

## Automated Teller Machine Network Pricing – A Review of the Literature

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### Abstract

Automated teller machines (ATMs) have altered the relationship between banks and their depositors, as well as the competitive relationships among banks. In this paper, I survey the literature to describe the ways that ATMs have influenced these aspects of banking markets, and conclude with suggestions for further research.

### 1 Introduction

Automated teller machines can offer significant benefits to both banks and their depositors. The machines can enable depositors to withdraw cash at more convenient times and places than during banking hours at branches. At the same time, by automating services that were previously completed manually, ATMs can reduce the costs of servicing some depositor demands. These potential benefits are multiplied when banks share their ATMs, allowing depositors of other banks to access their accounts through a bank's ATM. The decision by banks to share their ATMs is partially determined by the terms under which the sharing would occur. In particular, there are several prices that can be charged to or collected by the three main parties involved in an ATM transaction, the cardholder, the cardholder's bank, and the ATM owner. How, and by whom, these prices are set affects a number of economic decisions, including the number of machines that banks and non-banks choose to deploy, deposit market interest rates, distances traveled by depositors and non-depositors that wish to withdraw cash, profits of banks, and welfare of bank customers.

In this paper, I will review the literature on ATM pricing. I will first describe ATM fees and some rough empirical magnitudes in the U.S. context. In addition, I will examine the institutional framework under which most sharing agreements are formed. Following that grounding, I will review the literature, which has focused both on the motives for sharing ATM facilities, as well as on the pricing of the use of ATMs under a sharing agreement.

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## 2 Description of ATM fees

Most ATM networks began as joint ventures owned by a central group of bank members.<sup>1</sup> A network provides an array of services that link together the ATMs of its members. The activities of the network are governed by a set of rules that are agreed to and implemented by the network's board of directors. In the U.S., ATM networks are not directly regulated by any government agency.

ATM network organizations engage in a host of activities that support the trademark, brand name, reliability, and operation of the ATM system controlled by the network. The basic operational activity of the network is to support ATM cash withdrawals by the deposit account holders of any member bank. This function requires the network to transfer electronically, or "switch", the transaction information from the ATM to the account holder's bank and back again. This communication and sorting activity is accomplished through the aid of leased or dial-up telephone lines and centralized computers. Many networks also provide ancillary services such as ATM servicing and clearing and settlement of payments to its members or other banks.

Use of ATM services usually trigger the levy of two types of fees: wholesale fees, which are paid by the banks to other banks or to the network, and retail fees, which are paid by the person conducting the transaction to his or her bank or to the ATM owner. See for example Table 1.

Wholesale fees are set by ATM networks and comprise the switch fee and the interchange fee (most networks also charge a wholesale membership fee, which is not transaction-based). Switch fees, which cover the costs of routing transactions through the network's computer switching system, typically range from \$0.02 to \$0.15 per transaction.<sup>2</sup> The interchange fee is paid by the cardholder's bank to the ATM owner to compensate the owner for the costs of deploying and servicing the ATM; interchange fees typically range from \$0.34 to \$0.65 per transaction.<sup>3</sup>

The retail fees of an ATM transaction are set by the cardholder's bank and by the ATM owner. These fees are of two types, usage (or variable) fees and periodic assessments by banks per card (or fixed fees). For usage based fees, when a cardholder uses an ATM the cardholder could be charged a fee. If the ATM is owned by the cardholder's bank, the cardholder could be charged an "on-us" fee, though few banks charge such fee. Much more common is the "on-other's" or foreign fee that banks charge when their cardholder uses a machine owned by another party. These fees range from \$0.25 to \$2.50, and average more than \$1 per transaction.

Surcharges also fall under the category of retail fees. Surcharges are typically applied in a discriminatory fashion, that is, banks that own ATMs typically surcharge only other banks' depositors, and not their own account holders. Nonbank owners of ATMs typically apply surcharges to all users. Surcharges vary widely, ranging from as little as \$0.50 to as much as \$5, but they now average approximately \$1.50 per transaction.<sup>4</sup>

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<sup>1</sup> As these networks have evolved, in the U.S. a significant share of the large ATM networks are now owned by a nonfinancial corporation.

