

Technological convergence and scope of organizational innovation¹

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Many industries are faced with increasingly merging and overlapping technologies. With multiple technological strands converging, it is incumbent upon firms to stay on the top of these developments. A firm will succeed to the extent that it can cover a wider range of innovative activities, whether alone or in partnership with other firms. This paper examines a firm's innovation in information technology. Such innovations vary widely in their scope with some involving a very limited range of skills, rendering them more 'incremental.' Given a firm's inclination toward specialization, the adoption of broad innovations is more feasible if it has developed interfirm arrangements which provide access to distant technology. In a study of commercial banks, it was found that the scope of new information technologies is contingent upon a firm having developed linkages, particularly with firms whose industries provide complementary knowledge.

Introduction

This paper examines how organizations are drawn into converging technological developments. As carriers of certain strands of technology, organizations are constrained by the range of innovations that they might implement. Their proprietary technology is at once a platform to innovate in specific domains, and at the same time a constraint when pursuing innovations outside these domains. Sometimes, however, they attempt to implement innovations that not only encompass their own technology, but also that of

others. This increased overlap in various technological domains puts organizations at the crossroads of technological trajectories and requires them to extend the boundaries of their skills. The scope of new technological projects is contingent upon proprietary technology and access to that of others. Extension of firm specific technology will often necessitate interfirm networking.

Schumpeter, in his classical contribution, *The Theory of Economic Development* [30], indicated that innovation is simply a rearrangement of existing resources. However, such rearrangements might entail the technical and organizational resources of more than one firm. A firm's proprietary skills alone may not be adequate or sufficient to implement an innovation. The writings of Schumpeter do not preclude an organization's capacity to recombine various strands of technology, where some of these strands reside in other organizations. By forming strategic alliances and other forms of networking, organizations may gain access to outside sources of technology. Such access provides them with the opportunity to participate in the blending of technologies involving not just their own, but also other firms' technologies.

The firm needs to have accumulated proprietary knowledge. In fact, its capacity to participate in the blending of disparate technologies is very much contingent upon its 'absorptive capacity' [7]. This capacity is reflected by internal R&D activities which give the firm a better understanding of the potential contributions that external technologies can furnish. If the firm's R&D activities have been relatively limited, we would expect it to play a modest role in newly evolving technologies. Similarly, if a firm has been uncon-

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nected with other firms, it will be deprived of access to those evolving technologies.

Objectives

This paper presents arguments and empirical tests to account for the adoption of electronic banking, a new technology-based service, by commercial banks which varies by the range of skills involved. We take electronic banking as a prototypical innovation that encompasses multiple strands of technology, for example telecommunication, financial transactions and computer software. The banking industry provides an interesting case of converging technologies. Some of its members may alter the direction of technological developments in and around the financial services industry and influence the degree and form of technological convergence. We use the term *scope* to signal the difference in banks' behaviors to shape the technological trajectories that affect the contemporary banking industry. The study focuses on video banking. The *scope* of video banking services represents a spectrum from narrow to broad. It can be narrow if such services offer only a very limited set of banking transactions (transfer across accounts, bill payment); it is broad if they also provide other transactional services, such as stock brokerage, information retrieval, travel services, teleshopping, and so on. The historical conditions under which such banks adopt video banking services and the probable inducements for them to choose the scope of these services will be examined, employing event history analysis.

Banking

It is not just the so-called 'high-tech' sectors which set the stage for blending technologies and extensive interfirm networking. Much of the innovation research to date has covered manufacturing organizations, while service organizations have received little attention. This is remarkable in view of the fact that in our economy the service sector is far more important now. For example, less than one in five people are currently employed in the manufacturing sector, whose decline has been compensated for by a tremendous growth of the service sector.

