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RESULTS OF A SURVEY OF ATM NETWORK PRICING

by

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ABSTRACT

This paper presents the results of a survey of large automated teller machine networks undertaken in 1989 and 1990. The networks were asked to provide information on fees, membership, and governance. The responses to the pricing requests was the most complete. The survey reveals a significant variation in both membership fees and switch fees, with both fees often varying according to size of the participating member. Using other published data some simple economic relationships are estimated. They suggest that in 1990 there was a substantial complementarity between ATM and ATM-cards in producing ATM transactions, that there were economies of scale in networks, and that the ATM elasticity of demand was relatively large.

1. INTRODUCTION

In September and October of 1990, with follow-up through April 1991, a survey of the 20 largest regional automated teller machine (ATM) networks and the four largest national networks was conducted.[1] The survey solicited information on the networks' interchange and switch pricing and its governance structure and membership. This information is not collected on a regular basis by any governmental agency. The responses to the pricing requests was the most complete.

The survey reveals a significant variation in both membership fees and switch fees, with both fees often varying according to size of the participating member. The publication Bank Network News has done periodic surveys on switch and interchange pricing of ATM networks. Using that data some simple economic relationships are estimated. They suggest that in 1990 there was a substantial complementarity between ATM and ATM-cards in producing ATM transactions, that there were economies of scale in networks, and that the ATM elasticity of demand was relatively large.

ATM networks allow depositors of member banks to access their accounts from any network-affiliated machine by using an ATM card.[2] The network links banks' ATM machines to a central switch that routes a transaction from the machine used by a cardholder to the cardholder's bank. If a cardholder uses a machine owned by her own bank, the transaction is not necessarily routed through the network's central switch. Rather, such a transaction, an on-us transaction, usually is processed wholly within the cardholder's bank. If the cardholder uses a machine not owned by her own bank, then the transaction, an interchange transaction, is routed through the network switch. Two network-wide fees are charged in connection with an interchange transaction. First, the network charges a switch fee for each transaction that travels through the

network switch. Second, the network determines an interchange fee that the cardholder's bank pays to the bank that owned the ATM machine accessed by the customer.

The network does not determine consumer fees. The fees charged to an ATM user are determined by the bank that issued the ATM card to the customer. Banks often offer their customers a menu of deposit account options, some of which may explicitly charge the customer for each ATM transaction, while other options may bundle a variety of depository services into one monthly fee.

In addition to the transaction-based fees, ATM networks assess membership fees. These fees can be joining fees, charged upon joining the network, or periodic fees, charged regularly to the member banks.

ATM networks are often owned by a large subset of their member-participants and may be organized on either a for-profit or a not-for-profit basis. Even if not owned by a large group of members, a network's board of directors may be elected by the whole membership rather than by the owners of the network.

The survey collected information on switch and interchange fees, switch fees and membership fees, and the governance of the network. The paper is organized as follows: section 2 presents a short discussion of the economics of ATM networks; section 3 presents the survey results; section 4 presents analysis of the results; and section 5 concludes.

2. ATM NETWORKS

ATM networks link together many banks and their ATMs through an electronic communication network serviced by a central computerized network switch. On the cost side, the network switch may be thought of as an indivisible resource that generates economies of scale. Even relatively small

computers possess the capacity to process large numbers of transactions. On the demand side, ATM networks generate network externalities. Network externalities are present whenever the installed base of existing users of a product value the product more highly as new users adopt it. The new users confer an externality on the existing users. In ATM networks the existing depositors of a network-member bank value the network more highly when a new bank joins the network, bringing into the network ATMs at new locations. The existing network users value more highly a more geographically dispersed set of ATMs from which they may access their bank accounts.

Saloner and Shepard (1991) have measured the presence of network effects in the proprietary (single-bank) ATM networks of the 1970s. Two open questions are how valuable to depositors the network externalities in ATM networks are and how extensive they are geographically. While Saloner and Shepard were able to show that a proxy for the network benefit to a bank was explanatory in determining which banks adopted ATMs early, they were not able to measure the size of the benefit. The data requested in the survey, in particular, the pricing, membership, and affiliation date data, is potentially useful in addressing these questions.