<sup>2</sup> ATM & Debit News, EFT Data Book, 2002 Edition, Thomson Financial.

<sup>3</sup> *ibid.*

<sup>4</sup> The data for the retail fees are taken from Hannan (2002).

<b>Who sets the fee</b>	<b>Fee received by network organization</b>	<b>Fee received by cardholder's bank</b>	<b>Fee received by ATM owner</b>
<b>Set by the network</b>	Switch fee: fee paid by cardholder's bank to network organization for the costs of routing transaction information; typically varies from \$0.02 – \$0.15		Interchange fee: fee paid by cardholder's bank to ATM owner for costs of deploying and maintaining shared ATM: typically varies from \$0.30 – \$0.60
<b>Set by cardholder's bank</b>	On-Us fee: fee paid by cardholder to cardholder's bank for use of bank's own ATMs. Percent of banks charging such fees: 3.6 percent Average level of fee: \$0.81	On-Other's fee (or Foreign Fee): fee paid by cardholder to cardholder's bank for using an ATM not owned by the cardholder's bank; Percent of banks charging such fees: 78.5 percent Average level of fee: \$1.17	
<b>Set by ATM owner</b>			ATM surcharge: fee paid by cardholder to ATM owner for the costs of deploying and maintaining ATM; Percent of banks charging such fees: 88.5 percent Average level of fee: \$1.32

**Table 1: Variable ATM fees**

Source: Hannan (2002).

Most fixed fees based on account status or periodic card-based fees are assessed on a bank's own depositors. In some cases, banks have charged fees specifically for the use of a bank card for a certain number of times per month. Some banks, in fact, have charged negative fees for the use of their card, to compensate their depositors who face surcharges when accessing their accounts at foreign ATMs. This has been most common for banks that have few (or no) ATMs of their own.

### 3 Deployment of ATMs and network affiliation

The motivation of banks to deploy ATMs and share their ATMs with the customers of other banks are areas that economists have investigated. Humphrey (1993) examines the motive for deploying ATMs based on cost saving. He studies the costs of banking in the U.S. and how the costs are influenced by the deployment of ATMs. He finds substantial scale economies in the production of ATMs services, and that ATM transactions cost about half the amount that the same transaction would cost if it were conducted in a branch of a bank. However, no savings were realized from the significant expansion of ATM services that Humphrey observed. Instead, bank customers, taking advantage of the increased convenience of ATM services, increased the number of transactions, leaving total bank costs roughly the same as had no ATMs been deployed. Humphrey also found that some banks, those that carefully managed their service delivery operations, were able to reduce their costs by deploying ATMs. Humphrey's findings indicate that satisfying consumer demands is an important consideration in the decision to deploy ATMs, perhaps more important than an attempt by banks to reduce costs.

Saloner and Shepard (1995) examine the deployment of ATMs by individual banks prior to the advent of sharing ATMs in the U.S. By considering the size of the bank and the geographic dispersion of the bank's depositors, they are able to detect a significant network effect in the demand for ATM services by bank customers. They examine a dynamic model of investment. Banks whose customers have a higher willingness to pay for a service will invest in providing that service sooner than another bank that is similar in other respects. Saloner and Shepard find that banks that have a more extensive branch network adopted ATMs sooner than other large banks, as their customers could take better advantage of the geographic diversity of ATM sites (usually provided at a bank's branches) in meeting their demands for cash.

McAndrews (1991) measures an indicator of the demand-side network effect, the number of on-others transactions, sometimes called interchange transactions. He finds that interchange transactions increased as ATM networks were formed among banks and became more concentrated. As ATM networks became more concentrated, the ability of bank customers to use other regional banks' ATMs tended to expand as well. Carlton and Frankel (1995) closely examine the effect of a merger of two ATM networks in Chicago, Illinois, and find that the merger led to a significantly higher growth rates of total transactions, interchange transactions, and ATMs than were experienced nationally during the same time period. They conclude that the network effects in ATM services are very large at the level of a large metropolitan area. In addition, network operating costs fell substantially following the merger.

