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ABSTRACT

This paper presents an empirical study of the strategic contributions of automated teller machines (ATMs) to improving a bank branch's local deposit market share at the expense of its competitors. By extending previous models of deposit market share in branch banking to incorporate ATM technology variables, we develop a tool to provide answers and insights on key questions involving the evaluation of strategic impacts of information technology (IT) that have not previously been measured in this context. Our results suggest that a bank's ATM network membership decision is crucial to its later success in enhancing deposit market share. However, we find little evidence that branch ATMs provide additional competitive leverage to increase a branch's local deposit share.

1. INTRODUCTION

Automated teller machines (ATMs) are often regarded as weapons that commercial and savings banks use to capture or protect deposit market shares in return for providing higher levels of convenience to their depositors. Measuring these strategic impacts on deposit market shares poses a difficult problem for retail bank managers. ATMs, like other information technologies (ITs) that may play a role in improving a firm's competitive position, create strategic and operational impacts that are not readily traced directly to the investment itself.

As a result, electronic banking managers are faced with many questions related to the intrinsic value of the operations they oversee. For example, does the presence of an ATM at a branch provide extra leverage to improve market share? If so, to what extent can deposit market share be attributed to this kind of ATM deployment? Is the size of a regional deposit market increased by concentrated ATM deployment? How important is the bank's network membership decision? Under what conditions is it valuable for a bank to be a member of the dominant network in a region?

1.1 IS Research Context and Approach

In this paper, we present an *empirical* evaluation of the impact of ATMs on territorial competition among branch banks for retail deposits. By investigating their importance as determinants of deposit market share relative to other branch design variables, we hope to provide insights about how managers can gauge the strategic contribution of this information technology. The empirical evaluations presented here were developed to yield direct answers to key questions posed by electronic banking managers. This approach is suggestive of the kinds of evaluations that can be performed in other contexts where firms utilize electronic networks to improve their competitiveness.

Due to the difficulty of collecting data on the strategic outputs of production processes involving IT, state-of-the-art performance assessment methods often lack adequately rich test cases. In this study a large amount of data was collected to enable a thorough empirical evaluation of the strategic contributions of a well-known IT whose impacts are not well understood. As such, we believe this study provides a benchmark example for the literature on IT performance evaluation.

1.2 Organization of the Paper

The following section reviews the relevant literature on ATM assessment, branch banking performance and market share estimation. Building on this literature, we next present the bank branch deposit market share model and a description of the data set used in the empirical evaluation. The model focuses on two kinds of ATM-related variables: the presence of branch ATMs and network membership choice. The latter is particularly interesting in view of the continued growth and development of networks in the financial services and other industries. We then present the results of our estimation for the demand deposit and savings deposit data sets. In addition to the entire population of branches, we also perform estimations for a group of branches located in the center of a large city and for groups of branches competing in territories where a particular shared ATM network dominates. These *partitions* of our data sets enable us to validate our initial results and gain additional insights into the influence of specific regional and competitive factors. Following this, we present the form and estimation results of a model of deposit market size that incorporates ATM deployment. The paper closes with a summary of the major contributions of our work.

2. PREVIOUS RESEARCH

In order to evaluate strategic contributions of ATMs, we need to develop a basic model of the impacts of ATMs on deposit market shares and overall market size. Since ATMs create second order impacts, we must also consider other kinds of factors that drive inter-branch deposit competition. In this section, we review four studies that employ multivariate regression models for bank branch performance assessment, and a fifth that investigates a "multiplicative competitive interaction" (MCI) model of branch deposit market share (Jain and Mahajan 1979). The former group is useful in identifying the key candidate variables for inclusion in our models; the latter is useful for the variables it includes and the way it depicts branch-to-branch deposit competition. Each of the regression studies shares the commonality of attempting to estimate a particular metric that surrogates for overall bank branch performance in terms of three types of independent variables: demographics, competition, and branch design characteristics. For comparison to our own work, descriptive overview of the studies and the variables used for deposit market share estimation is presented in Figure 1.

