact if jointly owned switches allocate their fixed costs among members instead of maximizing representative members' profits.

to network 2 if $\pi^*(n-x)>\pi^*(x)$,[10] and vice versa if $\pi^*(n-x)<\pi^*(x)$. The incentive to switch is illustrated in figure 1, which shows the payoff that banks receive as a function of the network sizes. This generates a participation game, the equilibrium of which is defined as follows.

Definition: (i) $(x^*, n-x^*)$ is a long-run equilibrium configuration if $\pi^*(x^*)=\pi^*(n-x^*)$.

(ii) An equilibrium, x^*, is stable if there exists a neighborhood, N, of x^* so that $\pi^*(x) > \pi^*(n-x)$ for $x < x^*$ and $\pi^*(x) < \pi^*(n-x)$ for $x > x^*$, $x \in N$ (i.e., the curve $\pi^*(x)$ intersects $\pi^*(n-x)$ from above).

Therefore, the defining property of a long-run equilibrium is that banks are indifferent between networks, so they have no incentive to switch. An equilibrium is *stable* if, starting from a nearby configuration, it can be attained over time as banks switch from the low profit network to the high profit one. This concept is illustrated in figure 1, which shows both stable and unstable equilibria. The figure also shows that there may very well be *multiple stable* equilibria (which is further illustrated in the example below). The restriction to *nearby* configurations is needed because of the multiplicity of equilibria.

Next, we compare equilibria under two sole ownerships vs. one sole and one joint ownership, games A and B above. Since, as was just stated, there may be multiple equilibria in either game, we introduce a set-theoretic comparison.

Proposition 1: There exists a $\bar{k} < (n/2)$, so that any stable, sole-ownership equilibrium, x^*, with $x^* > \bar{k}$ can be paired with a joint-ownership equilibrium, $x^{**}>x^*$. Therefore, the effect of creating joint ownership is to increase the size of the network that operates as a joint ownership, as compared to its size when it was operated as a sole-ownership network.

The idea of the proof is to compare profits of banks under two solely owned networks ("before") with their profits under one solely owned and one jointly owned network ("after"). We show that the profits of banks in the jointly owned network increase while the profit of banks in the solely owned network decrease. This raises the attractiveness of the jointly owned network, which is the reason it increases its size. The reader should consult figure 2, which shows how banks' profit curves change as a result of creating a joint ownership structure, and what effect this has on the equilibrium.

Proof: First, considering expressions (4) and (5), it can be verified that $q^*_j(x) > q^*(x)$. Thus, for a given network size the profits of banks in the jointly owned network are increased. Second, we show in the appendix that the profits of banks in the solely owned network are decreased if

$2(n-k)[A+v(n-k)] < 4(n-k+1)[A+v(k)]$. But this inequality holds if $k = (n/2)$ and, therefore, if $k > \bar{k}$ for some $\bar{k} < (n/2)$.

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10. This reflects the myopic expectation that the payoff in the network banks switch into will remain higher also in the future. If the number of banks switching alliances in a period is sufficiently small (e.g., because contracts between banks and networks are staggered, only a small number of them coming up for renewal in any period), the system will converge to a long-run equilibrium without oscillations, which makes this expectation self-confirming.

The claim now follows from the fact that banks' profit curves are affected in this way and from the stability of the initial equilibrium (see figure 2). ■

As indicated above, this result shows that if the initial size of the network is above some cutoff point, it will gain market share–once it is organized as a jointly owned network. Furthermore, this cutoff point, $\bar{k}$, is below n/2, so the range of initial conditions that raises the market share of the jointly owned network is larger than the range that raises profits of the solely owned network (if any). Therefore, starting from an arbitrary initial condition, an increase in the market share of the jointly owned network is more likely than a decrease. This result is the theoretical counterpart of the empirical evidence we documented earlier, namely, the fact that network consolidation is positively associated with the number of networks that are jointly owned.

3.f. Policy implications and welfare

Next we consider the policy implications of this model. One policy concern about the ATM industry is that consolidation of networks would lead to monopolistic distortions due to the monopoly pricing of their services. An opposing view is that many consolidated networks are *jointly* owned by member banks, resulting in maximization of their members' objectives, monopolistic pricing not being an issue. As outlined by Rule (1985), and discussed above, the antitrust policy of the U.S. Department of Justice has favored the second view.

The model presented here makes two points relevant to this debate. First, the fact that a network is jointly owned is not a reason for monopoly power not to be exercised. To the contrary, we have the following corollary to Proposition 1:

Corollary: The jointly owned network of all n banks produces the monopoly output, and the consumers of the network members' services pay the monopoly price.