Models of services that generate network externalities display a tendency toward monopoly organization of the industry, depending on the value and extent of the network externality.[3] This conclusion can hold true even without economies of scale in production. Monopoly organization of an industry can, of course, lead to inefficiencies in pricing and in the quantity of the service provided. In network industries a particular inefficiency can arise through excluding from membership some potential users. Sponsors or owners of dominant networks can gain competitive advantage, in some

circumstances, by excluding their competitors from their network.[3]

There has been a general consolidation of ATM networks since the mid-1980s.[4] In many cities and regions of the country, only one regional network supplies ATM services, although both of the large national networks may offer services. Although there has been a great deal of consolidation in ATM networks, all the networks still face competition on the borders of their service areas. Furthermore, concerns about monopoly pricing are mitigated to a great degree in many networks, since the network is owned by its members and is managed as a nonprofit enterprise. Finally, many states have enacted mandatory sharing laws that require a network to accept membership from any potential user who meets an explicit entry requirement. The data on the governance of ATM networks was solicited to determine to what degree ATM networks are jointly owned, managed, and whether they offer open access to potential members.

3. SURVEY RESULTS

Included in Appendix A is a copy of the survey that was sent to the respondents. One of the four national networks was a nonrespondent, and five of the 20 regional networks were nonrespondents. One network requested that its fees not be made public, and several networks either did not provide their membership list or asked that it be kept confidential.[5] The quality of the responses varied, with some networks providing a complete pricing schedule, while others provided only incomplete information.

Table 1 presents the responses of the networks that provided pricing information on switch and interchange fees.[6] Included are the three national

network respondents, Plus, Cirrus, and the Exchange, and the 15 regional network respondents that did not require confidentiality of their responses. An additional regional network, Southeast Switch, is included as well. It was formed by the merger of the Honor, Avail, and Relay networks during the period of the survey and provided information on its pricing policies.

One notable feature of the pricing schedules is that, in many of the regional networks, the switch fees decline according to the quantity of transactions a member bank routes through the switch. This type of schedule is consistent with the presence of strong scale economies in switching services. It is also potentially consistent with monopoly price discrimination. In the Honor and Southeast Switch schedules, the switch fee reaches its minimum of $.02 at a transaction volume of more than 3.5 million monthly; in the Avail network a $.02 switch fee is charged for transactions in excess of 2.4 million That also represents the lowest switch fee in all the reporting networks. The highest switch fee is $.20 in the Exchange network; a $.15 switch fee is charged in two of the regional and one of the national networks. The average switch fee is unknown, since we do not have information on the weighted average switch fee for those networks whose switch fee varies by member volume. The average of the minimum switch fees of the regional networks is $.085, with a standard deviation of $.04.

Interchange fees typically vary depending on whether the transaction is monetary, such as a cash withdrawal, or nonmonetary one, such as a transfer. The monetary transaction is more costly for the ATM owner, and the added fee for the monetary transaction provides compensation for the added cost. The average interchange fee for a monetary transaction is $.39, with a standard deviation of $.08. For a nonmonetary transaction it is $.27, with a standard

deviation of $.13. The average difference between the monetary and nonmonetary interchange fee when the network charges different fees is $.17.

In two of the networks, interchange fees vary depending on whether the ATM is an on-premise or an off-premise machine. Again, an off-premise machine is more costly to service. For those networks that charge a different interchange fee for the use of an on-premise ATM and an off-premise ATM, the average difference is $.15. Finally, interchange fees for deposits, when they are allowed and when an explicit charge is made as in the Shazam network, are higher than those for a cash withdrawal.

For monetary transactions, the national networks' switch fees are $.05, $.10, and $.20, while the interchange fees are $.50, $.50, and $.40.

Membership and participation fees were not as well reported as interchange and switch fees. Three regional networks and the national network Plus provided their membership fees. These fees are included in Appendix B. The variance in these fees is notable. Honor and Plus are large networks owned by a relatively small subset of the membership (nine owner-members out of 411 members for Honor, and 57 owner-members out of more than 1,000 members for Plus). The Shazam network is smaller than Honor or Plus and is owned by all of its members. In the case of Honor, initiation fees are calculated on the deposit base of the member institution, and the continuing maintenance fee is based on both the deposit size and the card base of the member. For Plus the initiation and monthly fees are flat, based on the type of membership. For Shazam there is a flat initiation and maintenance fee.

Finally, there was little response to the question of governance of the networks. Some networks, including Star, Honor, Avail, and NYCE, reported that they were owned by a group of founding members, and their boards of

directors are elected by the owners. Shazam and Pulse reported that they are owned by all their members, and their boards are elected by all the members.