Authors / Estimation Method	Dependent Variables	Independent Variables		
		Demographics	Competition	Branch Design
Regression Studies				
Alexanderson (1969)	Net branch earnings	% > age 65 Median income	# of financial institutions	
Clawson (1974)	Net savings gain	% age 45-64	Avg savings gain by competition	Exterior attractiveness
Lord and Olsen (1979)	Demand/saving deposit dollars	% rented vs owned houses Local - employment - buying power - retail sq ft	# nearby owned branches # of other branches nearby	
Doyle et al (1981)	# of accounts Avg value of accounts	% > age 65 # retailers % service, prof, constr employed	# of banks Key competitors Region dummies	Branch age Night safe
MCI Studies				
Hansen and Weinberg (1979)	Demand deposit market share		Bank name Distance from shopping center	Branch age Drive-up window Walk-up window
Banker and Kauffman (1988)	Demand/saving deposit market share		Institution type - commercial - mutual saving - S&L ATM network membership	Walk-up window Drive-up window Branch ATM Branch age # platforms Name recog Interest rate

Figure 1. Variables in Six Bank Branch Market Share Studies

2.1 Multivariate Regression Models of Bank Branch Performance and Deposit Market Size

Alexanderson (1969) uses linear regression to estimate the net earnings of a branch. He finds that for people older than 65, median family income and the number of financial institutions are significant predictors of the dependent variable. This kind of approach provides management with information about the socio-economic correlates most beneficial to its own bank's performance. Clawson (1974) uses step-wise regression on a small sample of 26 savings and loan branches. He determines that for people aged 45 to 64, average net savings gain by the competition and the attractiveness of the branch exterior are significantly correlated with a branch's net savings gain.

Olsen and Lord (1979) model branch performance in terms of demand, supply and performance variables. *Demand variables* are demographic indicators of the extent to which a branch's products and services are demanded by consumers. *Supply variables* capture the extent to which a bank's and its competitors' are located nearby. Olsen and Lord find that demographic variables describing a combination of the local population and the commercial environment are most useful in predicting demand and savings deposit collection performance.

Doyle, Fenwick and Savage (1981) expand further on previous multivariate regression models and confirm the usefulness of Olsen and Lord's combination of population and commercial area regressors. They find that it is useful to model branch performance in terms of: interactions among the demographic and commercial characteristics of a logically defined trade area around a branch; a description of the branch site chosen in terms of distance from a retail area and proximity of competitive branches; a measure of the competitive intensity in a trade area; and two branch design characteristics -- branch age and the presence of a night safe.

2.2 MCI Model for Market Share Estimation

In addition to identifying relevant variables for inclusion in our models, we also need to identify a means by which to adequately represent market competition. Utilizing a "multiplicative competitive interaction model," Hansen and

Weinberg (1979) model the interaction among design characteristics of a branch bank and its competitors in terms of the extent to which they attract depositors and their deposits. For this reason the MCI model is often called a "gravitational model" of market share (Nakanishi and Cooper 1974). Hansen and Weinberg find that bank name, distance of the branch from a shopping area, branch age and the presence of drive-up and walk-up windows represent attractive features that can influence the deposit shares of branch banks.

The MCI model is well-suited to our purposes. It provides a useful tool to model competition, because it emphasizes the interactions among variables and competing firms. In this sense, it is the "right" modeling approach because it can simultaneously handle the design variables that distinguish branches from one another and varying numbers of competitors and territories. Incorporating ATM-related variables allows us to build on the results of Hansen and Weinberg while investigating ATM impacts on deposits directly. This also represents an improvement on the regression studies of branch deposit share, which are weak in capturing the rich tapestry of inter-branch competition. Using the MCI model also allows us to exclude demographic variables from our market share models, since all competitors in a territory face similar population demographics. Instead, demographic variables only need to be incorporated in our deposit market size model, where we focus on the collective impacts of banks' ATM deployment decisions in different markets.

The MCI model has been validated in a variety of areas outside retail banking. For example, Jain and Mahajan (1979) present an MCI model for urban supermarket chain store locations, which utilizes store image, layout, service and other design characteristics under the control of management. More recently, Ghosh and Craig (1983, 1986) discuss supermarket and convenience store outlet market share estimation problems in the context of integrated delivery system design.

3. BRANCH BANK DEPOSIT MARKET SHARE MODEL

We can attribute a strategic contribution to ATMs in the branch banking context if we are able to provide evidence that ATM-related design characteristics are significant predictors of a branch bank's share of market deposits. Providing such evidence requires:

- identification of a broader set of explanatory variables for branch deposit market share;
- realistic model of the mechanics of branch-to-branch deposit taking and the resulting equilibrium;
- sufficient competitive information to estimate the model.

3.1 Market Share and Branch Design Variables

Figure 2 presents an overview of the variables we utilized and distinguishes among those included in the savings and demand deposit market share models.