The financial services sector is one of several areas that have witnessed tremendous growth [11]. As Harianto and Pennings [13a] have shown, its firms have been very active in forming a multitude of strategic partnerships. Scherer [29] had noted earlier that the financial services sector is the largest buyer of information technology, except for the information technology industry itself. This trend, that Scherer discovered while information technology was barely out of its infancy, has continued into the present time and currently amounts to a veritable 'deluge' [11]. Banking therefore presents an ideal setting for studying the merging of banking knowledge with information technology and this presents a further ground for doing so. Furthermore, networking among banks has risen sharply. In the delivery of their services, banks have to coordinate with other banks. Such coordination is illustrated by ATM networks and electronic check clearing houses. In this respect, banks resemble airlines, telephone companies and health care systems, which have also erected coordinative mechanisms to regulate interfirm relationships.

Some financial institutions have also networked with providers of information technology. For example, BancOne, a midwestern US bank, has formed a joint venture with EDS to develop new software. There are numerous other examples of how firms participate in certain converging technological trajectories, culminating in the implementation of various innovations.

Video banking is an example of 'videotex' which combines knowledge from telecommunication, computer hardware and software, and providers of information such as banks, newspapers, and airlines. It links a customer and his personal computer through a 'gateway' with sources of information and services. Videotex as innovation is typical for having combined various disparate technologies and illustrates technological convergence rather well. Videotex is also a prime opportunity for firms to explore new networks across industry boundaries. Well known examples are Compuserve, Trintex, and Prodigy in the US and Minitel in France. Any information provider that enters the videotex technology should have major knowledge in information technology in order to absorb the additional inputs in information technology required for videotex. Moreover, it is bound to have an advan-

tage if well networked with hardware and software firms which are to provide videotex-relevant technologies.

This study focuses on the financial services sector as this sector has witnessed major inroads from telecommunication and computer industries. Video banking is one of many innovations which lends itself to an examination of an innovation incorporating diverse technologies. It was therefore a phenomenon that permitted the testing of theoretical arguments.

Theoretical arguments

Firms accumulate knowledge in the course of their existence. In this sense, they can be viewed as an integrated set of knowledge or competence, as reflected by their human and technical assets. Because this knowledge is anchored in complex socio-technical relationships, it is usually unique to the firm, and thus difficult to transfer. In the quest for expansion or enhancement of their skills, firms face key constraints as a result of their own baggage of existing skills. This inertia [12,18] stems from sunk costs in investments and entrenched social structures. Organizational members may have become attached to certain cognitive styles, behavioral dispositions, and decision heuristics, rendering them resistant to change (see also [9]). The accumulated knowledge which renders a firm inert also bestows opportunities for enhancing its unique advantage. Improvements may occur slowly and incrementally, but are consistent and reliable.

We stress that innovation entails a developmental process in which firms bridge the existing knowledge with that which they seek to possess. A continuous tension between the firm's current knowledge and its related inertia exists, and the distance between current knowledge and the new knowledge which is necessary for embarking on the innovation. If this distance is large, innovation is less likely; if it does materialize, it is less likely to succeed (compare this concept to the issue of diversification in the strategic management literature, e.g. [14,28]).

We propose that the most salient organizational knowledge can be classified with respect to its technology or structure content. Firms have technical and structural or managerial skills.

Technological innovation will be found in the neighborhood of existing technological knowledge. Within this domain of technological specialization (see Rumelt's technological relatedness category [28]), a technological innovation occurs which reflects prior technological experience.

Some of the new knowledge required to embark on an innovation resides in the environment, including in other firms. Such new knowledge can also be developed by combining general knowledge with the firm's existing competence [22]. If the new knowledge resides and is embedded in complex organizational routines of other firms, it will be difficult to acquire [24]. In such a case, the transfer of the required knowledge can only be effectively carried out if it can be replicated through certain mechanisms such as joint ventures [15]. Firms involved in joint innovative endeavors often confront the risks of sharing proprietary knowledge with one another. Prior working relationships with the same partners can reduce the risks and facilitate the innovation [13b]. More generally, prior experience regarding working and dealing with other firms can contribute to the success or survival of the innovative venture.

