CASE STUDY OF ELECTRONIC BANKING AT MERIDIAN BANCORP

Rajiv D. Banker
Robert J. Kauffman

Department of Information, Operations, and Management Sciences
Leonard N. Stern School of Business, New York University
44 West 4th Street, New York, NY 10012

CASE STUDY OF ELECTRONIC BANKING AT MERIDIAN BANCORP

by

Rajiv D. Banker
Arthur Andersen Chair in Accounting and Information Systems
Carlson School of Management
University of Minnesota

Robert J. Kauffman
Assistant Professor of Information Systems
Leonard N. Stern School of Business
New York University

June 1991

Published in:
Information and Software Technology, Vol. 33, No. 1, April 1991, Butterworth-Heinemann Ltd.

Working Paper Series
STERN IS-91-14
Replaces: Working Paper IS-89-7

Center for Digital Economy Research
Stern School of Business
Working Paper IS-91-14

The paper illustrates 'business value linkage impact analysis', a new method for measuring the business value of information technology (IT), in the context of a case study of electronic banking operations at Meridian Bancorp, a large commercial bank. Management science models were constructed to gauge the impact of automated teller machines (ATMs) on branch teller labour productivity and retail deposit market share, and the potential for substitution of labour by ATMs is shown. Econometric estimation of the models yielded the following results: the efficiency of teller labour was found to decline in the presence of a branch ATM; a bank's ATM network decision was shown to be an important determinant of the relative size of the retail deposit market it could capture in south-east Pennsylvania; membership in the regionally dominant MAC ATM network leveraged retail deposit market share when a clear majority of local branches and ATMs were members of a regionally smaller, competing network; and high-density ATM deployment did not lead to increases in the overall size of the deposit market.

case study, information technology, electronic banking, automated teller machines, management models

MEASURING BUSINESS VALUE: PROBLEM FOR ELECTRONIC BANKING MANAGERS

An important problem confronting electronic banking managers today is how to determine the 'business value' of automated teller machines (ATMs) to guide investment decisions. Most ATM investment decisions involve considerable judgement about how similar kinds of investments have performed in the past. As a result, there is a need for a procedure to help managers discriminate among alternative investment strategies. Since ATMs carry no direct revenue benefits other than 'interchange fees' for ATM use by a bank's competitors' customers, the indirect benefits must be considerable, even if they are not readily measured. Most electronic banking managers would agree that the relevant way to guide this process is the concept of cost-benefit analysis.

This approach is problematic for investments that involve information technology (IT). Electronic banking managers are frequently unable to quantify accurately the size of the benefits that accrue from their ATM investments. Though adding to an ATM network involves site-specific costs, the benefits to the bank are probably realised elsewhere in the organization, and so it is hard to operate an electronic banking operation as a profit centre. In addition, most ATM investments are accounted for as short-run operating costs, rather than capitalized; as a result, they flow through rapidly to the bank's income statement. The impacts, meanwhile, may take considerable time to show up. And when they do, the bank may only gain transient competitive advantage, as its competitors may react to shift the competitive balance in their favour. Thus the indirect contributions of ATMs tend to be ignored in most cost-benefit analyses because they are difficult to quantify.

One unsettling result is that ATM site proposals may be underestimating the true value of ATMs. As it is so difficult to quantify ATM investment value in most cases and the costs grow out of a firm's strategic necessity to invest, many of the investment decisions may be decided on faith alone. A benefit-myopic view of ATM investments would lead to underinvestment by senior management, and the bank's long-term strategic position might be harmed. On the other hand, it is also not difficult to understand why some ATM site proposals that are later approved 'for business reasons' may initially carry red ink.

This article presents an application of a promising new approach for measuring the business value of ATM investments: 'business value linkage (BVL) impact analysis'. It involves building the appropriate management science models to capture, or provide evidence for, IT value. Then, econometric tests can be applied to gauge the strength of the relationship between the IT investment and the resulting economic value created (if there is any) within the firm. This relationship is called the 'business value linkage', and an econometric analysis that provides evidence for such impacts is called a 'BVL impact analysis'. The purpose of using this approach to evaluate electronic banking technology investments is to provide evidence to support managerial intuition about the strategic necessity of ATMs, in view of the large financial commitments banks have made to them[1,2].

The findings presented are the results of an extended study to measure the business value of electronic banking investments, conducted during 1987 through 1989 at Meridian Bancorp, Reading, Pennsylvania, USA. The bank belonged to the MAC ATM network, the largest shared network in Pennsylvania at the time. Three kinds of business value impacts were identified in this context:

Dept of Accounting and Information Systems, Carlson School of Management, University of Minnesota, Minneapolis, MN 55455, USA.
*Dept of Information Systems, Stern School of Business, New York University, New York, NY, USA

operating costs savings, direct revenue impacts, and improved market share. Thus electronic banking offers a good testbed to illustrate how to carry out this kind of analysis.