BRANCH DESIGN VARIABLE	DEMAND SHARE MODEL	SAVINGS SHARE MODEL	VARIABLE DESCRIPTION
Dependent Variables			
Demand Deposit Share (DEMSHARE)	X		Branch demand deposits divided by the sum of all deposits in BOT
Saving Deposit Share (SAVSHARE)		X	Branch saving deposits divided by the sum of all deposits in BOT
Independent Variables			
Commercial Bank (COMMBK)	X		0/1 variable for commercial bank type
Mutual Savings Bank (MUTSAVBK)		X	0/1 variable for mutual savings bank type
Savings and Loan (S&L)		X	0/1 variable for savings and loan bank type
High Interest Rates in 1986 (HIRATE)	X	X	0/1 variable for higher than average bank interest rate, as judged by bank branch managers surveyed.
Branch Age (AGE)	X	X	Continuous with branches > 12 years old coded as 12 years
Name Recognition (NAME)	X	X	5-point scale, based on evaluations made by bank branch managers.
Walk-up Window (WALKUP)	X	X	0/1 variable for presence of walk-up window at branch.
Drive-up Window (DRIVEUP)	X	X	0/1 variable for presence of drive-up window at branch.
Platform stations (PLATFORM)	X	X	Number of human, non-teller service locations.
Branch ATM (ATM)	X	X	0/1 variable for presence of ATM.
MAC Member (MAC)	X	X	0/1 variable for MAC membership

Figure 2. Definitions of Branch Market Share Model Variables

The dependent variable in our market share model is a branch's percent of the total amount of deposits collected by all the banks within its competitive territory. Since bank managers believe a variety of design characteristics play different roles in influencing depositors to leave demand and savings deposits, separate models for demand and savings deposits will be tested.

The independent variables included in our market share models fall into four categories: the organization type of the owning financial institution; characteristics that are not part of a branch's physical design; characteristics that describe a branch's physical design; and ATM-related variables. The specific variables chosen are based on a combination of the guidance and experience in modeling presented in the literature and discussions we conducted with electronic banking and branch network administrators.

There are three kinds of bank organizations present in our empirical sample. *Commercial banks* and *mutual savings banks* are able to compete for both demand and savings deposits, although these bank types are not regulated by the same authorities. *Savings and loan associations* are restricted to competing for savings deposits. Similar to Hansen and Weinberg's model, we include branch interest rate, branch age, and the name recognition of the owning financial institution as the primary non-physical characteristics of a bank branch. We also include walk-up and drive-up window variables, and the number of non-teller stations on the branch service platform. Each of these variables is thought to provide convenience or additional service levels that make a branch attractive to retail depositors.

Our ATM-related variables were chosen based on the questions we hoped to answer. In order to test for the strategic contribution of branch ATMs, for example, our model contains a qualitative variable for the presence of a branch ATM. A second ATM variable indicates the shared ATM network to which a bank belongs.

3.2 Deposit Market Share Model Formulation

The mathematical statement of the MCI model for the market share of branch j in territory k for demand or savings deposits is given below.

$$MS_{jk} = \frac{\prod_{c \in C} X_{cjk}^{\beta_c}}{\sum_{j \in J_k} \prod_{c \in C} X_{cjk}^{\beta_c}}$$

where

MS_{jk} = *branch j's deposit share in territory k*

X_{cjk} = *the* c^{th} *design characteristic of branch j in territory k*

J_k = *the set of all branches,* $\{1, ..., n_k\}$, *in territory k*

β_c = *estimated "intensity" exponent for characteristic c*

This model states that a branch's ability to capture a share of the market for retail deposits is not just a function of management's design choices for the branch. It is a function of the design choices of the additional competitors in the set J_k in the branch k's territory. Because the MCI model is a multiplicative specification, it enables us to capture the interactions of the design choices of the branch competitors in their local markets. This model cannot be estimated directly using OLS methods. However, Mahajan, Jain and Ratchford (1978) suggest a log-transformed-centered form that enables direct estimation. The estimation form of the MCI model we used is as follows:[1]

$$log(MS_{jk} / MS_{jk}^{*}) = \sum_{c \in C} \beta_c \, log(X_{cjk} / X_{cjk}^{*}) = \sum_{c \in C} \beta_c Z_{cjk}$$

where

$MS_{jk}^{*} = [\prod_{j \in J_k} MS_{jk}]^{(1/n_k)}$ = *branch mkt share geometric mean, territory k*

$X_{cjk}^{*} = [\prod_{j \in J_k} MS_{cjk}]^{(1/n_k)}$ = *feature c's geometric mean among branches in k*