4. ESTIMATION

In this section we attempt to estimate simple economic relationships using a complementary data set collected and reported by Bank Network News. Although Bank Network News had done a pricing survey in 1985 it was not known at the time of my survey whether its survey would be repeated. While my survey was in progress, Bank Network News reported its 1990 survey of network pricing. In addition, Bank Network News conducts an annual survey of network transaction volume and number of ATMs. Combining the two 1990 surveys of Bank Network News provides a good source for both price and quantity data.[7]

The first relationship we wish to estimate is a simple production function of the form T = f(ATMs, Cards), where T is the number of network transactions, ATMs and Cards are the number of ATMs and bank cards in the network, and f is the production function. This specification of the production function of a network-supplied good was suggested by Salop (1990), Economides (1989), and Matutes and Regibeau (1988), who point out the complementarity of the components in a network. In their view, a network is a collection of compatible complementary goods, such as an ATM and a bank card. These two components are perfectly complementary: one cannot be put to use without the other. A network gains value by linking together competing suppliers of one (or both) of the components. In an ATM network, the network links together competing suppliers of ATMs.

The theoretical prediction is that there is a complementarity in ATMs and Cards. We estimate a production function using data from Bank Network News for the years 1988-1991 for the reported 85 networks each year. The

estimation is implemented using a constant elasticity of substitution function, which will allow us to estimate both the scale economies and the elasticity of substitution between ATMs and Cards. The production function is given by:

$$\ln T = (1/\rho) \ln (a + b\ ATM^{\rho} + c\ Card^{\rho})$$

The estimation procedure was maximum likelihood; various initial values were tried, and convergence to the same estimates occurred after approximately 35 iterations. The estimates and the t-statistics are as follows:

$a = -.21$, $b = .30$, $c = .11$, $\rho = -.67$.

t: (-0.39) (2.37) (3.12) (-2.55) adjusted R-squared =.92.

This estimation seems to fit the data to the CES specification quite well. Two results are as follows: when $a = 0$, as our estimate suggests, the production function displays constant returns to scale; when $\rho = -.67$, then the elasticity of substitution between ATMs and Cards is $-1/(\rho - 1) = 1/1.67 = .59$. An elasticity of substitution of .59 shows less than perfect substitutability between ATMs and Cards (perfect substitutability yields an elasticity of substitution of 1, while perfect complementarity yields an elasticity of substitution of -infinity).

A second use of the data is to estimate a stylized cost function for the ATM network. Several restrictive assumptions must be imposed in order to interpret the estimation that follows as a cost function. Nonetheless, the lack of data makes this a useful exercise. Using data from the Bank Network News 1990 pricing survey and the transaction volume reported for 1990, and cross-checking with our survey, we use the reported switch fees and interpret them as observations of the cost of switching the networks' transactions. Given that many of the networks are member-owned and are not managed to

produce dividends, this assumption is not too implausible to be useful. Furthermore, we use the minimum switch fee for those networks that use a switch fee schedule. A cost function is of the form $C = g(T,P)$, where C is the observation of cost, T is the number of transactions in the network, and P is a vector of input prices. Because we have no observations of other input prices we are not able to estimate the cost function in this form. Assuming that the other input prices do not vary across the 41 networks included in the Bank Network News survey, we estimate the function

$$\text{MIN SW} = a + b\,T$$

where MIN SW is in cents, and T is in thousands of transactions yearly. Running an ordinary least squares regression, we find the estimates

$a = 12.46$, $b = -0.000143$

t: (11.3) (-2.5), adjusted R-squared = .12.

While this equation can be interpreted only as a cost equation under severe assumptions, and although the fit is not excellent in that there is a great deal of unexplained variability, the estimation does reveal a significant relationship between the minimum switch fees and transaction volume, using only 41 observations. The estimate suggests that for every additional 1 million network transactions per year, the minimum switch fee falls by .143 cents (or \$.00143). Interpreting this result as decreasing costs suggests some substantial economies of scale in the provision of the network switch.[8]