BVL IMPACT ANALYSIS: APPLICATION AT MERIDIAN BANCORP

The Meridian Bancorp Electronic Banking Evaluation Project had several purposes[3]:

- to develop and apply state-of-the-art methods in business value measurement for investments in electronic banking technology
- to test specific hypotheses about the ways in which ATM business value is created within a bank
- to quantify ATM business value in Meridian Bancorp's electronic banking operations

These goals related to specific questions managers at the bank had been asking about ATMs. For example, what was the externality value to the bank and its customers of belonging to the MAC ATM network, then the largest in Meridian's competitive region?* How many dimensions of ATM business value can be quantified? Do ATMs provide the bank with greater benefits in some settings than in others? Do branch ATMs create deposit market share effects? Is the overall size of the deposit market influenced by ATMs? Do ATMs change the performance of branch tellers? To measure ATM business value the project was carried out in three major phases.

Phase 1: creating BVL for bank's electronic banking operations

In the first phase of the study, a BVL was developed for the bank's ATM network. Considerable effort was expended by managers at the bank, in consultation with the authors, to define the BVL so that it conformed to the organization's view of the perceived strategic impacts of ATMs. Defining the BVL for ATM impacts required several iterations with key managers in the bank's marketing research, electronic banking, and branch banking administration areas. Expending this extra effort up front, however, ensured that the study would be more useful to those who evaluated its results. The BVL defined at Meridian Bancorp is shown in Figure 1.

Creating the BVL involved specifying the input resources (e.g., cash on hand, fixed ATM and site costs, and maintenance labour) that are transformed by the production technology for ATM services into a set of valuable output commodities. This required identifying which ATM outputs make a direct impact on bank profi-

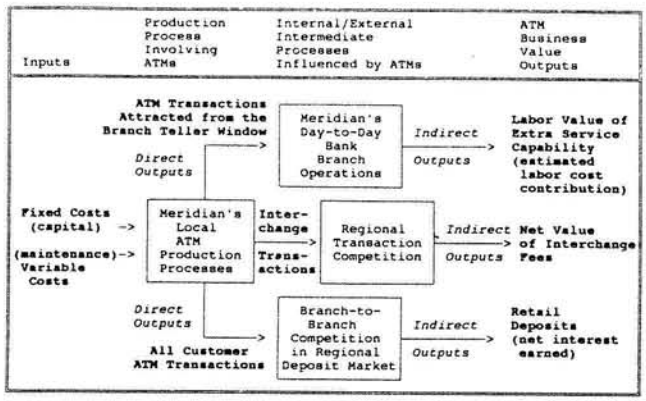

Figure 1. Conceptual model for measuring value of ATMs at Meridian Bancorp

tability (e.g., interchange fees), and which result in beneficial impacts felt by other related production processes (e.g., teller labour cost savings, and deposit volume increases in branches). In addition to the site-specific production, ATM deployment also influenced local branch operations, the market for regional interchange transactions, and regional competition for retail deposits and customer accounts.

Phase 2: output modelling and econometric estimation

The next step in the study was to create models to formalize the BVL for ATMs, as a means to identify the extent to which they were contributing to the creation of three classes of outputs. Teller labour produces banking transactions demanded by a bank's clientele. Branch ATMs can change the mix and volume of transactions that tellers are required to process. They also extend the capability of a branch and its teller labour to around-the-clock production. The production of retail deposit market share occurs in a local competitive environment in which branches configure service delivery mechanisms and offer products that generate accounts, deposits, and business for the bank.

To estimate how much ATMs contributed to the substitution of teller labour, the authors estimated ATM transaction volume for ATMs that were located at a branch or elsewhere, and the productivity of teller labour in the presence and absence of an ATM. Data for these estimations were drawn from branch platform automation, from electronic banking records kept by the bank and the MAC network, and from demographic data obtained from a local marketing research firm.

As the study was carried out to create a baseline of ATM performance at the bank, no attempt was made to build a predictive model for an ATM's ability to capture regional interchange transactions. Instead, monthly interchange transaction data were collected from electronic banking records for the ATM sites being studied, their stability evaluated from month to month, and their revenue value calculated directly.

