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*Inside the Black Box:  
What Makes a Bank Efficient?*

by  
Frances X. Frei  
Patrick T. Harker  
Larry W. Hunter

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**Abstract:** A decade of econometric research has shown that X-efficiency dominates scale and scope as the drivers of inefficiency in the U.S. banking industry. However, this research falls short in explaining the causes of the high degree of X-efficiency in the industry. This paper summarizes a four-year research effort to understand the drivers of this inefficiency. Key findings from this research, based on the most comprehensive studies to date of management practices in the retail banking industry, give insight into the drivers of X-efficiency. The paper provides a comprehensive framework for the analysis of X-efficiency in financial services.

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**Keywords:** Retail Banking, Services, Efficiency, Technology Management, Human Resource Management

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<sup>1</sup>Frances X. Frei is at Harvard University.

Patrick T. Harker is at the Department of Operations and Information Management, The Wharton School, University of Pennsylvania, Philadelphia, PA 19104-6366, harker@wharton.upenn.edu.

Larry W. Hunter is at the Department of Management, The Wharton School, University of Pennsylvania, Philadelphia, PA 19104-6358, hunterl@wharton.upenn.edu.

## 1.0 Opening the Black Box

A vast literature addresses the causes of inefficiency in financial services, particularly in banking. The typical study assumes that the bank is a “black box”; that is, the production function of the organization is a simple relationship between inputs and outputs. The goal of many of these studies is to ascertain whether scale or scope economies exist in banking. In addition to these traditional economic explanations of performance differences among firms, recent studies have focused on the notion of *X-efficiency* (Leibenstein, 1966, 1980), a measure of the performance of an organization relative to the best practice in that industry. More precisely, X-efficiency describes all technical and allocative efficiencies of individual firms that are not scale/scope dependent. Thus X-efficiency is a measure of how well management is aligning technology, human resources, and other assets to produce a given level of outputs. Summarizing this research, Berger, Hunter *et al.* (1993) state:

The one result upon which there is virtual consensus is that X-efficiency differences across banks are relatively large and dominate scale and scope efficiencies.

Other results, such as those reported by Fried, Lovell *et al.* (1993) in the context of credit unions, add additional weight to the importance of X-efficiency by providing evidence that it is a dominant factor in both large and small institutions.

Based on this evidence, it is clear that scale and scope economies are not the driving factor in explaining firm-level efficiency. The explanation of variance in firm-level efficiency is incomplete so long as it treats X-efficiency as an unexplained residual. Our goal herein is begin to build toward the understanding of variance in X-efficiency in financial institutions. *That is, we seek to understand how technology, human resources, and process management methods vary across these organizations and how this variation affects performance.* Put another way, our goal is to pry open the “black box” of the organization in order to ascertain what drives X-efficiency in the industry. In so doing, we are attempting to address the concern raised by Berger, Hancock and Humphrey (1993) at the conclusion of their profit efficiency study of banks:

Our results suggest that inefficiencies in U.S. banking are quite large - the industry appears to lose about half of its potential variable profits to inefficiency. Not surprisingly, technical inefficiencies dominate allocative inefficiencies, suggesting that banks are not particularly poor at choosing input and output plans, but rather

are poor at carrying out these plans.

What is inside this “black box”? Several attempts have been made to understand the role of management and managerial decisions in the efficiency of organizations. Hoch (1962) and Mundluk (1961) view management as the explanatory variable for the residuals in a production function estimation. While simple to operationalize, equating the residuals with management practices does not provide any theoretical basis for why such management practices matter. To address this concern, Mefford (1986) attempts to internalize these management practices in a production function as follows:

$$Q = f(K^*, L^*, \text{MGMT})$$

where  $K^*$  is quality-adjusted capital,  $L^*$  is quality-adjusted labor, and MGMT are management control variables that attempt to measure the relative quality of the management talent in the organization. The quality-adjusted inputs are equal to the raw capital and labor inputs to the firm, adjusted for the relative skill/ functionality levels of the capital and labor. While this approach can be operationalized using existing production function methods, it too lacks a firm theoretical basis for why such adjustments matter.

Nelson and Winter (1982) provide a theoretical basis for the role of management as the definers and modifiers of the “routines” used by the organization. That is, management’s role is to shape the processes by which goods and services are produced; i.e., their “technological regime”. This view of management as the “process engineers” has been the subject of numerous studies and extensions in recent years (see, for example, Morroni, 1992). Out of this work has emerged the view that the role of management is more than a control variable in the estimation of a production function. Management integrates people, technology, and routines/ processes to define the production function of the organization (Scazzieri, 1993). Thus, the management of the organization is intricately related to the production technology and subsequent productivity of the organization.