Interorganizational experience allows a firm to do at least two things. First, it enables the firm to develop skills necessary for dealing with difficulties inherent in interfirm relationships and for establishing long-lasting collaboration; second, it provides opportunities for the firm to bring distant knowledge close to its own domain. Indeed, firms with little interorganizational and relevant technological experiences are less likely to embark on an innovation.

An innovation can be differentiated in terms of its scope of application. This scope is narrow if the innovation covers only a very limited set of commercial applications. In other words, its narrowness reflects the range of technologies, knowledge, or competence being incorporated into the new services offered. An innovation with broad scope indicates a comparatively broad range of applications or services, blending various technologies and knowledge into it. Consider, for example, the computerization of a company's manufacturing system through the installation of computer-aided design and computer-aided manufacturing ('CAD/CAM'). Information technology makes it possible to design any product, whether it is a shirt, a chip or a tool. CAD/CAM

can be installed as a simple workstation to partially automate a stage in the production process, but it can also be utilized as the nerve center which integrates product development, manufacturing, and service delivery of the entire plant.

A broad-scope innovation might depart significantly from current organizational practices, frame of mind, competencies, and product use, reflecting what Normann [21] termed 'radical' innovation. The adoption of such an innovation often requires new values, goals, or a supporting power structure [21]; a separate, autonomous department; or a deliberate process of corporate internal venturing. Besides these structural arrangements, prior efforts or experimentation in successfully launching new products and services [20] are central to the efficacious adoption of radical innovation. These experiences and internal structural arrangements provide the firm with a variety of knowledge or technologies traditionally not accessible by its existing practices. While Nord and Tucker [18] delve into the internal structural arrangements required for innovation adoption, the present study considers the interorganizational ones.

Technological and interorganizational experiences endow a firm with the knowledge to implement innovation adoption, as they increase the firm's exposure to a larger and more diverse pool of knowledge or skills. In essence, both experiences curtail the distance that sets the firm apart from the innovation. While firms with extensive interorganizational experiences gain the benefit of being exposed to a variety, and broader range, of external stimuli, a firm without such experiences will confront obstacles when it attempts to acquire new knowledge from other firms. Firms which have accumulated various technological, as well as extensive interorganizational experiences, will have a better ability to offer innovation with broad scope than will those firms with marginal interorganizational experiences.

Alternately, firms which have accrued significant technological innovation through internal acquisition may still be able to innovate in the vicinity of their core technology. Indeed, firms with vast technological experience, but with little or no experience in dealing with other firms, will still innovate, but will offer only a narrow scope of services or applications, which do not require an extensive pool of knowledge or competence.

As single firms with little or no ties with other firms, they simply do not have a much access to knowledge that is located in other firms.

Hypotheses

The above arguments point to the central role of prior experiences, both technological and interorganizational, in linking a firm to a variety of external knowledge or skills. These experiences lessen the distance between the firm's existing knowledge with that required for innovation. Therefore, we hypothesize:

- (1) Given the prior technological experiences, the more extensive interorganizational linkages firms have accumulated, the higher their ability to adopt broad-scope innovation.
- (2) The greater a firm's domain activity, the higher its probability of engaging in broad-scope innovations, and the less it is likely to carry out narrow-scope innovation.

Research design

The setting for our empirical study is the adoption of video banking services in the United States. The first video banking service was offered in 1981, and by 1988, there were about 65 services known to have been adopted by commercial banks. Video banking refers to computer-based interactive systems that enable users to link into a network and have access to a variety of information and transactional services. It can combine banking transactions (transfer across accounts, bill payment) with other transactional services such as stock brokerage, information retrieval, travel services, teleshopping and so on. For banks, the delivery of such services entails the acquisition of extensive electronic and telecommunication capabilities. Provision of complementary transactional technologies requires interorganizational linkages.