To develop an estimate for the marginal impact of electronic banking operations on branch deposit market shares, 1986 share data were ob

*At the time the study was conducted, both the MAC and Cashstream networks operated in south-east Pennsylvania. Cashstream's operations have since been purchased by the owners of the MAC network, Philadelphia National Bank/Core States Financial. For a well documented discussion of the background and the evolution of shared electronic banking network membership and bank competition in south-east Pennsylvania, see Clemons' case study of the MAC network[2].

branches in Meridian Bancorp's operating region. Meridian's branch managers contributed a complete physical description of each bank branch competing with the one they managed, including their own. They also provided an assessment of competing branch interest rates and bank name recognition in the market. Among the most important data gathered were whether a competing bank branch deployed an ATM, and the ATM network affiliation (MAC or Cashstream) of the bank owning the branch. These data were double-checked by comparing them with related information obtained by Meridian from the MAC and Cashstream networks.

The econometric models developed provided evidence for links between ATM investments and their strategic and operating impacts. Thus the goal in this phase was the major challenge of the project as a whole: to isolate the business value of ATMs and ATM network membership in the context of the deposit market competition and branch transaction-processing activities.

Phase 3: validation and business value estimate calculation

Phase 3 concluded the project. The results obtained in Phase 2 were validated by partitioning the bank's operating region into logical subsets and re-running the econometric tests. As the data sets were large, little statistical power was lost in the tests carried out on partitioned data. This approach proved helpful in refining understanding of the competitive circumstances under which ATM business value is maximized. Finally, dollar estimates for ATM business value were calculated from the results, to estimate the relative magnitude of different impacts of ATMs. This provided a mechanism to evaluate the extent of the payback attributable to many electronic investments made largely out of strategic necessity.

BVL IMPACT ANALYSIS: RESULTS

The study obtained some new results for information systems research and useful insights for the bank. Estimates for two key ATM-related outputs were obtained that managers find difficult to measure in practice:

- the impact of a branch ATM on teller labour productivity and branch service value
- the impact of ATM network choice and branch ATM deployment on local market share of retail demand and savings deposits

ATM impacts on branch teller labour and service value

The impact of a branch ATM on teller labour productivity and branch service value was examined with two related BVL impact models. The first model forecasted ATM transaction demand in terms of population demographics, competitive factors, ATM availability, and ATM location. Although this model was interesting by itself as a transaction volume forecasting tool, the results also provided deeper insight into how ATMs can affect the demand for branch teller labour. For example, branch ATMs were found to process 25% higher transaction volumes than other ATM locations.

The second model was designed to determine whether teller labour becomes more or less productive in the presence of a branch ATM. Teller labour hours were estimated in terms of a variety of transaction types that tellers process, with and without a branch ATM present nearby. The results showed that teller labour becomes less productive in its processing of deposit transactions in the presence of branch ATMs.

A review of teller transaction-processing activities suggested that the ATM transactions represented the easiest kinds of window transactions that tellers could have handled. So, tellers were experiencing a shift in their mix of transactions; easier transactions were more often processed at the ATM. For this reason, the decrease in teller labour efficiency in the presence of a branch ATM does not diminish the business value of the ATM. Instead, the business value of the ATM becomes apparent if the costs of adding tellers to handle the cumulative transaction demand (window plus ATMs) are considered. Although some observers might argue that there is a 'technology effect' associated with ATMs (i.e., that bank customers demand more transactions from an ATM than they would ever demand at the teller windows), the business value implications are clear. The 'technology effect' should be recognised for what it is — extra service capability that only becomes available as bank customers use ATMs. Providing such service at the teller windows would be prohibitively expensive.

Direct interchange revenues

The results obtained for interchange revenue business value suggested that the bank's branch operating territories exhibit local equilibria in the competition for ATM transactions. It was found that 75% of the bank's ATMs have less than a 4% deviation from the mean percentage of interchange transactions created at each ATM month-to-month during the study period. It was assumed that all interchange transactions earned the same fee, and then multiplied interchange transactions times the fee to arrive at interchange revenues.

The results suggest it would be worth while to develop a forecasting model to estimate how interchange transactions are redistributed when a new branch or offsite ATM is deployed. This can provide an electronic banking manager with an estimate of what level of interchange revenues can be expected for a new ATM. Also it would be possible to predict how this estimate would change if a competitor responds by placing another new machine nearby[4].

ATM impacts on branch deposit market share

To investigate the impact of ATM network membership and locating an ATM at a branch on its competitive deposit collection ability, a 'gravitational model' of competitive interaction, adapte

used to represent branch-to-branch competition*. In this kind of model favourable characteristics and design features of a branch 'attract' retail accounts and deposits. To predict a branch's market share (MS), a set of IT and non-IT variables was used to describe its service delivery capabilities and attractiveness. Fixed branch features in the model included bank charter type within Pennsylvania (e.g., commercial, savings and loan, or mutual savings bank) and age. Other non-IT design features were interest rates, bank name recognition, the presence of service windows, and the number of platform service stations. The IT variables in the model were the bank's choice of ATM network and the presence of an ATM at the branch.