Proof: The proof of the corollary can be seen from examination of expression (5): $nq^*_J(n)=(A+v(n))/2$. That is, the jointly owned network produces the monopoly quantity. ■

Thus, while the jointly owned network has no incentive to extract monopoly rents from its ***member banks***, it has both the incentive and the capability (through pricing of switch services) to extract monopoly rents from *final consumers*. In effect, joint ownership acts here as a mechanism to monopolize the industry by 'delegating' the exercise of monopoly power to the upstream network and distributing the resulting profit through shared ownership. The argument against monopoly power confines attention to the upstream industry, which ignores the downstream industry and the fact that

monopoly power can be manifested at that level.[11] So joint ownership--by itself--is not a reason for monopoly power not to be exercised, only that monopoly rents are realized by different firms.

Notwithstanding this, upstream consolidation accompanied by joint ownership may still be (socially) beneficial because it realizes greater network benefits. Consider an initial situation where the upstream industry is in a symmetric duopoly equilibrium. Then, let one of the networks form a joint ownership structure, resulting in an upstream monopoly. The benefit from this is that fixed costs are saved (economies of scale on the supply side) and that consumers enjoy higher network benefit, since they are now connected to one grand network. The cost, on the other hand, is monopoly pricing and underconsumption of ATM services. Given this tradeoff, the next result delineates the conditions under which consolidation delivers a net benefit.

Proposition 2: Welfare under upstream monopoly and joint ownership exceeds welfare under upstream duopoly and sole ownership if

$$F > \frac{4[A+v(n/2)]^2 n(n+2)}{(3n+4)^2} - \frac{3}{8}[A+v(n/2)]^2$$

Proof: Since we have only fixed costs, we have to compare the cost savings (F) with the loss (if any) in consumers' gross benefit.

From equation (5), we see that total quantity under joint ownership monopoly is (A+v(n))/2. Therefore, given a linear demand curve with a price intercept of A+v(n), consumers' gross benefit is $(3/8)(A+v(n))^2$. Next, total duopoly quantity under sole ownership is determined by (4):

$$Q_d = nq^*(n/2) = \frac{2(\frac{n^2}{2}+n)[A+v(n/2)] - \frac{n^2}{2}[A+v(n/2)]}{4(\frac{n}{2}+1)^2-(\frac{n}{2})^2} = \frac{[A+v(n/2)][\frac{n^2}{2}+2n]}{4(\frac{n}{2}+1)^2-(\frac{n}{2})^2}$$

Or, after some simplifications, $$Q_d = \frac{2[A+v(n/2)]n}{3n+4}.$$

Therefore, given a linear duopoly demand with price intercept of A+v(n/2), consumers' gross benefit under duopoly is

11. Another way to make the point is that the outcome here is almost identical to the outcome under a solely owned monopoly:
$q^*(n)=(A+v(n))/2(n+1)=(A+v(n))/2n=q^*_i(n)$, the only difference being in how profits are divided between the switch and the banks.

$$A + v(n/2)]Q_d + Q_d^2/2.$$

Which, after substitution for Q_d, gives us $$\frac{4[A + v(n/2)]^2 n(n+2)}{(3n+4)^2}$$

Therefore, subtracting the monopoly gross surplus from the duopoly gross surplus gives us the result. ■

Finally, we illustrate our results using a linear network benefit function: $v(x)=v_0x$, v_0 being a positive constant. Consider two solely owned networks first. Then for $x<(n/2)$, we have $q^*(x) > q^*(n-x)$ (equivalent to $\pi^*(x) > \pi^*(n-x)$) if and only if $2(n-x+1)(A+v_0x)-(n-x)(A+v_0(n-x)) > 2(x+1)(A+v_0(n-x)) -x(A+v_0x)$, which is equivalent to $(A/v_0) > (n+2)$. This inequality shows how the dynamics of network sizes evolves over time. We distinguish between 2 cases.

Case S (i): $(A/v_0) > (n+2)$ (weak network externality case). Here we have a unique, stable long-run equilibrium with the two networks splitting the market equally ($x^* = (n/2)$).

Case S (ii): $(A/v_0) < (n+2)$ (strong network externality case). Here we have two stable long-run equilibria: $x^* = 0$, and $x^* = n$, i.e., a monopoly structure upstream.

The distinction between the two cases is that when the network externality is stronger (a large v_0), the network benefit more than offsets the monopoly distortion, so a monopoly structure arises in the long-run; otherwise, we get a duopoly structure.