To provide some rigor to the role of management in defining an organization’s productivity and hence, to understand the drivers of X-efficiency, consider an industry where  $S$  products or services are produced. Let  $O_s$  denote the level of output for service  $s \in S$ , and define  $O \in \mathbb{R}^{|S|}$  to be the vector of outputs for the firm. Given this vector of outputs, let  $v(O)$  denote the revenue or value created for the firm by the production of the outputs  $O$ . Note that, particularly

in services, this linkage between the outputs and the revenue or value generated for the firm is more complex than a simple multiplication of the price of each output by the quantity produced. In the recent study by the National Research Council (1994) on services, the linkage problem in the context of banking is summarized as follows:

... [existing approaches for productivity measurement are not] able to account for improvements in the quality of service offered to customers or for the availability of a much wider array of banking services. For example, the speed with which the processing of a loan application is completed is an indicator of service that is important to the applicant, as is the 24-hour availability through automated teller machines (ATMs) of many deposit and withdrawal services previously accessible only during bank hours. Neither of these services is captured as higher banking output at the macroeconomic level.

The linkage between output and value is complex. Let us consider one small, straightforward, and important example drawn from our work in retail banking: the quality of the service provided, as proxied by a simple metric such as waiting time in a bank branch or on the telephone. It is clear that this quality plays a major role in the acquisition of new business along with the retention of existing accounts (Rust and Metters, 1996). Furthermore, this quality output is the result of a series of decisions on the part of management (e.g., by deciding on the staffing levels in a bank branch, management has decided upon the level of service to offer to the average customer). However, the linkage between such quality measures and revenues is much more complex than assigning a dollar figure to a unit of quality; such relationships are highly nonlinear in nature (Rust, Zahorik, and Keiningham, 1995). The role of management is to discover these relationships between outputs and value; i.e., to discover, either through deliberate decisions or through the development of emergent strategies, the linkage of outputs to value creation for the firm. Further, we might note that this measure of quality does not adjust for the accuracy of any information provided or tasks completed, or for the accompanying emotional aspects of the service transaction (Rust, Zahorik, and Keiningham, 1995). Such attributes may also generate value for the bank, and these are also the result of managerial decisions regarding the allocation of resources.

Foremost of the decisions facing management is the choice of the production function itself. Either through incremental change (Rosenberg, 1982) or through discontinuous learning (Schumpeter, 1939), management “chooses” the production technology for the firm. Conceptually, let us define P as the set of all possible production functions/ routines/ technologies,

and let  $F_p$  be the production function associated with  $p \in P$ . Given the choice of  $p \in P$ , the choices for capital and labor inputs are severely constrained (Morrone, 1992). For example, if I choose a branch-based delivery system, I must staff the branch with a certain number of tellers in order to deliver a given level of quality (e.g., waiting time). If, however, I choose a production technology that is a mix of branch, phone, and ATM machines, my choices for meeting this same level of service are greatly expanded. Therefore, by the choice of  $p \in P$ , the firm constrains its choice of labor  $L_p$ , capital  $K_p$ , and information technology  $T_p$ . (note that throughout this paper, information technology (IT) and non-IT capital are kept separate due to the increasing importance of IT capital in financial services).

While the input choices are oftentimes limited, as noted by Mefford (1986), managerial decisions play a vital role in the creation of effective inputs. That is, the purchase of a computer in and of itself adds nothing to the productive capability of an organization. It is only after this computer has been integrated into the production technology of the firm that it adds value. The same is true of labor and other capital inputs. Without the proper training, additional labor adds no value to the firm. Thus, management plays a crucial role in transforming “raw” inputs into useful/ effective inputs for the firm.

Consider the management of human resources. Studies in manufacturing have clearly shown the effects of different ways of managing employees on performance outcomes such as productivity (MacDuffie, 1991; Ichniowski, Shaw and Prennushi, 1994) and quality (Arthur, 1994; MacDuffie, 1995). Considerable anecdotal evidence suggests that the management of people in financial services may also affect performance outcomes (see, for example, Long, 1988; Beatty and Gup, 1989; Roth and van der Velde, 1991a). Yet careful empirical studies considering the role of human resources in financial services have taken one of two tacks. Much of the solid econometric work on efficiency of financial service organizations considers crude aggregate measures of labor as an input (labor cost, hours worked, or number of employees) without attention to the management of labor. And work that considers management practices focuses on high-level managers (see, for example, Donnelly *et al.*, 1989; Sellers, 1992; Blackwell *et al.* 1994), but does not address the bulk of the workforce involved in delivering financial services to customers. Neither of these two approaches allows for the possibility that banks may gain competitive advantage from effective management of the broader workforce. One study,

however, suggests that top performing Finnish banks are leaders with respect to training and employee empowerment (Tainio *et al.*, 1991), a result consistent with the manufacturing studies cited above.

Technology also plays a key role in the performance of firms in this industry. Roth and van der Velde (1991b; Figure 3) show that \$392,000 per bank (\$2.1 million for banks with more than \$3 billion assets) is spent annually on platform automation and \$502,000 (\$3.2 million for the larger banks) is spent on upgrading information and transaction processing. Even with these large investments, it is still difficult to ascertain the payoffs associated with these projects. In manufacturing, recent studies (Brynjolfsson and Hitt, 1993; Lichtenberg, 1995) have found large payoffs in information technology (IT) investments, both in terms of equipment and personnel. For example, Lichtenberg (1995) states that “the estimated marginal rate of substitution between IT and non-IT employees, evaluated at the sample mean, is six: one IT employee can substitute for six non-IT employees without affecting output.” Unfortunately, similar results for financial services are not available, mainly due to the problems of accurately measuring IT investment and outputs.