Although the prices consumers pay for ATM service are not readily available, we wish to estimate a demand and supply system in order to gauge the relative magnitudes of the ATM elasticity of demand and the card elasticity of demand. We let supply be given by:

$$T_s = a_0 + a_1\text{Member} + a_2\text{Price},$$

where T_s is the transaction volume supplied by the network, Member is the number of member banks in the network, and price is the inclusive price of ATM services. Demand is given by:

$$T_d = b_0 + b_1 ATM + b_2 Card + b_3 Price,$$

where T_d is the transaction volume demanded by the network's consumers, ATM is the number of network ATMs, and Card is the number of network bank cards. All variables are in logarithms. By equating demand and supply and substituting for price, we have an estimating equation in T, ATM, Member, and Card:

$$T = c_0 + c_1 Member + c_2 ATM + c_3 Card.$$

We note that $c_1 = - a_1 b_3 (1/[a_2 - b_3])$, $c_2 = a_2 b_1 (1/[a_2 - b_3])$, and $c_3 = a_2 b_2 (1/[a_2 - b_3])$. Estimates for the equation, using 1990 data are

$c_0 = .85$ $c_1 = -.01$ $c_2 = .86$ $c_3 = .24$

t: (3.7) (-0.2) (9.1) (2.8) adjusted R-squared = .92.

The reduced form demand and supply system has positive and significant coefficients on both ATM and Card and an insignificant coefficient on Member. Perhaps this reflects the fact that the member banks of an ATM network move quickly to supply the demand of the cardholders of the network, regardless of the number of member banks in the network. In terms of elasticities note that $c_2/c_3 = b_1/b_2$; the latter ratio is the ATM elasticity of demand to the Card elasticity of demand. It equals .86/.24 (or 3.58); in other words, the ATM elasticity of demand is positive and more than three times the size of the card elasticity of demand.[9,10]

5. CONCLUSION

This paper has reported on a survey of ATM network pricing. The response of the networks yielded a more complete picture of both regional and national ATM network pricing. Membership fees, unavailable elsewhere, were

reported on by three networks.

Supplemented by information from Bank Network News, estimates of the complementarity between ATMs and bank cards were found to support the hypothesis that networks offer value by offering compatible complementary products. A crude cost estimation reveals that as of 1990 there still appeared to be unexploited economies of scale in network switching. Finally it was found that the ATM elasticity of demand is positive and large relative to the card elasticity of demand.

Much remains to be done in creating a more comprehensive data set with which more sophisticated testing can be done. Networks, with their mix of members and strong central organizations, would seem to offer an especially good source for case studies. The measurement of both network externalities on the demand side and economies of scale on the cost side is an important empirical challenge.

TABLE 1
Regional Networks

FEES	TRANSACTION VOLUME (MONTHLY)	NYCE
SWITCH FEES	First 50,000	.13
	Next 50,000	.12
	Next 100,000	.11
	Next 200,000	.09
	Next 200,000	.08
	Next 200,000	.07
	Above 800,000	.06
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.38
	Balance Inquiry	.20
	Transfers	.20
	Deposits	.70
	Denial/ No Response	.20

FEES	TRANSACTION VOLUME (MONTHLY)	CASH STATION
SWITCH FEES	Under 10,000	.0978
	10,000 - 19,999	.0906
	20,000 - 49,999	.0834
	50,000 - 99,999	.0725
	Over 100,000	.0653
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.25
	Balance Inquiry	.15
	Transfers	.15
	Deposits	.75 + float compensation

FEES	TRANSACTION VOLUME (ANNUAL)	HONOR
SWITCH FEES	Under 250,000	.10
	250,000 - 499,999	.09
	500,000 - 999,999	.08
	1,000,000 - 1,499,999	.07
	1,500,000 - 1,999,999	.06
	2,000,000 - 2,499,999	.05
	2,500,000 - 2,999,999	.04
	3,000,000 - 3,499,999	.03
	Above 3,500,000	.02
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.40
	Balance Inquiry	.20
	Transfers	.20
OTHER FEES[1]	Initiation[2]	$2,000 - 25,000
	Annual[3]	$2,000 - 125,000
	Cards above 2,500,000	.05 per card

[1]Other fees vary according to membership class. Fees shown are for participating membership.

[2]Figures are minimum and maximum calculated at $20/million in deposits.

[3]Figures are minimum and maximum calculated at $10-20/million in deposits.