$Z_{cjk} = log(X_{cjk} / X_{cjk}^{*})$

3.3 The Data Set

Our data set is based on the operations of a large regional commercial bank and its competitors in the southeastern part of Pennsylvania in 1986. The bank operates a large network of branches and ATMs, and is a member of a popular regional shared ATM network known as "MAC." MAC competes closely with a second smaller network known as "CashStream" throughout the state. We obtained data on a subset of the bank's and its competitors' operations, including 87 branches and their nearest rivals. The operating environments of these branches were studied by the bank's branch and electronic banking executives in order to represent the logical set of interactions that an owned branch and its supporting product delivery infrastructure is likely to have with those of its competition. As a result, we were able to identify all of the competing branches in the vicinity of the bank's branches. Altogether, we collected data on 508 branches that compete for savings deposits and 393 branches that compete for demand deposits. The difference in size of the initial samples is due to the fact that some savings and loan associations are left out of the demand deposit estimations, since they are excluded from the competition for demand deposits by state and federal banking authorities.

We subsequently utilized U.S. census maps and customer deposit account information, in consultation with bank managers, to identify the set of census tracts that would best represent the population demographics of the area in which a branch competes. The final determinant of a census tract's membership in a particular territory was whether the bank's branch held accounts of depositors living in the census tract. Where overlaps occurred, we later merged some of the previously defined territories. This resulted in 54 disjoint sets of census tracts and unique demographics. We term these competitive areas *branch operating territories* (BOTs). Our treatment is similar to that of Doyle, Fenwick and Savage (1981), who also use a trade area concept; we have also captured between 50 percent and 100 percent of a BOT's account holder demographics. This approach is attractive to managers because it enables them to represent the competitive environment as it exists, rather than in terms of artificial boundaries (e.g., all competitors within a 1.5 mile radius of the branch).

For an accurate reflection of bank branch savings and demand deposit market shares, we relied on an annual publication that gathers market share data from local, state and federal regulatory sources (Decision Research Sciences Inc., 1987). Information on the design variables at the branches of the bank and its competitors was developed in cooperation with branch managers at the research site. We cross-checked our data on the presence of an ATM at a competing branch, as well as the competing bank's network affiliation with ATM directories published by MAC and CashStream. Branch administration and electronic banking managers provided additional feedback. Finally, we benefited from the cooperation of a regional marketing research firm, which granted access to a database of recent census information. All the demographic variables used in this study were constructed from raw census tract data; this was later processed to match the level of aggregation of the BOTs.

4. MCI RESULTS

To produce the results presented below, we ran two separate MCI models for the 54 BOTs, one each for demand and savings deposits market share estimation. Following examination of our initial results, we further partitioned the data into exhaustive and mutually exclusive subsets to test whether our overall results were validated in smaller samples and to further explore regional competitive differences. Partitioning the data set allows us to implicitly treat variables that do not have different values within a BOT but vary across them. Our partitions are shown below, followed in parentheses by the estimations that correspond to them.

- The entire population of demand (saving) deposit competitors. (D1, S1)
- Demand (saving) deposit competitors in center city Philadelphia only. (D2, S2)
- Demand (saving) deposit competitors in BOTs dominated by MAC outside center city Philadelphia. (D3, S3)
- Demand (saving) deposit competitors in BOTs dominated by CashStream outside center city Philadelphia. (D4, S4)

Our reasoning for making the center city Philadelphia partition is that it is a major center of business, where many of the regional banks' head offices are located. We expected the dynamics of inter-branch competition to be quite different in this setting. Based on interviews with the bank's managers, we learned that branch design features may have less influence on deposit shares there. Many of the deposits result from commercial relationships; few branches have drive-up or walk-up windows; and often the head offices of regional banks book deposits that are not carried on smaller branches' ledgers. Partitioning the non-Philadelphia MAC and CashStream-dominated BOTs, on the other hand, is essential for our evaluation of ATMs' strategic contribution. It provides us with an intuitive means to identify the value of ATM network membership when a particular network is locally dominant. Competition may also be quite different in these areas because of the under-representation of key regional banks. Since southeastern Pennsylvania is largely MAC-dominated, the presence of CashStream-dominated BOTs may create special barriers to entry in the deposit market for MAC banks and their ATMs. If so, this may be reflected by differences in the coefficients of the ATM network membership variable in the partitions.

