8-25-1995

COMPETITOR AND VENDOR INFLUENCE ON THE ADOPTION OF AUTOMATED TELLER MACHINE SYSTEMS

Brian L. Dos Santos
University of Louisville

Ken Peffers
University of Hong Kong

COMPETITOR AND VENDOR INFLUENCE ON THE ADOPTION OF AUTOMATED TELLER MACHINE SYSTEMS

Brian L. Dos Santos
College of Business & Public Administration
University of Louisville
Louisville, KY 40292

Ken Peffers
Department of Computer Science
University of Hong Kong
Pokfulam Road, Hong Kong

INTRODUCTION

Although investments in innovative IT applications have been shown to add value to the firm (Dos Santos, Peffers and Mauer, 1993), these investments are expensive and risky (Dos Santos, 1991). Consequently, the decision to adopt innovative applications early or to wait until they have proven successful is a difficult and consequential decision for the firm. What determines the adoption timing by firms? Although adoption of IT and related phenomenon have received attention in the IS literature (Gurbaxani, 1990; Loh and Venkatraman, 1992), this is an important question that has not been considered to date.

We study the adoption of automated teller machine (ATM) technology by US banks. The ATM is one of the most visible and influential of IT innovations in the banking industry. As early as 1970, ATMs were widely expected to be an important emerging technology (ABA, 1972). Yet, nine years after the first ATMs appeared in 1971 less than 20% of all banks had installed ATMs and seven more years passed before a majority of U.S. banks installed any ATMs (Dos Santos and Peffers, 1995).

This paper presents the results of a study of ATM adoption between 1971 and 1992. We attempt to determine whether ATM adoption was influenced by internal factors, external factors or a combination of internal and external factors. Out analysis indicates that ATM adoption was influenced by internal and external factors; both adoption by competitors and efforts by vendors influenced adoption. The results have implications for potential users of new technology and manufacturers of new technologies.

THE INNOVATION ADOPTION DECISION

Factors in the Adoption Decision

What factors influenced the decision by bank managers to adopt the technology? Development of ATM applications resulted from a duel sponsorship by large innovative banks and the hardware and software vendors. Some large retail banks saw a potential in these systems, from advantages they had in existing systems and from expertise, to achieve competitive advantage and made efforts in the early 1970s to develop systems (e.g., Glaser, 1988). The development of innovative proprietary systems threatened other

banks, encouraging them to adopt their own systems. Thus, information obtained regarding adoptions by rival banks (internal information) may have helped managers make adoption decisions. Hannan and McDowell (1987) found that ATM adoption by local market rivals contributed to adoption decisions. Banks may have responded to avoid being left behind and losing market share.

The other sponsors of ATMs were the producers of the underlying hardware and software. These vendors promoted use of the technology by demonstrating its feasibility and disseminating information about its benefits. The vendors provided external information in their attempts to influence adoption decisions. Banks, especially those with few technical resources, may have responded to information from vendors to address concerns about technical and operational feasibility issues.

Influence Models

The external influence model assumes that adoption is driven by information from a source external to the social system; adoption is related over time to the number of banks in the population that have yet to adopt the innovation (Coleman, 1966; Venkatraman et al, 1994). The internal influence model assumes that adoption is driven by communication within a specific community or social system; the expected number of adopters in any period is related to the number of banks that have already adopted as well as the number of potential adopters (Mansfield, 1961; Venkatraman, Loh and Koh, 1994). The mixed model assumes that both internal and external information influence the adoption decision.

The models tested in this study; external, internal, and mixed influence models are shown in equations 1, 2 and 3, respectively.

$$x(t) = m\left[e^{(-p(t-1))} - e^{(-pt)}\right] \qquad (1)$$

$$x(t) = \frac{m}{1+\left((m-m_0)/m_0\right)e^{(-qmt)}} - \frac{m}{1+\left((m-m_0)/m_0\right)e^{(-qm(t-1))}} \qquad (2)$$

$$x(t) = m\left[\frac{1-e^{-(p+q)t}}{1+(q/p)e^{-(p+q)t}} - \frac{1-e^{-(p+q)(t-1)}}{1+(q/p)e^{-(p+q)(t-1)}}\right] \qquad (3)$$

In the models *m* represents the number of potential adopters in the community, *p* represents the relationship between the number of remaining potential adopters and adoptions in any period (coefficient of external influence), and *q* represents the relationship between the product of prior and potential adopters and the number of adoptions in any period (coefficient of internal influence). Parameters *m, p* and *q* are expected to have positive values.