The sample

The sample was drawn from a list of 250 of the largest banks as reported by *American Banker* [2]. Due to lack of data, only 157 banks were included. Of the 250 banks, 53 were known to offer

video banking services and 49 of them were included in the sample of 157. A detailed description of the sample and the sampling procedure have been reported elsewhere [24].

Method

The study deals with a dichotomous dependent variable: whether or not a bank adopts video banking services. In essence, we compare the 49 'cases' (banks adopting video banking services) with the 108 'controls' (banks without the services) on the basis of a number of attributes.

The general model for testing the hypotheses is as follows:

The probability of video banking adoption = f (technological experiences, interorganizational experiences, control variables).

A discrete time event-history analysis [1] is employed for incorporating the time-varying covariates of the model:

$$\log P(t)/(1 - P(t)) = a(t) + \sum b_i x_i(t)$$

$P(t)$ is the likelihood that an event (a bank adopting video banking) occurs at time t .¹ The term $a(t)$ implies that the hazard rate for adoption varies across time. The vector $[b]$ contains the regression coefficients of the independent variables $[x(t)]$, indicating their effects on the log-odds of the hazard, where i is the number of independent variables in the model.

In testing our hypotheses, we hold a number of firm attributes constant and treat them as control variables in our model. These include size (e.g. [25]) and economic performance (e.g. [20]). Supposedly, large firms are endowed with ample resources to fund innovative activities, and hence have the strategic capacity to innovate more. Empirical findings do not consistently support this argument (e.g. [29]). Besides the indeterminate nature of size itself, one counter-argument is that large firms are usually handicapped by their bureaucratic structure, rendering it difficult for them to innovate [18]. Similarly, firms with large in-

come streams have the slack resources, but will also confer more discretion to their top management. These issues will be incorporated into the current inquiry.

To test the hypotheses, the event is divided into two states: whether the video banking adopted has a broad or narrow scope. An example of narrow scope consists of a bank making retrieval of simple account information accessible; a broad scope entails interactive execution of financial transactions, telephone inquiries, as well as a range of other services such as making purchases.

The present estimation method can be compared to a multinomial logistic regression with the dependent variable having three discrete levels: non-adoption, adoption of narrow scope, and adoption of broad scope. Both methods are likely to yield similar qualitative results.

Data and measurement

The list of video banking adoption was obtained from the *Arlen Communication Videotex Directory* [3], the *1985/1986 Retail Electronic Fund Transfer Directory*, and the *American Banker* surveys [2]. Data about technological and interorganizational experiences were obtained from the *Predicast Index of U.S. Corporations* (1977–1988). Financial and several other types of data (e.g. the number of lines of businesses, investment in systems and equipment) were extracted from the bank's annual reports and *Moody's Manual Banking and Finance* (1977–1988). Interviews with 36 senior executives in relevant divisions of the banks, along with a small study reported in *Computerworld* (1989) involving some 100 firms outside the microelectronic sector, were also employed and used to validate our constructs and measurements.

Elsewhere [24], we have reported how the data were collected, and indicated the three procedures for examining the variables on their reliability and validity. First, the two authors coded the *Predicast* entries independently, and arrived at a high level of inter-rater reliability. Second, a telephone survey with a subset of the sample was used to triangulate some of the *Predicast*-derived variables. Finally, we compared a *Predicast*-derived measure of information technology with a ranking that was furnished with *Computerworld*.

¹ To estimate $a(t)$, a set of dummy variables is required to be incorporated in the model [1], corresponding to the number of t . For current purpose, we are not dealing with the hazard rate variation of video banking adoption across time.

Coding scheme, inter-rater consistency and two other triangulation procedures and their results have been reported in detail elsewhere [24].