Matutes and Padilla (1994) present a seminal paper on the factors that lead a bank to share ATMs with other banks. They consider a three-bank market, in which the banks are located around a circle. Within their model, there are both advantages and disadvantages to a bank considering sharing its ATMs with another bank. The advantage is that a bank's customers will tend to accept a lower return on their deposits, as sharing lowers the customer's expected transportation costs. The disadvantage is that by sharing, the bank reduces the differentiation its locational distinction otherwise provides it with. They conclude that less than full sharing of ATMs will result in the equilibrium of their model (that is, one equilibrium is for two of the banks to share ATMs, while the third bank is not included; there is no equilibrium with all three banks sharing ATMs).

Matutes and Padilla (1994) make a significant extension of their basic model to consider the imposition of an interchange fee. The interchange fee softens the effect of increased substitutability among banks. The interchange fee softens competition as banks' are less willing to bid to attract depositors, because depositors cause costly on-others' withdrawals. With interchange fees, full sharing of ATMs is a possible outcome of the model. This result is an important and quite general one.

In a paper that is consistent with Matutes and Padilla's analysis, Laderman (1990) finds that states within the U.S. that mandated the sharing of ATMs tended to experience slower growth of ATM cards, and therefore, probably in ATM transactions. Laderman points out that a number of states did not mandate ATM sharing by networks, while many states did. The laws tended to impose the requirement on ATM networks that they admit any qualified participant on reasonable terms. Nonetheless, such mandatory admission to the sharing of ATMs implied by network membership might not be desirable from the private point of view, as in Matutes and Padilla (1994). Laderman exploits the cross-sectional variation across the states to test the effects in number of ATM cards and in the number of ATMs. She finds that those states that mandated sharing the number of ATM cards is significantly reduced, while controlling for many other influences; the number of ATMs is not significantly reduced. The number of cards is a proxy for number of transactions (which cannot be directly observed at the state level), indicating to Laderman that mandatory sharing tended to increase the prices of ATM transactions in those states.

McAndrews and Rob (1996) consider whether the joint-venture structure by a network might influence the willingness to join an ATM network. In their model banks can join one of two networks, each of which set a switch price (there is no interchange fee in this model). The banks then compete in quantities in the downstream market, in which the demand for services displays a network externality in the number of banks belonging to a particular switch. They show that for any equilibrium of the model in which upstream competition for network affiliation is carried out between two third-party, for-profit networks, there is a corresponding equilibrium of the model in which upstream competition is between a third-party, for-profit network and a joint-venture, not-for-profit network. The main result shows that the corresponding equilibrium in the not-for-profit competition case is one in which the industry is more concentrated into a single network. In other words, by delegating the pricing power to its member-banks, the presence of a joint-venture network better achieves the extraction of the full gains from network expansion. In equilibrium the prices to consumers are the same, for the same sized networks, regardless of upstream for-profit or not-for-profit organization, the difference between the two is the level of the industry at which profits are extracted.

McAndrews (1996) indirectly estimates customer demand for the size of the network, by estimating how the foreign fee varies as the size of the network varies. He finds that in the U.S. the foreign fee tended to increase in the size of the network up to a certain point, and decline thereafter. This result is interpreted in the context of a model in which ATM sharing displays both a demand-side network effect, and ATM switching displays economies of scale. The first effect dominates up to some size of network, and banks increase their retail prices, while the second effect dominates after networks reach large scale, allowing banks to lower their prices, although their price-cost margin remains high. In addition, McAndrews (1996) concludes that networks operating nearby exert little competitive influence on an entrenched network.

#### 4 The advent of surcharges, and ATM pricing

In 1996, the two networks that facilitated “long-distance” ATM transactions in the U.S., Plus and Cirrus, dropped their long-standing opposition to allowing ATM owners directly to charge customers of their ATMs, known as surcharges.<sup>5</sup> Their rule change was preceded by the passage of legislation in 15 U.S. states that made illegal ATM networks’ rules that disallowed surcharges. Why did ATM networks ban surcharges? And why did states force ATM networks to allow surcharges? To understand these issues, we turn to models of the equilibrium fees in networks.