4.1 Overall Demand and Savings Share Results: D1 and S1

The results of our estimation of the model for demand (D1) and savings (S1) deposit market shares that include all the branch observations is shown below in Table 1. Similar to results presented by Hansen and Weinberg (1979), the variables included in our model provide substantial explanatory power for the variation in branch demand deposit shares.

4.1.1 Results for ATM-Related Variables

Our primary result is that membership in the MAC network (MAC) appears to have a significant and positive influence on a branch's market share of local deposits. This suggests that MAC membership creates strategic advantage for branches whose owning financial institutions have chosen this network. Since MAC is regionally the dominant network, this result make sense: bank customers benefit from the increased convenience associated with a larger number of ATMs and respond by giving banks their deposits. Our results quantify the payment consumers are willing to make to banks which provide this attractive network externality.

Table 1. Deposit Market Share Results: All Observations

Independent Variables	Estimation D1 Coef	Estimation D1 t-stat (Signif)	Estimation S1 Coef	Estimation S1 t-stat (Signif)
COMMBK	1.93	9.99 (.001)	----	----
S&L	----	----	0.49	4.08 (.001)
MUTSAVBK	----	----	0.97	6.73 (.001)
NAME	1.21	2.77 (.005)	0.64	5.16 (.001)
HIRATE	0.63	1.72 (.09)	0.11	1.06 (.29)
AGE	0.89	6.43 (.001)	0.64	6.72 (.001)
WALKUP	0.33	0.93 (.35)	0.00	0.04 (.97)
DRIVEUP	0.04	0.12 (.90)	-0.04	-0.27 (.64)
PLATFORM	0.629	5.125 (.001)	0.67	7.95 (.001)
ATM	-0.02	-0.17 (.87)	0.08	0.96 (.34)
MAC	0.26	2.03 (.04)	0.27	3.01 (.003)
R-squared	.37		.32	
Adj R-squared	.35		.31	

A second striking result is that the presence of an ATM at the branch (ATM) does little to improve the branch's strategic position. Instead, we may need to conduct other kinds of tests to identify different contexts where they create a quantifiable advantage. For example, we might wish to look at the impact of a branch ATM on the branch work flow or backoffice inquiry processing.

Though the results we found for the ATM-related variables are interesting, these variables do not provide the greatest explanatory power for deposit shares among the range of variables included in our model. Clearly, our IT variables represent second order impacts, thus confirming management's overall intuition about the strategic contribution measurement problem.

4.1.2 Results for Non-ATM-Related Variables

The age of a bank branch (AGE) and its organizational charter proved to be the most important predictors of market share. The positive sign of the AGE coefficient is generally confirmed by the literature (Hansen and Weinberg 1979; Doyle, Fenwick and Savage 1981). Branches require a startup period before they can capture an equilibrium market share. This result is strengthened by the fact that we truncated the AGE variable at twelve years. Although many of the branches are older than twelve years, we lost little explanatory power as a result.

The positive coefficient of COMMBK suggests the competitive value of a commercial bank versus a mutual savings bank charter for the southeastern Pennsylvania region. A similar result was found for the savings deposit estimation: mutual savings banks and savings and loans associations are legally able to offer different rates on certain classes of savings deposits.

The variable that is our surrogate for branch size, PLATFORM, is also positive, suggesting that larger branches typically capture larger market shares. We recognize that PLATFORM can also be a surrogate for branch effort, local advertising expenditures and so on; each could be a reaction to the current market share level. What is more important for our present purposes, however, is that PLATFORM is a separate construct, not highly correlated with our other independent variables.

Interestingly, the other primary physical design characteristics (WALKUP, DRIVEUP) at the branches appear to offer little explanatory value for market shares. This is an interesting result because it was rather unexpected: the bank managers we interviewed almost unanimously suggested that given competitive levels of account pricing, interest rates and service, these physical design characteristics were likely to be important.

Bank name recognition (NAME) in the local marketplace also explains a significant portion of the variance in both the demand and saving deposit market shares. Banks with relatively higher interest rates in 1986 (HIRATE) gained added market share on average, but the attractiveness of a high interest rate did not surpass the persuasiveness of a bank's name. One expects this to be the case when significant transaction costs exist that make it difficult for depositors to move accounts from one bank to another.

Overall, the evidence suggests that the processes underlying the creation of demand and savings deposit market share are not substantially different within our data set. Similar results and stable coefficients from two different samples increase our confidence in them by validating the models we tested as useful for understanding deposit market share competition in both contexts. Since we have only worked with data from the southeastern Pennsylvania region, external validation of our results on data from other areas is required before our result for the strategic contribution of ATM network membership for can be thought of as a general one.