FEES	TRANSACTION VOLUME (ANNUAL)	SOUTHEAST SWITCH
SWITCH FEES	Under 250,000	.10
	250,000 - 499,999	.09
	500,000 - 999,999	.08
	1,000,000 - 1,499,999	.07
	1,500,000 - 1,999,999	.06
	2,000,000 - 2,499,999	.05
	2,500,000 - 2,999,999	.04
	3,000,000 - 3,499,999	.03
	Above 3,500,000	.02
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.40
	Balance Inquiry	.20
	Transfers	.20

FEES	TRANSACTION VOLUME (MONTLHLY)	AVAIL
SWITCH FEES	Under 10,000	.12
	Next 20,000	.10
	Next 70,000	.08
	Next 100,000	.05
	Over 200,000	.02
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.40
	Balance Inquiry	.15
	Transfers	.15
OTHER FEES	Initiation	$5,000 minimum, $100/million in deposits
	Annual	$5,000 minimum, $30/million in deposits
	Card	.22 per card
	Terminal	$100/ATM/year

FEES	YANKEE24
SWITCH FEE	.14
INTERCHANGE FEE	.32

FEES		MOST
SWITCH FEE		.035 - .14
INTERCHANGE FEES	Cash Withdrawal	.40 - .42[4]

FEES		XPRESS 24
SWITCH FEE		.15
INTERCHANGE FEE	Cash Withdrawal	.38

[4]Pays acquirer volume credit.

FEES		BANKMATE
SWITCH FEE		.10
INTERCHANGE FEE	Cash Withdrawal	.55

FEES	TRANSACTION VOLUME (MONTHLY)	SHAZAM
SWITCH FEES	First 10,000	.09
	10,001 - 25,000	.07
	25,001 - 50,000	.06
	Over 50,000	.05
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.21
	Balance Inquiry	.16
	Transfers	.16
	Deposits	.76
OTHER FEES[5]	Installation	$150 - 250 per terminal
	Telephone Installation	$290 - 465 per terminal
	Administration	$150 - 250 per month

[5]Fees are for switch-in-front site.

FEES		MPACT
SWITCH FEE		.10
INTERCHANGE FEES	TRANSACTION TYPE	
	On-Premise Withdrawal	.40
	On-Premise Balance	.30
	Off-Premise Withdrawal	.60
	Off-Premise Balance	.40

FEES		THE OWL
SWITCH FEES		.10 - .12
INTERCHANGE FEES	TRANSACTION TYPE	
	Cash Withdrawal	.35
	Balance Inquiry	.15
	Transfer	.15
	Deposit	.55

FEES		PULSE
SWITCH FEE		.065
INTERCHANGE FEES	TRANSACTION TYPE	
	Monetary	.50
	Nonmonetary	.25
OTHER FEES	Initiation	$200

FEES	TRANSACTION VOLUME (ANNUAL)	STAR
SWITCH FEES	Under 50,001	.08
	50,001 - 150,000	.075
	150,001 - 300,000	.07
	300,001 - 500,000	.065
	500,001 - 750,000	.06
	750,001 - 1,050,000	.055
	1,050,001 - 1,400,000	.05
	1,400,001 - 1,800,000	.045
	Above 1,800,000	.03
INTERCHANGE FEES	TRANSACTION TYPE	
	On-Premise Monetary	.45
	On-Premise Nonmonetary	.20
	Off-Premise Monetary	.55
	Off-Premise Nonmonetary	.25

National Networks

FEES		PLUS
SWITCH FEE		.05
INTERCHANGE FEES	TRANSACTION TYPE	
	Monetary	.50
	Nonmonetary	.15
OTHER FEES	Initiation[6]	$10,000
	Monthly	$500
	Card	.025/card/year

FEES		CIRRUS
SWITCH FEE		.10
INTERCHANGE FEES	TRANSACTION TYPE	
	Monetary	.50
	Nonmonetary	.25
OTHER FEES	Card	.025/card/year

FEES		THE EXCHANGE
SWITCH FEE		.20
INTERCHANGE FEE	Cash Withdrawal	.40

[6]Initial fee depends on membership class. Figure shown is for licensee.

APPENDIX A

August 13, 1990

Dear Respondent,

I am investigating the possibility of doing an economic research paper on ATM networks and the value of membership to various classes of banks. I am requesting information from various regional and national ATM networks, including yours. My first request is for the following information:

1) A membership list.
2) The date of affiliation of each member.

Second, I am interested in the level of the interchange fee and the governance of the network. I therefore request the following:

3) Information on fees, particularly the pricing of interchange and switch fees.
4) Who sets the fees, e.g., the owner or the total membership.

I request your voluntary assistance in obtaining this information. Please note any information that you wish to be kept confidential and whether it could be used without identifying the network.

We would be happy to send you a copy of the paper upon its completion. If you have any further questions regarding this request, please contact me at (215) 574-6440.