Next, consider one jointly owned and one solely owned network. Then, $q_J^*(x) > q_J^*(n-x)$ (approximating $\pi_J^*(x) > \pi_J^*(n-x)$) if and only if $2(n-x+1)(A+v_0x)-(n-x)(A+v_0(n-x)) > 2x(A+v_0(n-x)) -x(A+v_0x))$. But this holds if and only if $2x[v_0(n+1)-A] > v_0n^2-A(n+2)$. Now we have to distinguish between three cases.

Case J (i): $v_0n^2-A(n+2) > 0$. Then, we also have $v_0(n+1)-A > 0$. Thus, $q_J^*(x) > q_J^*(n-x)$ for $x > \frac{v_0n^2-A(n+2)}{2[v_0(n+1)-A]} = \bar{k}$. Here we obtain two monopoly equilibria with $x^*=0$ and $x^*=n$, although the $x^*=n$ is more likely owing to the fact that $\bar{k}<n/2$.

Case J (ii): $v_0n^2-A(n+2)<0<v_0(n+1)-A$. Then, $q_J^*(x)>q_J^*(n-x)$ for all $x>0$. Thus, only the joint ownership monopoly equilibrium exists.

Case J (iii): $v_0(n+1)-A < 0$. This implies $v_0n^2-A(n+2) < 0$ as well. Thus, $q_J^*(x) > q_J^*(n-x)$ for

$$x > \frac{v_0n^2-A(n+2)}{2[v_0(n+1)-A]} = \bar{k}.$$

Therefore, we obtain an asymmetric duopoly equilibrium, the jointly owned network being larger than the solely owned

network (note that $\bar{k} > (n/2)$ in this case). Comparing these two situations provides an illustration of proposition 1: for any sole ownership equilibrium, there exists a joint ownership equilibrium that gives the jointly owned network a larger market share.[12]

4. Conclusion

In the model we've examined, the reason joint ownership of a network switch occurs is twofold. First, the joint ownership of the wholesale switch eliminates a double margin as in a standard vertical integration story (but with a demand side economy of scale being the reason for monopoly of the wholesale sector rather than a cost side reason). Second, in addition to the elimination of the double margin, joint ownership results in more concentrated markets, in which the network externality is more fully exploited. That is, the introduction of the joint ownership changes the structure of the upstream industries as well as changing the prices. This is a novel reason to backward integrate.

The jointly owned networks possess an advantage over solely owned networks in that they achieve critical mass with a smaller membership. This theoretical result helps explain the data on the prevalence of joint ownership in ATM networks. Both jointly owned and solely owned networks exist, which is also consistent with the implications of the model. However, the result that jointly owned networks lead to more concentrated markets is further supported in the data that show that jointly owned networks are more prevalent among the larger ATM systems--those that face less competition in their market area.

Our analysis calls into question the view that joint ownership is a benign structure that limits any antitrust concerns. That view focuses on one level of the vertical structure, namely transactions between networks and banks (i.e., the "upstream level"). Although joint ownership may align the objectives of networks and banks, there is nothing in it to guarantee that *consumers'* objectives have any representation. In fact our results show that joint ownership may very well lead to monopoly pricing at the *downstream* level. Therefore, far from alleviating the exercise of monopoly power, this arrangement is a mechanism for achieving it. Nonetheless, because of the presence of network externalities and economies of scale, a monopoly structure may be better in the end. Thus, the policy implication here is that the presence of monopoly power should not be dismissed at the outset, nor judged illegal per se. Instead, a rule of reason with focus on network benefits vs. monopoly pricing *downstream* is more relevant in network industries.

12.Proposition 2 cannot be illustrated here, since when a duopoly equilibrium obtains under sole ownership, a duopoly equilibrium also obtains (uniquely) under joint ownership.

Our view of how the joint ownership outcome occurs is not that it occurs as a cooperative necessarily, but rather that a joint ownership "constitution" is introduced into the market, and any firm that wants to join can do so individually. The introduction of the constitution would be in any individual firm's interest. Therefore, the joint ownership structure may arise from the action of an "outsider" who sells ownership shares to insiders , or from the actions of insiders (banks) who form a cooperative. Either way, the profit incentive are such that the joint ownership structure is viable.

While joint ownership can achieve the gains of the large network without the profit reduction of the monopoly provision of the switch services, there are costs to joint ownership as well. First, the costs of decision-making in a jointly owned facility are likely to be higher than in a solely owned one. Second, the costs of raising capital are likely to be higher as well. Hence, quickly adapting to technical changes that require large capital investments might be more problematic for a jointly owned switch, offsetting the benefits of the lower static prices. Because this issue concerns technical change, and our point is more easily made in the case of the fixed technology model we use, we do not address this aspect of joint ownership. The aim of this paper is to provide an explanation for the prevalence of joint ownership of wholesale network switch service provision.