4.2 Partitions for the Demand Deposit Share Estimations: D2, D3 and D4

In this section we elaborate on the results presented above regarding demand deposit market share competition by investigating three partitions of our data set (D2, D3 and D4). The results of our estimations of the partitioned data sets are shown below in Table 2.

Table 2. Market Share Results: Demand Deposit Partitions

Independent Variables	Estimation D2 Coef	Estimation D2 t-stat (Signif)	Estimation D3 Coef	Estimation D3 t-stat (Signif)	Estimation D4 Coef	Estimation D4 t-stat (Signif)
COMMBK	2.50	5.31 (.001)	1.15	3.92 (.001)	2.09	6.91 (.001)
HIRATE	0.83	0.98 (0.33)	-0.54	-1.01 (.31)	1.66	2.64 (.008)
AGE	0.74	2.14 (.04)	1.54	5.98 (.001)	0.76	3.96 (.001)
NAME	0.42	0.30 (.77)	1.79	2.46 (.01)	1.44	2.57 (.01)
WALKUP	0.13	0.16 (.87)	-0.23	-0.37 (.71)	1.22	2.57 (.01)
DRIVEUP	0.85	0.49 (.62)	0.80	1.79 (.08)	-0.38	-0.97 (.33)
PLATFORM	1.39	3.89 (.001)	1.79	1.87 (.07)	0.53	3.41 (.001)
ATM	-0.58	-1.24 (.22)	-0.16	-0.87 (.38)	0.14	0.92 (.35)
MAC	0.41	1.04 (.30)	0.14	0.66 (.51)	0.35	2.24 (.025)
R-sq.	.45		.43		.41	
Adj R-sq.	.39		.39		.38	

4.2.1 Demand Deposit Share in Center City Philadelphia

In center city Philadelphia (D2), MAC network participation (MAC) is no longer a significant explanatory variable of demand deposit levels. This is not unexpected given the primarily commercial nature of bank business in the area. The variable representing an ATM at the branch (ATM) is also not very significant. The slightly negative coefficient we estimated might be explained by the fact that head offices of regional banks may not have located as many ATMs in the area as smaller banks, which push for the center city retail business. The somewhat negative ATM coefficient, then, may reflect the niche strategies of these smaller competitors, who are at a competitive disadvantage for large dollar deposits due to their business orientation.

The AGE, COMMBK and PLATFORM variables continue to be strongly positive and significant. Further support for the usefulness of our partitioned estimates is that the coefficient of COMMBK is even more positive in the center city Philadelphia sample. This is indicative of the concentration of commercial bank head offices and the higher levels of non-retail deposits.

4.2.2 The Effect of Network Dominance on Market Share

Moving on from purely regional differences, we further probed the results of Estimation D1 to deepen our understanding of the conditions under which membership in the dominant network matters. In particular, we posed more specific questions about deposit market share influences, such as:

- Does the network membership decision matter when the *regionally dominant* network is also *locally dominant* within the BOT?
- Do branch ATMs evidence a strategic contribution in these special circumstances?

The means developed for our test was to classify BOTs in terms of whether they were "MAC-dominated." A BOT is said to be "MAC-dominated" if greater than two-thirds of the total ATMs in the BOT are MAC network ATMs. Thus, the estimations we are reporting were performed using just two categories: "MAC-dominated" (D3) and "not MAC-dominated" (D4). The latter aggregates Cash-Stream-dominated and neutral BOTs.

MAC membership in MAC-dominated BOTs is no longer significantly different from zero. A possible explanation follows from the logic of gravitational models of market share. A competitor with attractive features will increase market share only so long as the desired feature is not shared by the competition. In this case, participation in the dominant network, while beneficial to a branch's customers, does not make it any more attractive than other participating branches.

In those BOTs that are not locally dominated by MAC, a different picture emerges. Membership in MAC exhibits a positive effect, stronger than in any other sample we tested. As in other models, the AGE, COMMBK, NAME and PLATFORM variables also provide significant explanatory power. The presence of an ATM at a branch, however, continues to be a poor predictor of a branch's competitiveness. Clearly, the potential deposit market share effects of an ATM at a branch would be a poor basis on which to justify a new location decision.