The dependent variable was the adoption event and has been coded as a dummy variable. The unit of analysis was the firm year; each observation received a code of 1 if the firm adopted video banking in that year, and 0 if it did not. Once a firm adopted video banking in a certain year, it became 'censored' (i.e. was deleted) and contributed no more observations to the data pool for subsequent years. The dependent variable for hypotheses 2 and 3 was scored analogously, except that it indicated the scope of the video banking being adopted (i.e. narrow versus broad). In other words, the event was coded to reflect the scope of the video banking services, and not simply adoption or non-adoption. Before the actual hypothesis testing we performed an event-history analysis on all innovations. Subsequently, we compared the narrow-scope adoption with the rest of the sample (excluding the broad-scope adoption), followed by a similar procedure for the broad-scope adoption. A separate event-history analysis was conducted for the types of adoption events.

The independent variables were constructed from the archival sources. The scores of technological and interorganizational experiences were obtained directly from the coding scheme. The firm's score indicated the cumulative number of involvements in that particular category from 1977 up to a particular year as reported by *Predicast*. Strictly speaking, we counted the number of times a firm was listed as being involved in a particular category of events. All events were equally weighted, but if a particular event was mentioned more than once, it still was classified as a single event.

The proportion of interfirm linkages specifically intended for technology acquisition is also of interest. This proportion is measured as the number of linkages for that reason divided by the total number of experiences in dealing with other firms. While banks have witnessed greater amounts on interfirm networking, including networking with other banks, we are here primarily interested in their technological networking: it was surmised that banks with a disproportionate high incidence of technological networking are more prone to cast their innovative net widely,

and thus give more momentum to convergence of technology strands.

In subsequent analyses, technological experiences were subdivided further into the following categories: the number of involvements in back-office technological developments (e.g. computer operation, local area network (LAN), electronic mail), and the number of involvements in user-interface technological developments (e.g. automated teller machine ('ATM'), point of sales ('POS'), phone banking). Categories of technological experiences were mutually exclusive.

Interorganizational experiences were also broken down into three distinct categories: linkages with information technology firms (computer, telecommunication manufacturer, software firms), complementary transactional or service providers (information retrieval, retailer), and other banks and financial services (insurance, stock brokerage). In our coding, the occurrence of technical projects employing interfirm arrangements (e.g. 'National City and Ameritrust introduced on-line telephone enquiry services') was coded as both a technological (user-interface technology) and an experience in dealing with and working together with other firms (in conjunction with another bank).

The independent variables showed moderate to low intercorrelations. The highest correlation was between technological and interorganizational experiences, with a product moment correlation of 0.76. A redundancy analysis showed, however, that this multicollinearity did not present estimation problems [5]. The measures of this study provide a reasonably good basis for empirical testing.

Results

Tables 1, 2 and 3 report the results of this study. Table 1 presents the means and standard deviation of the independent variables and displays the results of the regression equation with the logistic transformation of video banking adoption as the dependent variables. Table 2 presents a similar analysis but provides further disaggregation of the independent variables. In both Tables 2 and 3, results of the different scopes of video banking adoption are reported individually.

Table 1
Means and standard deviation of independent variables

		Means	S.D.
1	\$ Investment, systems & equipment	0.341	0.182
2	Prior experience, back-office technology	0.227	0.800
3	Prior experience, consumer interface technology	0.378	0.876
4	Interorganizational experience, with information technology firms	0.038	0.225
5	Interorganizational experience, with transaction/service Providers	0.029	0.187
6	Interorganizational experience, with other banks & financial services firms	0.406	0.865
7	Number of lines of businesses	2.939	1.646
8	Size (log assets)	3.656	0.436
9	Return on equity	12.701	4.423

In Tables 2 and 3, several independent variables play a different role in affecting the scope of video banking adoption. Model 2.1 in Table 2 shows that significant predictors of video banking adoption are interorganizational experiences (in the hypothesized direction), and bank size measured as the logarithm of bank assets. The results for broad-scope video banking (model 2.2) basically resemble those of model 2.1. In addition to these variables, technological innovation is a significant predictor, but, unexpectedly, with a negative sign. For narrow-scope video banking adoption (model 2.3), significant predictors are the proportion of interorganizational linkages used for technological acquisition (positive) and the number of lines of businesses (negative, as hypothesized).