A discussion of the origins of these models and their development may be found in Low and Venkatraman (1992).

DATA

The data used in this study are a time series of population estimates of the number of individual US banks which adopted ATM technology. Specifically, the data estimates the cumulative number of banks that had installed at least one ATM in each of 13 years from 1971 through 1992. We developed this data from three sources. For each year between 1971 and 1979 the US Federal Reserve surveyed more than 3000 banks to determine whether they had installed ATMs.

Table 1. Cumulative ATM adoptions among US banks, 1971-1992.

	Number of	adoptions
Year	Federal Reserve Data	ABA Data
1971	33	
1972	88	69
1973	266	
1974	379	
1975	596	
1976	869	
1977	1145	
1978	1416	1580
1979	1923	
1981		2735
1986		6203
1989		7230
1992		9576

The American Bankers Association (ABA) surveyed member banks about the status of ATM adoption in 1972, 1975, 1978, 1981, 1986, 1989, and 1992. The number of respondents ranged from 1,657 in 1975 to 373 in 1989. We used the data from these two surveys, with population data about the characteristics of US banks from the FDIC Report of Condition and Income, to develop population estimates of cumulative first time ATM installations, using piecewise linear extrapolation to eliminate survey bias by bank size. Table 1 shows the resulting estimates produced from each survey. We were unable to develop a credible estimate from the 1975 ABA survey data.

ANALYSIS AND RESULTS

To determine which influence model best explains ATM adoption, we fit each of the three models to the combined adoption data. We used an iterative non-linear least squares

procedure. To avoid local minima, we repeated the procedure with a variety of starting points.

The estimated coefficients for the three models are shown in Table 2 and are plotted with the adoption data in Figure 1. All the coefficients are statistically significant at the 0.05 level. The external influence model appears to fit the data quite well, as indicated by the high adjusted R2. However, coefficients *m* and *p* are negative. A negative value for *m*, the estimated number of potential adopters, is meaningless. In addition, the fitted curve suggests that the number of potential adoptions is unbounded over time.

Table 2. Coefficients for best least squares fit for ATM adoption by US banks, 1971-1992.

Parameters	Influence Model		
	External	Internal	Mixed
m	**-1638**	**8387**	**12413**
p	**-0.0888**		**0.0081**
q		**5.70E-05**	**1.59E-05**
Adjusted R^2	0.982	0.952	0.995
All coefficients are significant at the 0.05 level.			

The internal influence model also is a reasonable fit to the data, although it is not as good a fit as is the external influence model. The S-shaped curve of the internal influence model underestimates adoptions for 1972-1981, and predicts the maximum number of adoptions at 8387, far less than the actual number of banks adopting ATMs by 1992.

The mixed influence model is the best fit as indicated by the adjusted R2. The coefficient for *m* suggests that the number of potential adopters is 12,400, which is approximately the total number of US banks. Moreover, the parameters for external and internal influence are both positive and significant.

DISCUSSION

The failure of the external influence model and a good fit for the internal influence model, suggests that communication within the banking industry, rather than promotion by vendors was the primary source of influence in the adoption decision. Firms in the banking industry, with large industry organizations such as the ABA and a large number of trade publications, are likely to receive a great deal of information about important decisions such as ATM adoption (Ridlehuber, 1976).

The internal influence model is believed to be most appropriate when an innovation is socially visible and not adopting it places social system members at a disadvantage (Mahajan and Peterson, 1985). Such was clearly the case with ATMs; ATMs were widely anticipated by industry members, many of whom thought that ATMs would eventually be widely adopted (ABA, 1972).

Through 1979, however, the mixed influence model 'accounts for' 46% more of the actual adoptions by that date than the internal influence model alone. The mixed influence

model also incorporates the influence of change agents on the adoption decision (Mahajan and Peterson, 1985). It has been used to forecast sales of consumer durables, where the effects of sales efforts by vendors as well as imitation of other consumers both play a role in the adoption decision. This suggests that external influence also contributed substantially to adoption decisions during the first few years. Vendor sales efforts may have had an impact on decisions to invest in the innovative technology in this period, before there was a great deal of information available about the experiences of the early adopters.