Economides and Salop (1992) make a contribution to this literature by examining how prices are determined in an environment in which competitors sell complementary components of a good under different market conventions. The application to ATMs is quite straightforward: two banks each sell deposit account services, and they each sell ATM access. The ATM access is complementary with deposit account services, regardless of which bank produced the deposit account service. They examine alternative fee-setting conventions, including joint fee-setting, and separate fee-setting. Their work capitalizes on Cournot’s result that prices for complementary goods are lower with joint fee-setting than with independent actions by the competitors. The reason for this fundamental result is that with independent fee-setting, the action by one firm to increase its price does not take into account the decline in demand for the other firm’s output. As a result, independent competition in markets with complementary goods can result in prices that exceed the joint profit-maximizing price. One result of Economides and Salop, for example, is that under “one-sided joint price setting”, in which the network sets the interchange fee at marginal cost, surcharging is not allowed, and banks can independently determine the foreign fee, prices to the consumer are lower than under independent price setting. Such a result can explain networks’ reluctance to allow members to charge surcharges to ATM users.

Salop (1990a, 1990b) and Gilbert (1991) consider the issue of allowing networks to regulate the prices of their members, and come to different conclusions. Gilbert (1991) reasons from a model that is, like Economides and Salop (1992), focused on the inefficiency of independent price-setting in the presence of closely complementary goods. He concludes that delegating price regulation to the network can lower prices, by preventing the independent actions that lead to prices that exceed the joint profit maximizing levels. Salop’s (1990a, 1990b) papers take a different approach. First, he examines a model in which the interchange fee is redundant. He shows that for any arrangement of foreign fee, surcharge and interchange fee, a second set of fees, consisting solely of an foreign fee and a surcharge (but at different levels than the first set) can accomplish the same set of transfers among the agents. In this (algebraic) sense, the interchange fee is redundant. He does not show that it is economically redundant, however.

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<sup>5</sup> Most foreign, or interchange, transactions at ATMs in the U.S. were facilitated by “regional” ATM networks, which began operation in a fairly circumscribed region within the U.S. Most of the surviving regional networks have expanded, and now offer services over much wider areas. Plus and Cirrus have always operated on a national basis, but are often the second choice of network, as their interchange fees tend to be higher than the regional networks’ fees. Under most network routing rules, if the only two logos on a card and machine that match are a regional network’s logo and a national network’s logo, the transaction will be routed through the regional network; the national network would be used only if it were the only logo displayed that matched both card and machine. See McAndrews (1991) for more on the industrial organization of regional and national networks, and Cynrak and McAndrews (1999) for a discussion of network routing rules in ATM networks.

Salop (1990, 1991) goes on to argue that the logic for price regulation based on Cournot's insight regarding competition among producers of complements is not well-founded. In particular, he points out that most of the models that make that argument use an assumption of a fixed number of competitors. Regulating the prices of the competitors, it must be remembered, is a second-best outcome. Were there perfect competition among compatible components, no price regulation would be desirable. Salop (1990, 1991) then focuses attention on the deleterious effect that price regulation can have on the supply of multiple brands, and on the degree of product variety (which in the case of ATMs might be measured by the locations at which ATMs are made available). Salop (1991) examines a model that shows under what conditions price regulation is desirable, and under what conditions it reduces consumer welfare, primarily by setting the wrong degree of product variety. Salop shows that under free-entry, depending on the levels of elasticity of customer demand for variety and the price elasticity of demand, in some cases a price floor can increase consumer surplus by increasing variety and in some cases a price ceiling can increase consumer surplus by increasing output. In addition, Salop shows that one-sided buyer cartels can have an incentive to extract rents from the other side of the market, regardless of the degree of competition in the segments. Salop also argues that while vigorous inter-network competition would tend to reduce one's concern about network price self-regulation, it is unlikely that vigorous competition will exist precisely because of the underlying economics that create the network itself.