Otherwise, the competition for demand deposits in MAC-dominated BOTs appears to behave as we described in the base case, Estimation D1, with few exceptions. Branch age, commercial bank charter, branch interest rates and the number of platform stations (AGE, COMMBK, HIRATE, PLATFORM) are all positive and significant. In addition, the qualitative variable for the presence of a driveup window (DRIVEUP) has become positive and weakly significant. Thus, the presence of an ATM at the branch seems to be less important in a branch's service delivery system than a driveup window, at least for gathering deposits, since it is unlikely that the ATM variable is significantly different from zero.

4.3 Partitions for the Saving Deposit Share Estimations: S2, S3, S4

Table 3 reviews the results of the partitions made for Estimations S2, S3 and S4.

Table 3. Market Share Results: Savings Deposit Partitions

Independent Variables	Estimation S2 Coef	Estimation S2 t-stat (Signif)	Estimation S3 Coef	Estimation S3 t-stat (Signif)	Estimation S4 Coef	Estimation S4 t-stat (Signif)
MUTSAVBK	0.67	2.55 (.01)	1.28	5.51 (.001)	0.98	3.50 (.001)
S&L	0.51	1.33 (.18)	0.66	3.12 (.002)	0.47	2.91 (.004)
HIRATE	0.19	0.87 (.38)	0.06	0.34 (.73)	0.12	0.72 (.47)
AGE	0.48	2.36 (.02)	1.05	5.50 (.001)	0.63	4.55 (.001)
NAME	0.18	0.52 (.61)	0.69	3.12 (.002)	0.79	4.47 (.001)
WALKUP	-0.18	-0.64 (.40)	-0.17	-0.76 (.45)	0.28	1.78 (.08)
DRIVEUP	0.01	0.02 (.98)	0.18	1.18 (.24)	-0.18	-1.52 (.13)
PLATFORM	1.35	6.15 (.001)	0.46	2.85 (.004)	0.56	4.62 (.001)
ATM	-0.31	-1.23 (.22)	-0.001	-0.002 (.99)	0.27	2.32 (.02)
MAC	0.03	0.14 (.88)	0.22	1.45 (.15)	0.46	3.93 (.001)
R-sq	.50		.35		.33	
Adj R-sq.	.44		.31		.30	

The results obtained for the savings market shares of branches located in center city Philadelphia (S2) are quite comparable to the results of the demand deposit estimation for the area (D2). When we compare the results of the MAC-dominated BOTs (S3) to center city Philadelphia, we again find that membership in the dominant network, MAC, alone cannot boost a branch bank's competitiveness when its competitors are also connected. The MAC variable is not highly significant. The presence of an ATM at the branch also provides little additional explanatory power for variation in savings deposit market shares. Besides the ATM variables, the coefficients of most of the other variables have the same signs, magnitudes and levels of significance.

The results of the savings share estimation for branches located in CashStream-dominated and neutral BOTs, are quite different. It turns out that the MAC membership variable there is now highly significant and positive. In addition, the branch ATM variable takes on a positive value which suggests that a branch ATM variable may play a role in aiding the branch to gain savings deposit market share. This latter result is not validated elsewhere by our partitioned data.

Based on corroborating evidence from multiple partitions of our data sets, we can make the following assertions regarding the strategic value of ATMs in southeastern Pennsylvania.

1. Membership in the *regionally* dominant network (MAC) improves a branch bank's market share of deposits, particularly when the branch operates in a BOT that is otherwise dominated *locally* by the smaller network overall (CashStream).

2. Our results offer little evidence that ATMs at the branch can beneficially impact deposit market shares, with the exception of BOTS that are not-dominated by MAC. In southeastern Pennsylvania it generally does not make sense to justify new ATM locations on this basis.

5. THE IMPACT OF ATM DEPLOYMENT ON DEPOSIT MARKET SIZE

Retail banking industry observers frequently speculate that high density deployment of ATMs may enable banks to increase the overall size of the deposit market in a region. The convenience consumers experience supposedly encourages them to concentrate more funds with banks given the ease with which money can be moved among these and other demand and savings deposit accounts. Previous work in this area, particularly the multivariate regression studies discussed earlier (Alexanderson 1969; Clawson 1974; Olsen and Lord 1979), offers a useful basis to build predictive models for total BOT demand and savings deposits. Such models incorporate the exogenous influences of the demographic environment that characterizes competitive territories and suggest the *potential*, rather than actual, levels of deposits that banks can capture.