Thus, the firm selects the levels of labor (L), capital (K), and information technology (T) to deploy in a given production process in addition to the methods for managing these “raw” inputs to create useful productive assets for the firm. That is, the firm transforms these inputs into “effective” inputs through the choice (deliberate or emergent) of the transformation functions  $g_i$  for each input  $i \in K, L, \text{ and } T$ :

$$\begin{aligned} L^* &= g_L(L) \\ K^* &= g_K(K) \\ T^* &= g_T(T). \end{aligned}$$

Lastly, the firm is faced with a cost function  $c(L,K,T)$  for the inputs. Note that this function is again more complex than the simple summation of costs and input levels due to the presence of cost complementarities (Milgrom and Roberts, 1990; 1995).

Given this framework, the problem facing the management of a firm can be stated as:

$$\text{maximize } v(O) - c(K,L,T)$$

by selecting:

- the levels of inputs K, L, and T;
- the input transformation functions  $g_i$ ;

- the production technology/ function for the organization  $p\&P$ ; and
- the mix of outputs  $O_S$  that will derive the value  $v(O)$ .

The key decisions facing the firm are the last three in the sense that the input levels are derived from the latter decisions.

Therefore, the management qualities that generate differential X-efficiencies are defined by their ability to (1) align the outputs of the firm with strategic directions that are profitable today and tomorrow; (2) align the production function/ technology of the organization in the most efficient manner to produce these outputs; and (3) align/ transform the raw inputs into effective human resources, capital and technology for the given production technology. That is, management must *align* strategy with the design of the production processes of the organization and the inputs in order to become effective and efficient.

### ***This Paper***

This paper summarizes a four-year research effort aimed at understanding this alignment of strategy, process, people, and technology in the retail banking industry. Rather than reviewing any one managerial action or explanation of the drivers of efficiency in detail, the current paper synthesizes the detailed research in several papers by the authors with the results of our field-based research investigations. While not providing definitive answers in the form of a full estimation of the conceptual model described above, this paper presents evidence (both statistical and case-based) on the drivers of efficiency and effectiveness in the choices of human resource practices, technology management, and the design of the production processes. Based on the most comprehensive data collection effort ever undertaken in the retail banking industry (see Appendix A for details), the aim of this paper is to provide insights into what drives X-efficiency in this industry. In this sense, our goal is to fulfill the desire expressed by Griliches (1992, p. 7) in his review of the state-of-knowledge on service-sector productivity:

... the necessary economic-engineering research that would tell us which of the characteristics and training levels are important for their successful performance has not been done. We are thus lacking the scientific base for the desired measurement procedures.

Through the synthesis of detailed operational, human resource, technology, process, and strategy data, our purpose is to build a base of knowledge for the banking industry. The plan of

the remainder of this paper is as follows: the next section reviews the overall design of the retail banking study. Sections 3 and 4 then explore the results of previous research on the data described in Appendix A by the authors on the effectiveness of management practices to deal with human resources and capital (especially information technology), respectively. The issue of selection/ alignment of production processes is explored in Section 5, and the question of aligning these practices with strategy is dealt with in Section 6. The paper concludes in Section 7 with a discussion of our view as to what drives efficiency in retail banking as well as describing a set of research questions that emerge from this analysis.

## **2.0 Study Design**

The focus of all of the research reported herein is on the products and services provided by the banking industry to the consumer marketplace. Given the fact that the retail operations of a typical bank are only a portion of its overall enterprise, why focus solely on the consumer market? And, given this choice of focus, what data problems arise?

Each of the studies reviewed in the following sections relies on a set of data collected by the authors. We describe this data collection effort here. In the field-based portion of the data collection (see Appendix A for details), interviews with industry executives clearly surfaced the increasing emphasis they are placing on the retail consumer. The growth of non-bank competitors and the advent of new distribution channels enabled by advances in information technology are rapidly changing the competitive landscape of consumer financial services. Banks are responding to this challenge with variety of choices of delivery systems, human resource changes, and massive technology investments. Thus, the retail banking operations of the industry provide a significant “natural variation” that can be used to study the impact of process, technology, and human resource practices on performance. In other words, the field-based interviews with industry executives led to us to conclude that a significant cause of the variation in X-efficiency lies in the consumer operations of a typical bank<sup>1</sup>. In addition, it is precisely this variation that is of interest to the industry executives. Given the detailed data requested from the banks in the study, including several confidential pieces of information, it was vital that senior executives found the results of interest in order to participate. By focusing on the retail business, a data set

that was developed that covers almost 80% of the industry (by asset size); see Appendix A for detail. Therefore, by limiting the focus to retail banking, a very rich set of strategy, operational, and performance data was created for the industry. Again, each of the studies summarized herein analyzes this data set.