The model can be summarized as:

$$MS = \frac{\text{A function describing the relative attractiveness of a branch's features in terms of IT and non-IT variables}}{\text{The sum of the functions of the relative attractiveness of all competing branches in territory}}$$

This model states that a branch's deposit market share is a function of its own design choices, divided by the sum of similar functions of its competitors' design choices — in short, individual bank branch deposit shares are determined by the competitive environment faced by all branches. Thus it provides a means to test for incremental branch deposit market share that is due to a bank's decision to join an ATM network or deploy a branch ATM. And it simultaneously takes into account decisions made by the branch's competitors, as it evaluates a Meridian branch's IT configuration.

A second model was constructed to predict the size of demand and savings deposit markets in which branch banks competed in south-east Pennsylvania. The model attempted to explain the overall size of local demand and savings deposit markets in terms of demographic, competitive, and ATM variables.

A thumbnail sketch of the market share results is shown in Table 1.

Overall, a bank's ATM network decision was shown to be an important determinant of branch market size in south-east Pennsylvania. However, this occurred only under a limited set of circumstances. Membership in the MAC network was particularly beneficial in securing market share when two-thirds or more of nearby branches were members of the regionally smaller Cashstream network. Validating results were also obtained from separate estimations of demand and savings deposit market shares.

In branch territories where the regionally smaller network, Cashstream, was locally dominant, the externality benefits of access were insufficient to induce bank depositors to forgo the benefits of access to the regionally larger network. The results suggested that depositors were willing to give a larger portion of retail deposits (an important source of funding for a bank's balance sheet) to MAC banks. This externality effect was absent, however, in other partitions of the data tested. For example, in central Philadelphia and other territories where the MAC network dominated locally, the estimations confirmed that no single branch's deposit-taking ability was enhanced by MAC membership*. This makes sense as no branch can differentiate itself from its competitors on the basis of MAC membership, when the majority of branches and ATMs are associated with MAC†.

Table 1. Territorial deposit market share impacts of branch ATMs and MAC membership

Competitive region	If branch ATM deployed	If bank branch is member of MAC
Meridian's competitive region overall	No impact	1–2% gains in demand and savings deposit market share present
Philadelphia city centre (partition #1)	No impact	No impact
Other territories dominated by MAC network (partition #2)	No impact	No impact
Territories not dominated by MAC network (partition #3)	Increase in savings deposit market share only	Demand deposit share increased by 1.7% Savings deposit share increased by 3.6%

Branch ATMs were shown to have significant strategic value for increasing savings deposit market shares only in the partitions of the data set representing territories not dominated by MAC. MAC banks, before the MAC buyout of Cashstream, may have been justified in 'backfilling' ATMs at branches that did not have them, when there were few MAC machines locally[10]. Such motivation would have evaporated after the networks merged.

A final result was derived from the deposit market size model. No evidence was found to suggest that high-density ATM deployment helps banks to increase the overall size of the deposit market. Nor was there evidence to suggest that greater representation by MAC or Cashstream was responsible for increasing the size of the deposit market.

CALCULATING ATM BUSINESS VALUE: ILLUSTRATION

To illustrate how a business value estimate can be arrived at from the impact analyses discussed, one of Meridian's branch territories is now looked at more closely. The

*Additional background on the assumptions, functional form, specification, and estimation of the 'multiplicative competitive interaction' model has been given[5,6]. The mathematical development of the model for use in the electronic banking context has been reported[7].

*Later, the data were further partitioned to examine the relative influence that territories with varying demographic and competitive descriptors had on the overall parameter estimates for branch ATM and MAC network business value. This enabled a closer look into the environmental factors that either enhance or suppress the creation of IT value[4].

†The interpretation was confirmed by James McAndrews, an economist at the Federal Reserve Bank of Philadelphia, who is currently conducting research on electronic banking and shared network competition in the USA. He suggested that the externality results reported are the first to be quantified by researchers studying e

Table 2. Summary of business value of branch ATM

Source of business value	Business value of branch ATM: territory not dominated by MAC (adjusted for one year period)
Costs of branch labour replaced	$ 16 872
Creation of interchange transaction revenues	$ 6 896 (most tangible)
Incremental value of market share for:	
demand deposits	$ 12 652 (least
savings deposits	$113 720 tangible)
Total estimated business value	$150 140

territory chosen for the illustration is representative of a small number of the bank's branch and ATM locations in which ATM deployment provides special benefits to the bank. The local area around the branch was dominated by Cashstream, rather than MAC, and this Meridian branch had an ATM deployed there for some time before the beginning of the study period.