Table 3 signals further which category of experiences, interorganizational and technological, has a significant bearing on the likelihood of video banking adoption. Prior interorganizational experiences, especially links with information technol-

ogy firms and other banking/financial services firms, have a positive and significant effect, as hypothesized, to the adoption of video banking in general and broad-scope video banking in particular (models 3.1 and 3.2). These variables, as expected, are not significant in affecting the likelihood of narrow-scope video banking adoption (model 3.3). Similar to what has been reported in Table 2 (model 2.3), the only significant independent variable in predicting the log-odds of narrow-scope video banking adoption is the number of lines of businesses occurring in the predicted direction (negative). The overall models reported in Tables 2 and 3 have high goodness of fit, as indicated by their value of chi-squared statistics.

Among the control variables, only company size, measured as the logarithm of bank assets, has a positive and significant consequence for the probability of video banking adoption, and particularly those with a broad scope. This indicates that only larger banks have ample resources to be deployed for such an adoption, a result which is consistent with other adoption research (e.g. [25]).

Discussion and conclusion

The overall results of this study indicate that larger banks with high interorganizational experiences are more likely to adopt broad-scope innovations incorporating other services beyond their standard banking transactions. Cooperative experiences with strategically interdependent organizations [23], particularly with information technology firms and other banking/financial firms, allow banks to access various external knowledge.

Among the control variables, it is particularly organizational size which predicts the adoption of innovation, and the scope of innovation. Smaller banks have a much lower likelihood of adopting technological innovations, and if they do such innovations tend to be rather narrow. Organizations are more or less constrained in their efforts to diversify technology-based services. The implication is that technological diversification requires considerable assets, considerably more than diversification moves that are based on personal service.

In the 1980s, telecommunication and computers firms were among the most important organizations for financial institutions [4], as the finan-

cial sector is by far the largest recipient of micro-electronic output [29]. Partnering with firms from those sectors through technological projects endows banks with the capacity and flexibility to experiment and enter into new commercial applications when a fresh combination of technologies emerges.

Strategic partnering

Strategic partnering through interorganizational cooperation has become increasingly pertinent in dynamic, technology-intensive industries. This includes alliances between small, entrepreneurial firms and large, established enterprises [10,31,32] and between firms across national boundaries [13]. Motives for strategic partnering are plentiful; they may include minimizing transaction and production costs [6,15], maintaining or enhancing market position [8] or cross-transferring idiosyncratic, specialized skills [15]. However, there have been only a few attempts to examine innovation around a set of converging technologies (e.g. [24]).

This paper has suggested that innovation evolves from a firm's past experience. A historical approach, in this sense, might shed some light on the direction of innovation [17]. The documentation of a firm's prior experiences, both technological and interorganizational, may reveal their critical role in facilitating a subsequent technological innovation.

Technological innovation here refers to the adoption or use of new technologies for specific commercial application, or readily applicable technologies for new commercial application. Note that the newness can be either in terms of the technology being used or the services being rendered. We define innovation as a developmental process in which firms bridge the existing knowledge with that which they seek to acquire. The findings of this study show that banks will be more 'bold' in their quest for new service delivery if they have been aggressive adopters of previous chunks of information technology and if they have been active in linking their resources with other firms, especially information technology firms and firms in their own industry. Domain

Table 2
Logistic regression of innovation dependent variable: entry into video banking by scope of innovation ^a

	Model 1 full sample	Model 2 broad scope	Model 3 narrow scope
Intercept	-8.188 *** (1.815) ^b	-11.133 *** (2.410)	-6.239 *** (2.717)
Prior technological experience	0.193 (0.213)	-0.032 (0.245)	0.083 (0.264)
Prior interorganizational experience	1.339 * (0.589)	1.600 * (0.799)	0.991 (0.937)
Proportion of interorganizational linkages for technological purpose	0.738 (0.829)	0.932 (1.133)	0.321 (1.124)
No. of lines of businesses	-0.117 (0.101)	0.017 (0.123)	0.376 * (0.181)
Size (log assets)	1.369 ** (0.467)	1.911 ** (0.610)	0.759 (0.671)
Return on equity	-0.006 (0.039)	-0.036 (0.042)	0.045 (0.071)
-2 log likelihood	376.52	259.21	181.32
Chi-squared (D.F. = 9)	113.86 ***	130.01 ***	33.05 ***
<i>N</i> ^c	865	845	835
Number of adoption events	49	30	19

^a + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

^b Standard errors are in parentheses.