The focus on the retail side of the banking industry does limit the data in several ways. It is very hard, even for the banks in the study, to clearly separate, in terms of financial and operating data, the retail and non-retail portions of their business. For example, the expenditure of technology on the retail business versus on the bank as a whole is often impossible to discover. To deal with this inability to disentangle the retail business from the overall bank operations, an elaborate data collection effort was undertaken in this study. Specific data has been collected, per the advice found in Griliches (1992), micro-level details on the operations of the retail bank (number of full-time equivalent employees (FTE), the actual functionality of the technology deployed in the branch system, etc.) in addition to cost and revenue figures. While the financial data is suspect due to the reasons listed above, we are very confident in the quality of the micro-level/ “engineering” data that was collected.

Thus, using this combination of bank-level financial data and the detailed “engineering” data, the studies discussed below were able to undertake analyses of retail bank efficiency at a variety of levels: from the efficiency of the bank as a whole, using the financial data collected despite its limitations, to detailed analyses of the efficiency of key service delivery processes in the bank. While none of these analyses is without its limitations due to the data collected, it is the combination of all of these analyses that begins to paint a picture of what drives X-efficiency in this industry. It is in the combination of these studies that this current paper makes its contribution. Ideally, there would be similar data on the other parts of the banking establishments (wholesale, commercial, off-balance sheet activities, etc.) to be used to create a full and consistent data set for the bank; this is left for future research. At this point, the studies focus only on the retail bank. While limited, this focus does uncover interesting patterns of efficient versus inefficient organizations; it is these patterns across the studies that are the focus of this paper.

### ***The Inputs and Outputs Considered in the Studies***

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<sup>1</sup> This conclusion is based on our observation that each of our seven pilot institutions stressed their opinion that consumer operations were in fact a large cause of inefficiency.

As described above (and more fully in Frei, Harker, and Hunter, 1994), the choices of human resource, technology and process management techniques and their impact on the quality, cost and convenience of the services provided by the financial institutions are vital drivers of efficiency. The three studies that we will synthesize address each of these factors in detail:

*Human resource management practices* are considered in a number of areas: compensation, hiring and selection, staffing, training, work organization and employee involvement. Further, these practices are analyzed as they govern both managerial and non-managerial employees. Both groups play important roles. In branches of retail banks, for example, employees from the manager's office to the teller window sell products and support selling at previously unprecedented levels. Practices in successful retail banks must reinforce the ability of the organization to compete for investment dollars, to solve customers' problems, and to complete transactions quickly and accurately. (Hunter, 1997)

*Technology* in banking (IT) is considered at two basic levels within a bank: overall investment in IT, and the functionality of the technology deployed in the production/ service delivery processes in the branch and phone delivery systems. Thus, technology is viewed at both a macro-level in terms of investment, and at a micro-level in terms of its ability to perform certain functions within the organization. In addition, the management of IT, both in terms of the selection of projects and their management, are crucial factors in transforming the investment T into effective technology T\*. The key technological thrusts found in the retail banking survey conducted by Roth and van der Velde (1992) suggest that major technology investments are underway to integrate the traditional front- and back-office systems into a seamless service delivery process. These and many other studies of information technology suggest that IT is best able to add value when it *informs*, creating new sources of information in an organization, rather than simply automating existing processes (Zuboff, 1985). In banking, this trend manifests itself in the desire to provide expertise and information to the people who are in closest contact with customers. (Prasad and Harker, 1997)

In order to understand how a bank interacts with its customers a subset of the *product and service delivery processes* has been examined across five representative products of the *core* retail bank. The products include consumer checking, certificates of deposit (CD), home equity loan, small business loan, and mutual funds. For each of these products typical transactions such as opening an account, as well as error resolution transactions, such as double posting a check were analyzed. Variation in work-steps and available tools can affect the characteristics of processes. For example, more sophisticated technology may speed up a process through automation. At the same time, technology may lengthen process time by increasing the information available to the bank or the customer. Similarly, staffing a particular process with a highly experienced employee may increase speed or accuracy, but also may increase the amount of time introducing the customer to additional appropriate products (cross-selling).

Combining different levels of technology and human resources has different effects; and there are tradeoffs in results associated with different process designs. In addition, customers have co-productive effects on processes. As an integral part of the process, the customer is a resource just as the platform representative's time is a resource. In fact, the time required of the customer may be a consideration in particular process designs. Some processes may waste the customers' time, others will not; some processes will take advantage of interaction with the customer to increase sales or the information available to the bank. (Frei and Harker, 1996, Frei et al 1997)

As described above, the limitations of the data collected as part of this study restrict our ability to definitively link management practices to overall profitability of the retail bank for two reasons. The first reason lies in the inability to disentangle the financial data of the retail bank from the overall organization. Ideally, a longitudinal data set would permit one to decouple the retail and non-retail portions of the bank. However, the current data is cross-section in nature and thus, it must be assumed that the overall profitability of the organization is highly correlated with its retail bank performance. While this assumption seems reasonable given the prominence the retail bank is given both organizationally and in terms of managerial resources dedicated to it, only a panel data set would permit one to formally test this hypothesis; this is left for future research. Second, the bank provides a variety of outputs, such as quality, that are crucial in growing the business, but are difficult to link to overall value. There is significant theoretical and anecdotal evidence to suggest that outputs such as quality, convenience, etc. are linked to value creation; the exact form of this transformation function,  $v(O)$ , however, can only be discovered with a longitudinal data set. Thus, the cross-sectional operational data somewhat limits our analysis.