The model we've examined shows that the joint ownership structure does not allay concerns about monopoly markups. Indeed, the monopoly equilibrium of the jointly owned network produces the same output as the solely owned network. Hence the antitrust authorities should be equally vigilant in examining the exercise of monopoly power by ATM networks, whether solely or jointly owned.

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APPENDIX 1

The Extent of Shared Ownership and Market Control in Regional ATM Networks

Here we present the evidence on the extent of "shared ownership" of regional ATM networks that was discussed in section 2.

Our focus is on the regional shared ATM networks. The national ATM networks, including Cirrus and Plus, are relatively small by comparison, at least in the business of domestic ATM transactions. The national networks in 1993 switched about 50 million transactions a month vs. 652 million transactions a month for the regional ATM networks.

The first table shown documents the decline in the number of networks that were listed as owned by a nonbank corporation or by a single bank or bank holding company in the issues of the EFT Network Databook for the years 1982-1993.

NUMBER OF NETWORKS OWNED BY A NONBANK CORPORATION OR BY A SINGLE BANK BY NETWORK SIZE RANKING: CUMULATIVE TOTAL

YEAR	TOP 10	TOP 20	TOP 30	TOP 40	TOP 50
1982	5	12	20	30	38
1983	5	13	18	25	32
1984	3	10	17	24	32
1985	2	7	15	21	28
1986	1	9	15	20	27
1987	1	8	12	19	27
1988	1	6	12	17	24
1989	2	7	11	18	25
1990	1	7	12	18	25
1991	1	7	13	18	25
1992	1	7	12	18	26
1993	0	6	10	19	25

Next we directly focus on the extent of joint ownership among regional ATM networks in 1993.[13] As discussed earlier, we focus on three criteria for examining the degree to which ownership and control of the wholesale organization

13.The *Bank Network News* identified only 50 regional shared networks in the U.S. in 1993, down from more than 170 in 1986 (McAndrews, 1991). Only 0.7 percent as many transactions were conducted in the smallest network identified as compared with the largest one.

is shared: the diffusion of ownership shares by retail member banks, the non-profit structure of the network and finally, if ownership is concentrated, the extent to which a large share of system usage is generated by the owners and their customers.

The following tables categorize the ownership of regional shared ATM networks in the U.S. using data for 1993 found in *Bank Network News*, Vol. 12, No. 13, and using its ranking of the transaction volumes of the networks. Personal interviews with the management of the top 10 networks were conducted in December of 1993 to determine if they were not-for-profit, and to determine the share of switch volume generated by the owners. The final column of the table includes both those networks with diffuse ownership and those whose owners contribute a substanstial share of the system usage. In particular, while the number of owners for NYCE, MAGIC LINE, and MONEY STATION (each with seven owners) might arguably be placed in the concentrated owner category, information provided by those networks reveals that they satisfy Rule's third criterion for "joint ownership," that is, the proportions of equity ownership of system participants approximate their respective shares of system usage. The share of system usage generated by the owners of MONEY STATION is approximately 85 percent. For MAGIC LINE the owners' usage share is "significant." Finally, in 1993, the owners of NYCE issued 34 percent of the system's bankcards; if usage is proportional to cardholders, then NYCE owners contribute 34 percent of the system usage.

OWNERSHIP OF TOP 10 REGIONAL ATM NETWORKS

NON-BANK OWNER	SINGLE BANK OWNER	CONCENTRATED BANK OWNERS (NUMBER OF OWNERS IN PARENTHESES)	DIFFUSE BANK OWNERSHIP (NUMBER OF OWNERS IN PARENTHESES)
NONE	NONE	MAC (4)	STAR (17, not-for-profit) NYCE (7) HONOR (27 ownership capped at 15 percent) MOST (26) PULSE (1,489, not-for-profit) ACCEL/EXCHANGE (32) YANKEE (9, not-for-profit) MAGIC LINE(7) MONEY STATION (7)
0	0	1	9

OWNERSHIP OF REGIONAL ATM NETWORKS RANKED 11 THROUGH 20

NON-BANK OWNER	SINGLE BANK OWNER	CONCENTRATED BANK OWNERS (NUMBER OF OWNERS IN PARENTHESES)	DIFFUSE BANK OWNERSHIP (NUMBER OF OWNERS IN PARENTHESES)
MPACT PRESTO MONEYMAKER	NETWORK ONE XPRESS24 JEANIE	BANKMATE (3)	CASH STATION (252) SHAZAM (all Iowa members) GULFNET (22)
3	3	1	3