^c The difference in number of observations (*N*) in last two columns is due to the omission of those adopters for which the type of adoption does not apply.

activity, such as changes in their line of business, is also pertinent, but to a lesser extent.

In the onset of this paper, we argued that banking presents an interesting case of convergent technology as it has been an unusually voracious user of information technology. Although it does not show any R&D outflow to other industries, it is a major recipient of R&D flows from telecommunication and computer industries [29]. The results of this study provide compelling evidence that members of the banking industry vary in the range of 'alien' skills that they bring to bear in the rendering of new services. They differ therefore also in the extent to which they latch on to converging technological developments, or contribute to the direction of a 'technological trajectory' [19] that is discernable in and around the banking industry. Whether alone or with strategic partners, the scope of new services signals the magnitude of a bank's contribution toward significant technological developments.

Banking versus other industries

Such observations accord very well with the observed trends in the financial services sector. Deregulation, the increased blurring of distinctions among retail stock brokerage, securities underwriting, money markets, and thrift are highly visible developments. In the past, larger commercial banks have competed mostly on a cost basis since interests rates on loans and deposits are coupled with the prime rate set by the Federal Reserve Bank. Information technology has not waited for deregulation to undermine the equilibrium in the banking industry, but now that this changing industry is being deregulated, its competitive conditions have become more unmerciful.

In some ways, however, banking is quite different from industry, in that banks rarely report the extent of their R&D activity. The Scherer study [29] indicates that financial services do not report

Table 3
Logistic regression of innovation; dependent variable is broad or narrow scope of video banking ^a

	Model 1 full sample	Model 2 broad scope	Model 3 narrow scope
Intercept	-8.188 *** (1.815) ^b	-11.133 *** (2.410)	-6.239 *** (2.717)
\$ investment, systems and equipment	0.865 (0.919)	1.963 (1.075)	-0.816 (1.592)
Prior experience, back-office technology	0.193 (0.213)	-0.032 (0.245)	0.083 (0.264)
Prior experience, consumer-interface techn.	-0.518 ** (0.199)	-0.913 ** (0.303)	0.081 (0.274)
Interorganizational experience, with information technology firms	1.339 * (0.589)	1.600 * (0.799)	0.991 (0.937)
Interorganizational experience, with transaction/service providers	0.738 (0.548)	0.932 (0.647)	0.321 (0.998)
Interorganizational experience, with other banks/financial services firms	0.538 ** (0.176)	0.666 ** (0.206)	0.263 (0.308)
No. of lines of businesses	-0.117 (0.101)	0.017 (0.123)	-0.376 * (0.181)
Size (log assets)	1.369 ** (0.467)	1.911 ** (0.610)	0.759 (0.671)
Return on equity	-0.006 (0.039)	-0.036 (0.042)	0.045 (0.071)
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any R&D outlays, but this might be misleading. Banks certainly engage in product development, as our limited field research of two banks indicated. They typically do not have research laboratories, but may invest in a joint venture with one or more industrial firms. The implication is that internal R&D expenditures as a precursor for the acquisition of technology is not pertinent in this study; as a proxy we have accumulated the total number of information-technology projects. Obviously, this study should be replicated on industrial firms to gauge the relative importance of internal R&D versus strategic partnering in a firm's technology acquisition.