To overcome these limitations, analyses across these studies have been performed at three levels: overall profitability, performance in terms of quality, and detailed process-level performance of the organizations. As stated above, none of these analyses lead to definitive results by themselves. However, when viewed together along with the results of our field-based interviews, they begin to surface the key drivers of efficiency in the banking industry.

Thus, the outputs of the retail bank are viewed in at three levels. For aggregate analyses comparing one bank to another, Return On Assets (ROA) is used as the financial performance metric. While this measure is aggregate in nature and, hence, suffers from the fact that the retail franchise is only a portion of the overall bank, it does provide some insight into the payoff of

various investments and management practices. Thus, these aggregate analyses focus on overall profitability  $v(O) - c(K,L,T)$ .

Finally, the detailed process-level data collected creates the ability to study the drivers of profitability and satisfaction in terms of the convenience, precision, and adaptability of the retail bank:

*Customer convenience.* Historically, consumers chose financial services based largely on availability and location. With advances in technology and innovations in human resource practices, the concept of convenience has been extended well beyond availability and location to imply easy access to a wide range of products and services available at any time, from any place. Rapid turnaround time of customer product and service requests also is increasingly important. For example, customers expect firms to be capable of moving money instantly between investment product options and accounts. Equally important is the amount of time required of the customer in these co-productive processes. Whether it is standing in the teller line, filling out a loan application, or coming to the branch for a loan closing, the demands placed on the customer must be measured and made mutually beneficial.

*Precision.* While customers may make many choices based on convenience, they also expect quality in the delivery of financial services and products. The customer defines quality as a broad range of tangible and intangible attributes. Examples include error free statements, checks printed correctly, and the operational soundness of all delivery channels. Consumers and shareholders also want the firm to be able to make good business decisions, which requires operating precision from the bank. First, the source information, which forms the basis for any decision must be accurate. Second, the institution must have the tools that enable accurate interpretation of the source information. For example, making good lending decisions requires accurate information from the consumer, a detailed understanding of the economic environment, and tools such as credit scoring models to facilitate the analysis process. While these decisions may occur without the benefit of sophisticated tools, the bank's ability to increase precision even slightly on an individual credit analysis might translate into systemic improvements.

*Adaptability.* The first indication of an organization's adaptability is its willingness to adapt to the demands of the customer. Pricing flexibility may evidence this willingness. It also surfaces in the concept of mass *customization* of services (Pine, 1993). Customers have individual needs that are not easily satisfied by standard products and services. Not surprisingly, the need to customize products and services underlies much of the IT investment in banking. In addition to responding to the customer, financial institutions display adaptability in their ability to respond to the marketplace. In competition with non-bank financial institutions, the bank's challenge is to create competitive products and introduce them effectively to protect or enhance the firm's relative competitive position. Changes in products or the IT infrastructure require the institution to change business

processes. Organizations and processes should be able to withstand and plan for change.

Appendix A describes the survey methodology that was used to capture data on all of these elements of the banking industry's performance listed above. This data was then analyzed in the previous studies using a variety of statistical and linear programming-based methods; Appendix B summarizes the analytical methodology used in most of these studies. Rather than focusing on the detailed results of these analyses, which are described in the papers cited herein, the remainder of the paper turns to the question of what these analyses say with respect to uncovering the drivers of X-efficiency in the banking industry. That is, what do the various levels of analyses and field-based interviews with those in the industry, both in the boardroom and in the bank lobby, say about what makes a retail bank efficient?

We begin with a discussion of human resources in banking.

### **3.0 Aligning Labor**

There is solid empirical evidence that human resource management (HRM) contributes to organizational performance (Arthur, 1994; Cutcher-Gershenfeld, 1991; Delery and Doty, 1996; Huselid, 1995; Huselid and Becker, 1996; Ichniowski, Shaw, and Prensushi, 1994; MacDuffie, 1995). Recast in terms of the literature on banking efficiency, this implies that some of the inefficiencies in banking may be attributable to ineffective management of human resources.

Understanding of the management of human resources may be cast at multiple levels (Becker and Gerhart, 1996). The "architecture" of a human resource system provides a high-level framework and guiding principles for HRM, while policies bring this framework down closer to an operational level. At these levels, the limited evidence suggests there may be some *best practices* in HRM (Pfeffer, 1994; Huselid, 1995; Milgrom and Roberts, 1995). Such evidence raises the question of why firms do not adopt these architectural characteristics and policies (such as valuing employee performance, developing employee skills, and encouraging commitment and involvement). There are, however, both in-firm and external impediments to such adoption (see Levine, 1995 for more on this argument). The result is that effective HRM may be difficult to adopt or imitate. HRM may therefore serve as a source of competitive advantage in the resource-based sense (Barney, 1991; Lado and Wilson, 1994; Pfeffer, 1994). This seems to be at least partially true in banking. Delery and Doty (1996), for example, find that the existence of HRM

policies favoring profit-sharing and results-oriented performance appraisals for lending officers are significantly related to return on average assets and return on equity for U.S. commercial banks.