OWNERSHIP OF REGIONAL ATM NETWORKS RANKED 21 THROUGH 50

NON-BANK OWNER	SINGLE BANK OWNER	CONCENTRATED BANK OWNERS (NUMBER OF OWNERS IN PARENTHESES)	DIFFUSE BANK OWNERSHIP (NUMBER OF OWNERS IN PARENTHESES)
SCS INSTANT TELLER FLSERV SHARED HANDIBANK CREDIT UNION 24	INSTANT CASH FASTBANK ROCKY MOUNTAIN EXPRESS TELLER MONEY BELT TRANSFUND BANK OF HAWAII 7/24 NETWORK VIA BANKMATE TELLERIFIC EXPRESS MONEY NETWORK CHECOKARD	QUEST (7) ALERT (9)	TYME (486, all) NETWORKS (478, all) THE CO-OP (210, all) EFT ILLINOIS (247, all) TX (24) SC 24 (115, all) CACTUS NETWORK (48, all) ALASKA OPTION (8) KETS (69, all)
5	14	2	9

APPENDIX 2

Here we show how the Cournot quatities are determined under a solely-owned structure (equations (4) and (5), section 3.d.) First of all let us denote the strategic variable of the switches by Q^k=kq(k) and Q^{n-k}=(n-k)q(n-k) respectively. Then, substituting (2) into (3) and using the new notation, the objective functions of the switches are:

$$Q^k[A+v(k)-Q^{n-k}-\frac{(k+1)}{k}Q^k] \quad \text{and} \quad Q^{n-k}[A+v(n-k)-Q^k\frac{(n+1-k)}{(n-k)}Q^{n-k}]$$

Now we can differentiate these equations with respect to the strategic variables Q^k and Q^{n-k} and equate the derivatives to zero. This gives us

$$A+v(k)-Q^{n-k}-2\frac{(k+1)}{k}Q^k=0 \quad \text{and} \quad A+v(n-k)-Q^k-2\frac{(n+1-k)}{n-k}Q^{n-k}=0.$$

But these are two linear equations in two unknowns, Q^k and Q^{n-k}, which can be readily solved. Then, using the definitions of Q^k and Q^{n-k}, we obtain q(k) (=Q^k /k) and q(n-k) (=Q^{n-k}/n-k).

The same exercise can be repeated to obtain equation (5) in the text.

APPENDIX 3

In this appendix we show in which market structures, (k, n-k), the profits of banks in a solely owned network will decrease when the other network becomes jointly owned (proposition 1), i.e., for which $q^*(n-k) < q_j^*(n-k)$. From (4) and (5) this will be the case when:

$$\frac{2k(A+v(n-k)) - k(A+v(k))}{k(3n-3k+4)} < \frac{2(k+1)(A+v(n-k))-k(A+v(k))}{4(k+1)(n-k+1)-k(n-k)}$$

Presuming both numerators are positive this is equivalent to:

$[4(k+1)(n-k+1)-k(n-k)][k(n-k)][2k(A+v(n-k))-k(A+v(k))]$

$< k(3n-3k+4)[2(k+1)(A+v(n-k))-k(A+v(k))]$

and to

$[A+v(n-k)]\{2k[4(k+1)(n-k+1)-k(n-k)]-2(k+1)k(3n-3k+4)\} <$

$[A+v(k)]\{k[4(k+1)(n-k+1)-k(n-k)]-k^2(3n3k+4)\}$

Or,

$[A+v(n-k)\}k\{8(k+1)-(n-k+1)-2k(n-k)-2(k+1)(3n-3k+4)\} <$

$k[A+v(k)]\{4(k+1)(n-k+1)-k(n-k)-k(3n-3k+1)\}$

But the RHS is equal to

$k[A+v(k)]\{4(k+1)(n-k+1)-k(4n-4k+4)\}$

$k[A+v(k)]\{4(n-k+1)[k+1-k]\} = k[A+v(k)]4(n-k+1)$,

while the LHS is equal to

$(A+v(n-k)]\{(k+1)[8n-8k+8-6n+6k-8]-2k(n-k)\}$

$[A+v(n-k)]\{(k+1)2(n-k)-2k(n-k)\}$

$= 2(n-k)[A+v(n-k)]$.

Therefore, $q^*(n-k) < q_j^*(n-k)$ for all k's for which $2(n-k)[A+v(n-k)] < 4(n-k+1)[A+v(k)]$, which is the expression used in the text.