5.1 The Deposit Market Size Model

Our model is operationalized as a multiplicative power function, similar to those found in Ryans and Weinberg (1979, 1987), and Banker, Morey and Wilson (1987). Application of a logarithmic transformation yields the estimation form of the model:

$$\begin{aligned} \text{TOTALDEP} = {} & \text{CONSTANT} + \beta_{\text{FIHH}}\log(\text{FIHH}) + \beta_{\text{POP}}\log(\text{POP}) \\ & + \beta_{\text{POPHH}}\log(\text{POPHH}) + \beta_{\text{PCINC}}\log(\text{PCINC}) \\ & + \beta_{\text{HH35}}\log(\text{HH35}) + \beta_{\text{HIATMPOP}}\log(\text{HIATMPOP}) \\ & + \epsilon \end{aligned}$$

The variable FIHH represents the number of financial institutions per household in a BOT. This provides an indication of aggregate effort made by all banks in the BOT to capture household deposits. Our demographic variables were chosen to represent the size of the population, its age and its income level. Variables POP and POPHH represent population and population per household in a BOT. The variable PCINC is a measure of BOT per capita income. Aggregate potential deposit levels are also likely to be influenced by the extent to which a given population saves its income. We utilized HH35, which represents the number of household heads of age 35 or less, as an indicator. Finally, HIATMPOP was included as a qualitative variable that identifies BOTs that have a relatively high density of ATMs per person. HIATMPOP was coded 1 when a BOT had greater than the mean number of ATMs/POPULATION in our sample, and 0 otherwise. The same variables were tested for both savings and demand deposits. The data set in this case was limited to 54 observations, the BOTs described above.

Inspection of Table 4 (below) suggests that the deposit market size models we constructed have substantial predictive power.

These results, however, provide little evidence that a high concentration of ATMs provides banks with added leverage in extracting potential market deposits. Similar results were obtained for both demand and saving deposits. Although the coefficients of HIATMPOP are negative in our results, it is unlikely that they are significantly different from zero. If they were less than zero, this might provide evidence that an area is over-banked, experiencing excess competition in view of the population demographics. At best, we expected only a slightly positive coefficient, indicating the presence of a small second order effect.

Table 4. Market Size Results: Demand and Savings Deposits

Independent Variables	Demand Deposits Coef	Demand Deposits t-stat (Signif)	Saving Deposits Coef	Saving Deposits t-stat (Signif)
CONSTANT	0.81	0.20 (.84)	10.70	3.96 (.001)
FIHH	1.23	6.42 (.001)	1.29	10.06 (.001)
POP	1.20	8.07 (.001)	1.12	11.25 (.001)
POPHH	-1.29	-1.47 (.15)	-2.18	-3.69 (.001)
PCINC	0.96	2.68 (.01)	0.20	0.85 (.40)
HH35	1.11	2.17 (.04)	0.10	0.29 (.77)
HIATMPOP	-0.04	-0.15 (.88)	-0.17	-0.92 (.36)
R-squared	.73		.84	
Adj R-squared	.70		.82	

6. CONCLUSION

The main contribution of this paper is its empirical approach to the measurement and modeling of the strategic contributions of a financial services industry information technology: ATMs in branch banking. By building relatively intuitive models of inter-branch deposit competition, we were able to show that a bank's ATM membership participation choice can produce substantial second order strategic benefits in deposit market share. Refining our analysis, we partitioned our data sets and determined that it is particularly beneficial for a branch to be a member of a regionally dominant network that may not be dominant in its own BOT. This may indicate that network externalities are perceived by bank depositors at the regional, rather than local, level. Branch ATMs, however, were shown to have little strategic value in all the partitions of our data set, with the exception of MAC-dominated BOTs. Moreover, we found no evidence to suggest that high density ATM deployment helps banks to realize greater deposit collection potential in a market.

Our deposit market share model was developed based on insights gained from prior literature on multivariate regression and MCI models. We validated and extended results presented in earlier papers by incorporating IT variables in our analysis. By estimating partitioned data sets for both the demand and saving market share models tested, we also were able to validate the results. Based on our experience here, we feel that the MCI model is a useful tool for modeling the strategic impacts of IT in competitive situations; it warrants investigation in other IT contexts. The development of models that empirically test for linkages between information technology deployment and its strategic contributions is essential to help managers get better estimates of the return on investments in IT.

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9. ENDNOTES

1. To estimate the model we use an exponential transformation to convert qualitative variables. For example,

$$X_{cjk} = \begin{cases} e & \text{if characteristic c is present at branch j in territory k} \\ 1 & \text{otherwise} \end{cases}$$

Note that without this addition, the absence of a qualitative characteristic at a branch would force the entire geometric term for a territory to be zero, making estimation impossible.