At increasingly specific levels below HRM architecture and policy lies the implementation of particular HRM practices. It is at these levels that HRM practices might actually create value. Practices, as organizational structures, attract and retain employees, reinforce employee behaviors, and develop employee skills (Wright and McMahan, 1992). One open question is the extent to which these practices are inimitable and therefore the potential source of performance differences. The appropriate alignment of these practices toward the solution of particular sets of business problems (such as effective customer service, cost minimization, revenue generation, and the like) under a broader architecture may be quite idiosyncratic and could therefore represent such a resource (Becker and Gerhart, 1996).

In complex organizations such as banks, different groups of employees are governed by different “subsystems” of HRM practice (Osterman, 1987). Each subsystem may have its own distinct logic and appropriate accompanying set of HRM practices. For example, branch-level employees may be embedded in one subsystem and governed by one set of practices, telephone center employees may work in another subsystem, corporate lenders in another, and traders in another. Each employment subsystem in a bank generates multiple outcomes. Each subsystem may contribute to the overall efficiency of the bank independently and may make contributions that are complementary (Milgrom and Roberts, 1990) to the contributions of other groups.

Alignment of HRM practices in these subsystems can contribute to efficiency in a number of ways. First of all, where practices within a subsystem are aligned with one another toward key goals, that subsystem performs more efficiently. For example, bundles of lean-production HRM practices in auto assembly production facilities lead to higher levels of productivity and quality (MacDuffie, 1995). Further, the alignment of HRM practices within one subsystem with those in other subsystems may produce further efficiency benefits; these may be in addition to or traded off against those benefits within the subsystem in question. And it is clear that the problems of alignment in complex organizations are themselves computationally complex, requiring considerable information; as the number of choice parameters and the strength of complementarities grow, the problem of selecting among policies becomes more difficult (Milgrom and Roberts, 1990).

This discussion has so far had a fairly abstract character. Our work in banking, however, enables us to make a start on understanding the relationships between HRM and efficiency by considering the effects of alignment of HRM practices within and across particular subsystems. We start by considering the subsystem of HRM practices governing branch employees. As we noted in the earlier discussion of measures of value creation, branches have a number of subordinate goals that might in turn contribute to organizational efficiency: provision of services in ways that customers find convenient; precision in the provision, collection, and analysis of financial information (which in turn contributes to risk minimization and fraud detection); cost control and efficient sub-processes; adaptability to the demands of customers (particularly those customers with whom it is profitable for the bank to maintain relationships); and high-quality customer service leading to satisfaction and increased sales. In a previous study of this data, it was found that branches with HRM practices aligned toward particular sets of goals perform better than those that do not have such alignment. Where HRM practices develop skills and reward behaviors in line with these subordinate goals, performance on a given dimension is typically superior to performance in other units where such practices are not so aligned (Hunter 1997).

Because each bank may have its own weighting scheme for valuing outcomes, aligned sets of practices -- even in efficient banks -- may look somewhat different. For example, a bank that values streamlined processes quite highly may have practices (such as training, incentives, job design) that encourage employees to move customers swiftly through such exercises as checking account openings. A bank that values sales more highly may have differently designed training practices, reward structures, and jobs. This raises two questions, separable in principle. First, the mixes of outcomes banks obtain from different sets of HRM practices may represent more or less efficient performance. Second, banks may have HRM practices more or less effectively aligned toward the production of a given mix of outcomes. The first question is, in principle, a more strategic decision (based on the value weightings banks assign to sub-outcomes). The second question is more oriented toward implementation, asking whether banks have optimal HRM practices for the achievement of particular outcomes. (Empirically, however, separating these two questions is more difficult since variance in value weightings of outcomes across banks may in part derive from the cost of implementing the HRM practices necessary to achieve those

outcomes.)

Taking this to an increasingly specific level, and again with application to the branch subsystem, two different trends have been identified (see Table 1) guiding the re-shaping of employment practice in leading American retail banks (Hunter, 1997). Both trends involve a departure from the traditional, bureaucratically organized bank branch, in which jobs were narrowly defined, linked in a hierarchical ladder, and governed by a set of restrictive rules over behaviors.

**Table 1. Two Models of Employment Practice for Bank Branches**

<b>HRM Practice</b>	<b>Inclusive Model</b>	<b>Segmented Model</b>
<b>Selection criteria</b>	High school, some college Trainability Customer focus	College required for platform High school for tellers
<b>Training emphasis</b>	Broadly cast	Focused on platform
<b>Compensation</b>	At or above market Incentives for team/group Returns to tenure	Above market for key platform employees Low for others Individual incentives
<b>Job Design</b>	Broad cross-training Teamwork	Narrow, specialized Autonomy within specific tasks
<b>Use of Part-Timers</b>	For “retention” reasons	Use where possible, cost-control-oriented
<b>Role of Local Manager</b>	Facilitator/trainer Customer relations Generalist	Supervisor and scheduler Facilitator to platform Product specialist
<b>Organizing Logic of Worksite</b>	Team of generalists	Collection of specialists

The *inclusive* strategy involves investment in the entire retail workforce. In this model, tellers’ jobs are enriched to include sales responsibility and cross-training to platform functions. All employees are to some extent responsible for initiating and maintaining customer contact. Tellers focus on the provision of basic services, while platform employees engage in relationship management and active selling, but either employee may be expected to cover the duties of the other. An ideal-typical inclusive system couples relatively high wages with incentive pay for effective sales and sales referrals. The model also includes elements of teamwork within the branch, cross-functional cooperation between different job families, and branch or unit-based performance bonuses. The role of the branch manager in this environment is one of a team facilitator and customer-relations expert, with a wider array of knowledge about products and services, and overall responsibility for the performance of the unit.