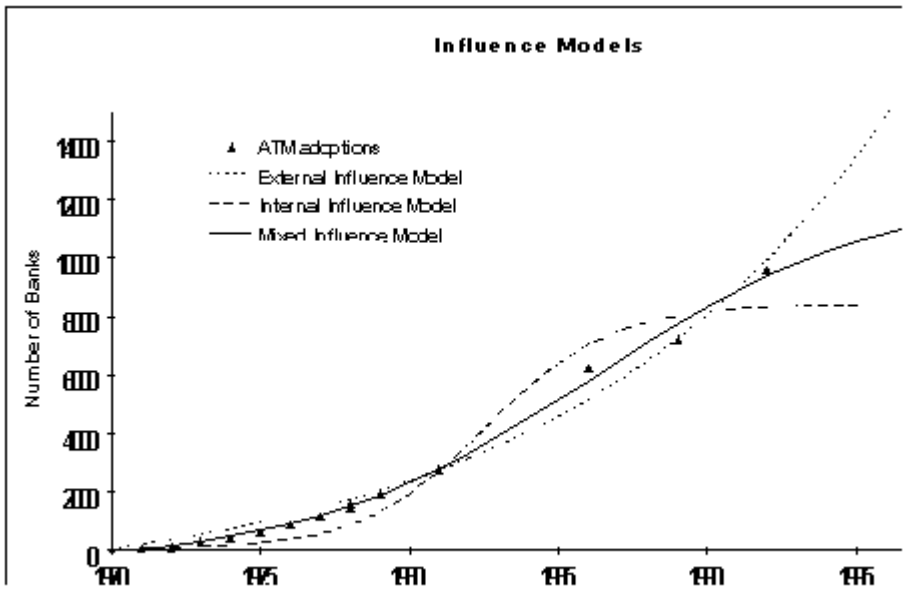

Figure 1. Fitted influence models on the cumulative number of US banks that had installed at least one ATM.

These results have implications for the prospects for adoption of other major new IT, such as electronic data interchange (EDI) and document management systems, suggesting that successful sales efforts by change agents may influence a small number of early adoptions, but that large numbers of potential adopters may wait to observe and imitate the innovators.

References

American Bankers Association, *Results of the 1972 National Automation Survey*, Washington DC, 1972.

American Bankers Association, *National Operations/Automation Survey 1986*, Washington DC, 1986.

Banker, R.D. and R.J. Kauffman, "Strategic Contributions of Information Technology: An Empirical Study of ATM Networks," *Proceedings of the Ninth International Conference on Information Systems*, Minneapolis, MN, 1988.

Coleman, J.S., E. Katz and H. Menzel, *Medical Innovation: A Diffusion Study,* Bobbs-Merrill, Indianapolis, IN, 1966.

Dos Santos B.L. and K. Peffers, "Rewards to Investors in Innovative Information Technology Applications: First Movers and Early Followers in ATMs," *Organization Science*, 1995 (to appear).

Dos Santos B.L., K. Peffers and D.C. Mauer, "The Impact of Information Technology Investment Announcements on the Market Value of the Firm," *Information Systems Research*, 4:1, 1993 1-23.

Dos Santos, B.L., "Justifying Investments in New Information Technologies," *Journal of Management Information Systems* , 7:4, Spring 1991, 71-89.

Glaser, P.F., "Using Technology for Competitive Advantage: the ATM Experience at Citicorp," in *Managing Innovation Cases from the Services Industries*, Guile, B.R. and J.B. Quinn (Eds.), National Academy Press, Washington, D.C., 1988, 108-114.

Gurbaxani, V., "Diffusion in Computing Networks: The Case of BITNET," *Communications of the ACM*, 33, December 1990, 65-75.

Hannan, T.H., and J.M. McDowell, "Rival Precedence and the Dynamics of Technology Adoption: an Empirical Analysis," *Economica*, 54, May 1987, 155-171.

Kantrow, Y.D., "ATMs called 'only hope' to Minimize Costs, Cope with Shrinking Labor Force," *American Banker*, January 4, 1989.

Laderman, E.S., "The Public Policy Implications of State Laws Pertaining to Automated Teller Machines," *Economic Review (Federal Reserve Bank of San Francisco)*, 1990, 43-58.

Loh, L., and N. Venkatraman, "Diffusion of Information Technology Outsourcing: Influence Sources and the Kodak Effect," *Information Systems Research*, 3:4, 1992, 334-358.

Mansfield, E., "Technical Change and the Rate of Imitation," *Econometrica*, 29, 1961, 741-766.

Ridlehuber, L., "FNB-Atlanta's rules for ATM success," *Banking*, Vol. LXVIII, No. 5, May 1976, 34.

Venkatraman, N., L. Loh, and J. Koh, "The Adoption of Corporate Governance Mechanisms: A Test of Competing Diffusion Models," *Management Science,* 40:4, April 1994, 496-507.