This ATM processed about 74 000 transactions during the study period. Of these, 18 800 (25% of the total) were identified as having been drawn from teller windows. Another 25% of the transactions were interchange transactions. This branch held about $21 million in demand deposits and $92 million in savings deposits; these deposit levels represented about 12.6% and 15.0% of the local market for the respective deposit types. During the study period, the spread between the bank's marginal cost of funds and its deposit interest costs averaged 3.45%.

Table 2 summarizes the annualized business value created by the ATM in the three output classes.

The estimated value of branch labour displaced is based on the estimate of what it would have cost to have tellers perform the transactions the ATM drew from the teller windows. Annual interchange revenues were measured directly in terms of monthly transaction volumes at the ATM. The value of incremental deposits was calculated by multiplying the portion that was attributable to MAC membership by 3.45%, the net value of funds to the bank. This yielded the annualized business value estimates of incremental deposits shown in Table 2. For both teller labour value and the marginal market share value, the calculations relied on using estimated parameters from the models that formalized the BVL.

The illustration suggests that an ATM's marginal contribution to deposit market share can be quite substantial. Where the MAC network was not well represented the least tangible business value output appears to have the greatest potential bottom-line impact. This points out the importance of being able to track differential performance of ATM investments. One result is clear for electronic banking: high ATM transaction volume alone was not a sufficient statistic for ATM business value, because the ATM for which the estimates were calculated actually produced less than the bank's average for transactions at its ATMs.

CONCLUSION

The work conducted at Meridian Bancorp has broken new ground in electronic banking and IT performance assessment methods. Based on the scope of the study, the amount of data collected, the support and participation of key managers within the bank, and the interesting results that emerged, this study is a 'benchmark' for the kinds of results that can be achieved using modern methods in IT business value research. (For a fuller discussion of some of the competing approaches and an evaluative framework for IT value research, see the recent review by Kauffman and Weill[11].) Employing BVL impact analysis as an integrating perspective shifts the focus in cost-benefit evaluation for IT from using only direct impacts, to providing validating evidence for the 'right' set of strategic outputs. Models that empirically evaluate the linkages between IT deployment and the classes of strategic outputs that the authors have emphasized help the managers get a clearer picture of the returns on their IT investments.

REFERENCES

1 **Clemons, E K** 'Information systems for sustainable competitive advantage' *Inf. Manage* Vol 11 No 3 (October 1986) pp 131–136

2 **Clemons, E K** 'MAC — Philadelphia National Bank's strategic venture in shared ATM networks' in *Proc. 1989 Hawaii Int. Conf. Systems Sciences* Hawaii, USA (January 1989)

3 **Kauffman, R J** 'Assessing the performance of information technologies which deliver financial services' *PhD dissertation* Graduate School of Industrial Administration, Carnegie-Mellon University, Pittsburgh, PA, USA (May 1988)

4 **Banker, R D and Kauffman, R J** 'Quantifying the business value of information technology: a conceptual framework and illustration' *Working paper* Stern School of Business, New York University (October 1990)

5 **Cooper, L G and Nakanishi, M** *Market-share analysis: evaluating competitive market effectiveness* Kluwer (1988)

6 **Nakanishi, M and Cooper, L G** 'Parameter estimation for a multiplicative competitive interaction model: least squares approach' *J. Marketing Res.* Vol 11 (August 1974) pp 303–311

7 **Banker, R D and Kauffman, R J** 'Strategic contributions of information technology: an empirical study of electronic banking networks' in *Proc. 1988 Int. Conf. Information Systems* (December 1988)

8 **Kauffman, R J, Ghosh, A and Bansal, A** 'Parameter non-stationarity in a model which estimates the business value of information technology' *Working paper* Stern School of Business, New York University (November 1989)

9 'Personal communication' J McAndrews, Staff Economist, Federal Reserve Bank of Philadelphia (October 1990)

10 **Banker, R D, Kauffman, R J and Lally, L** 'Gauging the quality of managerial decisions involving information technology deployment' in *Proc. 1991 Hawaii Int. Conf. Systems Sciences* Hawaii, USA (January 1991)

11 **Kauffman, R J and Weill, P** 'An evaluative framework for research on the performance effects of information technology investment' in *Proc. 1989 Int. Conf. Information Systems* Boston, MA, USA (December 1989)

Center for Digital Economy Research
Stern School of Business
Working Paper IS-91-14