Balto and McAndrews (1998) review the state regulation of ATM surcharges and report that states claimed that their laws disallowing bans on surcharging by networks were passed explicitly to enhance consumer welfare by leading to the deployment of more ATMs. McAndrews (1998) reviews the deployment of ATMs following the widespread surcharging that was introduced in 1996, and estimates the number of interchange transactions, before and after the advent of surcharging. Several changes in the market were closely related to the introduction, on a widespread basis, of surcharges. First, the growth rate of ATM deployments rose from its previous level, and increasing shares of these ATMs were located off-bank premises, and were owned by nonbank companies. Second, the number of total ATM transactions rose only slightly as the number of transactions per machine fell significantly. Not surprisingly, the number of interchange transactions fell, consistent with the notion that there is a downward sloping demand for interchange transactions. Looking at the change in transactions and in the number of ATMs between 1995 and 2001, the number of ATMs increased by 264 percent, while the number of ATM transactions increased by 140 percent, resulting in a 47 percent fall in the number of transactions per machine. Another coincident development is that ATM machines have greatly declined in price during the period. The percentage of machines that are deployed at locations other than bank branches has increased from 31 percent in 1995 to 60 percent in 2001.

As reported in McAndrews (1998), widespread ATM surcharging led to a vigorous public debate in the U.S. The two primary views that were expressed might be characterized as follows. One set of views focused on the confusing situation of consumers being charged both a foreign fee by their bank, and a surcharge by the ATM owner. Concerns were expressed that banks with large fleets of ATMs could make customers move to their bank, and otherwise stifle competition for deposits. In addition, it was pointed out that the prices for surcharges did not vary significantly between machines. The alternative set of views focused on the benefits of ATM-specific prices, pointing out that

some remote locations previously unserved by ATMs were now able to support one, with many fewer transactions than had been necessary without the ability to assess surcharges.

Several theoretical papers have attempted to incorporate various of these concerns in models of ATM price setting. Massoud and Bernhardt (2002) develop a spatial model in which consumers both choose a bank at which to deposit and choose their use of ATM services. In their model two banks are on either side of a circle, and consumers are uniformly distributed around the circle. Consumers choose a bank, knowing that they face a fixed fee for banking services, and that, as they travel around the circle, they might experience a need for a banking service, and incur fees to conduct those services. For some services, the consumers need to travel to their bank, while others can be completed at an ATM. Massoud and Bernhardt find that banks discriminate in favor of their customers, and that imposing uniform fees on the ATM prices of banks would result in fees higher than the surcharges for all customers (and would increase bank profit). In their model, the ATM surcharges are set explicitly to induce potential customers to establish accounts at the bank. They also find that when they alter their model to allow for heterogeneous-size banks, larger banks charge higher surcharges than smaller banks do.

Prager (2001) empirically examines the experience of small banks in states that allowed surcharging prior to 1995 and comparing them to small banks in states in which surcharging was not allowed. She found that the small banks in the surcharging states did not lose market share or show a decline in profitability relative to small banks in the non-surcharging states. She concludes that the level of surcharges that existed during that period was not enough to provide a strong incentive for small bank customers to switch their allegiance to banks with large ATM networks. Hannon, Kiser, Prager and McAndrews (2003) empirically examine the determinants of the decision by a bank to impose surcharges by 1997. They find that larger banks, both in terms of asset size, as well as in share of the market's ATMs, were more likely to impose surcharges. In addition, they find that some variables associated with the depositor affiliation decision, such as the amount of immigration to the market, tend to be associated with higher surcharges. This evidence is consonant with a bank's desire to influence potential depositors' choices when determining its surcharges. They conclude that surcharges are not determined solely as convenience fees for ATMs in high-cost or high-value locations, but as strategic tools for raising the costs of customers of rival banks.