An alternative ideal-typical strategy for organizing the branch, the *segmentation* approach, focuses chiefly on cost containment in the mass market, with specialized services for an elite segment of customers. In this model, banks attempt to match different kinds of employees to sharply distinct roles. A few specialized employees -- branch managers, product specialists, and “personal bankers” on the platform -- are responsible for managing relationships between the bank and qualified customers. Ideally these are customers with high profit-potential such as upper-income professionals and owners of small businesses. The employees responsible for serving these customers are carefully screened, typically college educated, and, increasingly, licensed to sell investment products. They are well paid, and embedded in the internal labor market of the bank, with opportunities for advancement and access to training. These employees also have considerable range for discretionary decision-making; they are charged with using this autonomy to enhance the relationship between the bank and its customers. In this model, however, the majority of branch and telephone center employees receive considerably less compensation and training. They are often employed on a part-time basis and their compensation may not include benefits. Typically, they are shut off from promotion opportunities unless they acquire an external credential such as a college degree. The positions, typically, tend to be high-turnover and to have relatively flat wage profiles. Further, the distinctions between the jobs are quite sharp: cross-training is scant and there are few cross-functional responsibilities. In this model, the role of the branch manager is less that of a facilitator and more that of a traditional supervisor.

The two models for organizing work are neither entirely orthogonal to one another, nor do they represent different ends of a unidimensional continuum. Most branches feature some aspects of segmentation and other aspects of inclusion. On some dimensions of practice (cross-training of tellers, for example), a choice between the two models is required: more inclusion necessarily implies less segmentation. On other dimensions (incentive pay, for example), it is possible to have aspects of the segmented model (with its focus on individual incentives), aspects of the inclusive model (with group pay incentives), both, or neither.

Both branches with more inclusive HRM practices and those that employ segmentation may be effective in some dimensions. Inclusive HRM practices in branches are significantly and positively related to customer satisfaction measured at the bank level (Hunter, 1996b), for example. Further kinds of effectiveness are contingent on the consistency with which the model

of HRM is applied. Consider key branch-level outcomes such as rates of “cross-selling” (as measured by the average number of standard retail products held per customer) and basic productivity (as measured by customers served in a branch, per full-time equivalent employee). Analyses controlling for other plausible determinants of performance, such as characteristics of local markets, show that branches which employ either high levels of cross training from teller to platform and vice versa, or high levels of employee autonomy, significantly outperform those with branches which take neither approach and those which have both cross-training and high autonomy (Hunter and Hitt, 1997).

Effectiveness is also contingent upon the role the branch plays in the strategic direction of the bank. If pure process efficiency, for example, rather than customer satisfaction, is a target, then inclusive models are less desirable. Alignment of practices in an inclusive direction has a negative and statistically significant relationship to measures of process efficiency (Frei, 1996). Further, while banks that feature low levels of cross-training and low levels of employee autonomy – in short, those traditional bureaucracies comprising narrow and constrained jobs – do not perform well on sales or straight productivity outcomes, these same banks actually appear to have lower levels of branch-level losses as measured by branch “out-of-balance” figures (Hunter and Hitt, 1997). These results suggest that the question of which kinds of HRM practices in bank branches are most efficient remains open and may depend upon the cost of implementing such practices (something we need more data on), as well as on the varying values different banks place on the different outcomes (sales versus traditional productivity versus process efficiency versus losses, for example). It is also worth noting here that there is no direct evidence that HRM practices in branches are associated with performance with respect to risk beyond simple losses due to error or fraud (for example, poor lending decisions). The HRM data are cross-sectional and, presumably, the effects of HRM practices on risk-related outcomes would take a considerably longer period of time to emerge.

The above discussion discusses effects of HRM on performance outcomes within a single subsystem. There may also be important effects on efficiency that depend upon alignment of practices *across* subsystems. Here, consider the examples of either multiple branch subsystems, or branch and telephone center subsystems. HRM subsystems may be locally aligned yet have negative effects on efficiency if those subsystems have negative effects on the efficiency of other

subsystems. To take one example, HRM practices in a single branch might contribute positively to improved sales or customer convenience at that branch, but negatively to customers' willingness to use alternative delivery channels (such as telephone banking) which themselves have higher rates of sales conversion or more streamlined processes.