The commercial bank's market is being transformed by the diffusion of new technologies in such a way that their traditional domain definitions no longer apply. Consider, for example, brokerage houses such as Merrill Lynch which exploited information technology advancements and new opportunities to expand its domain. Merrill Lynch introduced the Cash Management Account, which bundles various services such as money market accounts, stock brokerage, credit cards, checking accounts and electronic fund transfer. The strategic implications of such trends for banking innovation are self evident. Banks are induced to innovate in order to differentiate their service portfolio. Videotex affords one opportunity for service differentiation.

The results of this study show the importance of domain activity in facilitating the aggressive use of videotex in broadening a bank's service offerings. Even more important is a bank's interorganizational conduct, particularly that which exposes it to information technology. Banks which score high on such dimensions are better positioned to fend off the threats emanating from deregulation and technological diffusion and to exploit the service differentiation opportunities which are made possible by videotex innovations.

It is quite remarkable to notice that banks' experiences in user-interface technology have a significant but negative bearing on the likelihood of video banking adoption. Videotex technology itself is in the same category of user-interface technology. One possible interpretation of this result is that videotex is more remote, or 'radical,' than the other user-interface technologies, and forms an alternative route to service differentiation. Bank-by-phone, for example, is a very grad-

ual innovation, involving some variation of an answering machine that triggers clerical tasks for a bank employee. Here, the amount of information technology is quite restricted. Videotex, in contrast, requires sophisticated networking, computer-integrated information systems, and extensive software capabilities. While all this is a matter of conjecture, it clearly indicates that one should not generalize from one type of innovation to another. Additional research is required to identify the antecedents of technological innovation.

A kindred hypothesis can be suggested which merits further testing. The results in this paper might be criticized in that they do not provide an unequivocal test on prior experiences and innovation. Rather, an alternative plausible hypothesis can be advanced: the banks in this study differ in their strategic readiness to develop and implement strategic change. The prior involvement in information technology and strategic partnering signals a strategic disposition, or a what Mintzberg [16] might call 'realized strategy.' Interfirm linkages and technological experiences, as well as subsequent innovations mirror a firm's strategic momentum. New commitments toward information technology, particularly when they involve broad-based actions as indicated by the term scope, signal a continuation of a bank's technological strategy.

We are not able to rule out this alternative hypothesis. The technology strategy of banks is not well publicized, except for some cases such as Chemical Bank and BancOne. A full inventory of each bank's intended or emergent strategy is required for testing such an hypothesis. The results of this study clearly show that banks with prior experiences have a greater strategic *discretion* to engage in technological innovations, and might therefore also play a more prominent role in shaping the 'technological trajectory' [19] in and around the financial services industry. Since they are major users of information technology, such banks might also shape technological developments in telecommunication and computer hardware and software industries.

The number of lines of businesses also has a significant and negative effect, although its effect pertains primarily to the adoption of narrow-scope video banking. Number of businesses might be construed as another proxy for realized strategy.

If we accept the view that prior experiences increase the 'absorptive capacity' [7] of an external domain of knowledge, then we can surmise that internal historical conditions have to be identified before we can make predictions about a firm's likelihood to be active in its domain.

As was suggested at the onset of this paper, this study can be generalized beyond the financial services sector. This sector illustrates a setting where disparate technologies are coming together. The high levels of strategic partnering around these technologies mirror this trend. We submit that similar trends might occur among airlines, telephone companies and health care providers. This study could be replicated in such industries in order to furnish insights in how and where organizations, as players in technological trajectories, give form and direction to those trajectories. This study suggests that the organizational level of analysis should be combined with the level of technology. By recognizing that organizations have formed a variety of strategic alliances, we begin to understand their individual and collective role in triggering the emergence of new technologies. The more they reach out to outside sources of technology, and the greater their extent of interfirm networking, the more important is their role in bringing about technological innovations. The scope of those innovations stands to benefit as well, rendering innovation less 'incremental' [21]. Therefore, the present study also sheds light on the role of organizations in bringing about technological change.

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