Massoud and Bernhardt (2001) extend the results of Massoud and Bernhardt (2002) to the case in which banks endogenously choose the number of ATMs to deploy. As in their previous paper, banks can better extract surpluses from their own depositors by charging them two-part prices. Banks set transaction prices at marginal costs for depositors, and extract surplus via high fixed fees. A set of such fees causes no distortion in depositors' choice of transactions. At the same time, banks can extract surplus from non-depositors only by charging high (and distorting) surcharges. Adding the ATM deployment decision to the mix, Massoud and Bernhardt (2001) find that banks will deploy more ATMs than is socially optimal. They do so because having a large number of ATMs allows a bank, *ceteris paribus*, to better compete for depositor affiliation in the first instance. As all banks respond to this incentive, overprovision results, both in games in which prices and ATM locations are chosen simultaneously, and in a game in which investment in ATM location precedes price competition. One criticism of the Massoud and Bernhardt papers is that in their models there is no interchange fee or foreign fee (this does not seem to correspond exactly with any country's pricing arrangement). As a result, the potential richness of the

competitive environment is somewhat muted as a competing bank cannot, for example, subsidize its own customers transactions made at a high-cost rival's ATMs, nor is the collective setting of fees an issue.

Donze and Dubec (2002) examine a model that might be considered as a successor to Matutes and Padilla (1994), in that there are no surcharges or foreign fees, but banks make a decision to deploy machines in a context of a collectively determined interchange fee (the authors report that this observed in the U.K. and France, among others). Banks compete for both deposits (and earn revenue from deposits) and withdrawals (and earn interchange fees) when they deploy ATMs. Donze and Dubec note that there are two effects of interchange fees. As interchange fees are set at a higher level, the competition for withdrawals quickens and more ATMs are deployed, which increases deployment costs. Each bank, however, experiences a squeeze on its profits from offering deposit services as it must service costly foreign withdrawals by its customers (as in Matutes and Padilla). As a result, banks tend to increase their retail deposit prices to compensate. Donze and Dubec show that the second effect dominates the first (under conditions that continue to assure the willingness to share ATMs) and conclude that the interchange fee can be used as an instrument of tacit collusion. They also show that for large numbers of banks, ATMs will be over-deployed in equilibrium.

In what is perhaps the richest model of ATM pricing, Croft and Spencer (2002) examine a spatial model of ATM pricing by banks that examines the effects of interchange fees, foreign fees, and surcharges, and considers the effects on shifting customers away from the use of branch resources and on bank competition given a set of depositors (but does not consider the deployment decision). In the model, following Salop (1979) bank customers and ATMs are positioned around a circle and "interleaved" so that the ATMs are equidistant from their customers. They first examine the joint profit-maximizing price for ATM services, which can be collected from consumers by foreign fees and surcharges; it increases in the greater consumer utility from ATM use, and increases the smaller is the cost savings from conserving on branch resources. Then Croft and Spencer consider the case in which surcharging is banned, the interchange fee is set equal to the marginal cost of an ATM transaction, and banks non-cooperatively set the foreign fee: the resulting prices maximize the joint profit. Allowing surcharging yields the result that banks with a larger customer base would prefer lower surcharges (as the bank with the larger customer base has the lower demand for foreign transactions). The model is examined to determine the conditions under which banks would voluntarily agree not to surcharge. They find that only when banks are of sufficiently similar sizes would such agreements be struck, but the agreement would entail higher interchange and foreign fees than would be the case were surcharges simply banned. They point out that given the heterogeneity in sizes of ATM network participants, especially when one considers non-bank ownership of ATMs, no-surcharge agreements are simply impractical, and that as long as surcharges aren't banned they will likely become widely adopted. They address the fixed size of the network to some extent in their model by showing that greater customer access to ATMs by linking or sharing of ATMs always raises customer welfare. As a result they express the opinion that the loss of welfare from ATM surcharges may be a short-run effect followed by increased customer welfare with the increased number of ATMs that surcharging encourages.