Sincerely,

James McAndrews
Research Economist

APPENDIX B
MEMBERSHIP FEE SCHEDULES

SHAZAM NETWORK:

For each financial institution participating through a data processing center, Shazam charges a one-time fee of $50 to be added to the system.

All financial institutions must pay a fee to cover normal settlement and administrative costs incurred by Shazam. The administrative fee is $2 per day.

AVAIL NETWORK: For both the Avail and the Honor network the fees reported are for Participating Members. A Participating Membership is a class of membership that does not involve any ownership interest in the network.

Membership fees for participating members include a one-time initiation fee of $100 per million in deposits with a $5000 minimum and an annual fee of $30 per million in deposits with a $5000 minimum. Members pay a card account fee of $.22 per AVAIL card account per year and a terminal fee of $100 per ATM per year.

HONOR NETWORK: (Member must be an insured Florida depository institution.)

Initiation fees: One time only; $20 per million of deposits (minimum of $2000, maximum of $25,000.)

Membership fees - payable annually (minimum of $2000, maximum of $125,000)

Florida Deposit Size:	FEE:
less than $1 billion —	$20 per million of deposits.
between $1 billion and $5 billion —	$19 per million of deposits.
between $5 billion and $10 billion —	$17 per million of deposits.
over $10 billion —	$10 per million of deposits.

Florida Card Base:
Under 2.5 million cards — No charge
Over 2.5 million cards — $.05 per card over 2.5 million.

Outside Florida Card Base: (Fee based on total cards)
Under 2.5 million cards — $.01 per card.
Over 2.5 million cards — $.05 per card.

PLUS NETWORK:
Initial Membership Fees:

Proprietary Membership Fee	—	$25,000	These categories of membership
Processor Membership Fee	—	$12,500	grant different privileges to the
Category A Licensee	—	$10,000	member firm.

Monthly Fees
Administrative Fee - $500 per month per proprietary member, processor member, or Category A licensee.

ENDNOTES

1.The national networks surveyed were the Visa network, Plus, Cirrus, and the Exchange. The regional networks were NYCE, MAC, Star, MOST, Pulse, Honor, Exchange/Accel, Relay, Yankee 24, Network One, Money Station, Magic Line, XPress 24, Avail, MPACT, Cash Station, BankMate, The Owl, Jeanie, and Shazam. The Southeast Switch network was surveyed during the followup survey.

2.See Felgran (1984) or McAndrews (1991) for more detailed descriptions of ATM networks.

3.See Heal (1990), Arthur(1989), Katz and Shapiro (1986) for models that display this tendency.

3.See the remarks by Rule (1985) for a discussion of the antitrust implications of exclusion from network participation.

4.See McAndrews (1991) for details.

5.Among the national networks, the Visa network did not respond. Among the regionals, the MAC, Exchange/Accel, Relay, Money Station, and Jeanie did not respond.

6.The three responding national networks, Plus, Cirrus, and the Exchange, are placed at the end of Table 1.

7.We were able to verify many of the prices reported in the 1990 pricing survey of Bank Network News using the responses to our pricing survey.

8.An alternative quadratic specification yielded a positive but insignificant coefficient on the squared volume term. Minimizing the resulting quadratic cost function showed that the cost reached a minimum at a yearly volume of 55 million transactions. Only 2 of the 41 networks had transaction volume in

excess of 55 million. The quadratic cost function then suggests that all but the largest networks were operating with unexploited scale economies in switching in 1990.

9.Given that the estimates of c_2 and c_3 are positive, then b_1 and b_2 are both positive so long as $a_2 \geq 0$, and $(a_2 - b_3) > 0$. Recall that a_2 is the price elasticity of supply, and b_3 is the price elasticity of demand; as such, the theoretical presumption is that $a_2 \geq 0$, and $b_3 \leq 0$.

10.Unfortunately, the information that $c_1 = 0$ does not allow us to extract much more information from the estimation. We have that $c_1 = 0$ implies that either $a_1 = 0$ or $b_3 = 0$. If $a_1 = 0$, no new information is revealed about the other parameters of the model. If $b_3 = 0$, then we have that $c_2 = b_1$, and $c_3 = b_2$. In this case, the ATM elasticity of demand is .86, and the card elasticity of demand is .24. However, economic theory and anecdotal evidence suggests that $b_3 < 0$, while it is plausible that supply of a network is responsive only to price and not to the number of its members. In other words, for a given level of demand, the network would supply the same amount of ATM services whether it had a large or small number of bank members. This would imply that $a_1 = 0$.

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