## 5 Summary and suggestions for future research

There are four general areas of effects of ATM pricing regimes that are identified in the literature on ATM pricing. ATM prices regimes can affect the welfare of consumers directly in their searching for and traveling to the most economical ATMs to access to their deposit accounts. ATM pricing regimes can affect the number of ATMs deployed, and the ownership of ATMs by banks or by nonbank organizations. ATMs and their pricing regimes can affect the use and pricing of branch and account facilities of banks. Finally, ATMs and ATM pricing regimes can affect rates paid on deposits, and banking competition generally. Some of these different aspects of ATM pricing are touched on in several of the models reviewed here. Some models cannot address a particular effect, and no model addresses the issues involved in all of the areas identified by the themes.

The introduction of ATMs by banks produced a significant increase in transactions by bank customers, as basic price theory would predict, given the convenience of ATMs. This effect has been attenuated by the increasing propensity of banks to levy both foreign fees and surcharges for ATM use, but several models still suggest that consumer welfare is enhanced by the presence of ATMs.

The strategic use of ATMs and ATM fees has been explored in the theoretical literature. ATMs themselves can be used to increase the differentiation of a bank's services, and reduce the intensity of deposit-fee competition. ATM fees can subtly affect banking competition in a number of ways. Various models show that a collectively set interchange fee can be an instrument of tacit collusion. Other models show that by setting the interchange fee at marginal cost, and banning surcharges, the non-cooperative setting of on other's fees can achieve the joint profit-maximization outcome.

Other models consider the affect that prices and the pricing regime has on the deployment of ATMs. Salop (1990) suggests that self-regulation of pricing by ATM networks should be deregulated, allowing banks to charge surcharges and foreign fees with no interchange fees. He claims that deployment of ATMs will increase relative to the no-surcharge, interchange fee regime. ATM deployments did appear to increase following the rule changes that allowed banks to charge surcharges, but other authors, such as Massoud and Bernhardt (2001) caution that the deployment of ATMs might be excessive, and that ATM surcharges could exceed joint profit-maximizing levels.

Future research could focus on unifying the somewhat disparate results in different papers in the literature. The spatial competition of banking and how it is modeled is an important building block of pricing models and their equilibria, and it would be useful to examine all the different pricing regimes considered by various authors in a single model of the spatial market. Croft and Spencer (2002) have perhaps the richest model, both in terms of using a well-known model of spatial competition, but also by considering a wide range of pricing regimes that capture the complexity of various institutional arrangements in different countries. Models based on their set-up could be constructed then to focus on depositor affiliation and ATM deployment under specific pricing regimes to determine the outcomes of those additional considerations under various pricing regimes.

The empirical literature could also be enriched. Here the constraint may well be the availability of data. Federally sponsored surveys provided the data for Saloner and Shepard (1992) and Hannan et al. (2003). These surveys provided snapshots of behavior at particular times. More extensive work with individual ATM networks might yield a more complete set of data with which one could test some of the hypotheses the theoretical

literature has generated. One state in the U.S., for example, resisted surcharging for a considerable time after surcharges became common in other states. Such a case can provide a natural experiment for testing whether surcharges raise prices, increase deployments of ATMs and raise consumer welfare, as long as sufficient data can be collected.

ATM networks have created some of the most challenging pricing problems that have been confronted by industrial organization economists. By employing interchange fees, foreign fees, and surcharges, banks can affect one's own customer's use of one's own branches, ATMs, and other banks ATMS, as well as affect other customer's use of one's own ATMs. In addition a bank can deploy ATMs and set ATM fees, holding fixed the deposit fees, to attract depositors to the bank. Banks also face fringe competition from nonbank owners of ATMs. Interchange fees are jointly determined, competition takes place spatially, and with network effects in demand. As a result, the literature has not yet fully determined a general model of the affects on competition of various pricing regimes, and different countries utilize alternative models. One would expect a great deal of research to continue to pursue a number of open questions, including whether ATM surcharges lead to an over-deployment of ATMs, whether bank competition for depositors is softened by interchange fees, and whether large banks can use ATMs and surcharges to disadvantage smaller rivals in competition for depositors.

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