From the point of the view of the bank, aggregate efficiency depends upon the proper aggregation of HRM effects not only within but also across subsystems. The cross-channel evidence is more circumstantial than our within-unit evidence. However, fieldwork in one leading U.S. bank is suggestive here. The bank is implementing a variety of segmentation-oriented HRM practices, coupled with decreased levels of employee autonomy driven by process reengineering. Consistent with our broader work, we find that the adoption of these practices contributes negatively to a variety of sales- and service-related performance outcomes at the branch level. However, the same practices contribute positively to customers' willingness to transact in other channels that the bank *believes* to be more efficient in serving customers. If the HRM subsystem in the telephone call center of this bank is designed appropriately, the net effect of both subsystems on efficiency could well be positive.

#### **4.0 Aligning Capital**

The preceding section argued that evidence suggests that the way in which labor is managed may be closely related to X-efficiency in banking. Similar considerations apply to capital; that is, while capital itself may serve as an input in the construction of efficiency measures, the management of capital contributes to the explanation of the sources of X-efficiency in the industry. More specifically, consider the role of information technology (IT). Financial services are the largest consumer of IT in the economy. It has been a matter of much debate whether or not investment in IT provides improvements in productivity and business efficiency. For several years, scholars and policy makers lacked conclusive evidence that the high levels of spending on IT by businesses improved their productivity, leading to the coining of the term *IT Productivity Paradox*. Morrison and Berndt (1990) concluded that additional IT investments contributed negatively to productivity, arguing that "estimated marginal benefits of investment [in IT] are less than the estimated marginal costs". Others, such as Loveman (1994) and Baily *et al.* (1991),

posit that there is no conclusive evidence to refute the hypothesis that IT investment in inconsequential to productivity. Of late, researchers working with firm-level data have found significant contributions from IT toward productivity (Lichtenberg, 1995, and Brynjolfsson and Hitt, 1996, for example). Most of these firm-level studies have been restricted to the manufacturing sector, in large part owing to lack of firm-level data from the service sector.

Prasad and Harker (1997) take an aggregate approach to consider the effects of IT on productivity in the retail-banking industry in the United States using the data described in Appendix A. This section summarizes the results of this analysis.

Using a Cobb-Douglas production function as in Loveman (1994), Lichtenberg (1995), and Brynjolfsson and Hitt (1996), Prasad and Harker (1997) estimate the following equation using the data described in Appendix B:

$$Q = e^{\beta_0} C^{\beta_1} K^{\beta_2} S^{\beta_3} L^{\beta_4} \quad (1)$$

where Q = output of the firm

C = IT Capital Investment

K= Non-IT Capital Investment

S = IT Labor Expenses

L = Non-IT Labor Expenses

and  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$ , and  $\beta_4$  are the associated output elasticities.

Using this function, the following hypotheses were tested:

- H1: IT investment makes positive contribution to output (i.e., the gross marginal product is positive)
- H2: IT investment makes positive contribution to output after deductions for depreciation and labor expenses (i.e., the net marginal product is positive)
- H3: IT investment makes zero contribution to profits or stock market value of the firm.

Studies of productivity in the banking industry struggle with the issue of what constitutes the *output* of a bank. The various approaches chosen to evaluate the output of banks may be classified into three broad categories: the assets approach, the user-cost approach, and the value-added approach (Berger and Humphrey, 1992). As a result, various measures of output were

tested in Prasad and Harker (1997). Benston, Hanweck and Humphrey (1982) posit that “output should be measured in terms of what banks do that cause operating expenses to be incurred.” Prasad and Harker (1997) look at a wide variety of output measures, both financial and customer satisfaction (i.e., the first two levels of analysis described in Section 2). The most meaningful results from this analysis arise when Total Loan + Deposits is used as the output of the institution; these results are summarized in Table 2.

**Table 2. Output = (Total Loans + Total Deposits)**

Parameter	Coefficient	Std. Error	t-statistic	t-statistic: Significance	Ratio to Output	Marginal Product
IT Capital	0.00116	0.013	0.089	7%	0.000452	2.56
IT Labor	0.25989	0.031	8.34	100%	0.0006	449.75
Non IT Capital	-0.02071	0.026	-0.79	57%	0.00428	-4.84
Non IT Labor	0.53244	0. 059	8.95	100%	0.01475	36.10

R<sup>2</sup> = 41% (OLS); 99% (2-Step WLS)

From this table, it can be seen that the elasticities (the coefficients) associated with IT capital and labor are positive. However, the low significance associated with the IT capital coefficient implies that there is a high probability (0.93) that the elasticity of IT capital is zero. Thus, there is not sufficient evidence to support Hypothesis H1 for IT capital (i.e., that IT capital produces positive returns in productivity). It is interesting to note that the elasticity of non-IT capital is, at best, zero (being not significantly different from zero), implying that IT capital investment is relatively better than investment in non-IT capital. However, the results show that H1 cannot be rejected for IT labor, and since the marginal product of IT labor is \$449.75, it can be concluded that IT labor is associated with a high increase in the output of the bank.

Since H1 can not be supported for IT capital, the discussion of the stronger hypotheses, H2, is restricted to the IT labor results. First, it can be seen that the marginal product for IT labor is very high. Since IT labor is a flow variable, then every dollar of IT labor costs a dollar. In view of this, the excess returns from IT labor can be computed to be \$(449.75 - 1), or \$448.75. Thus, H2 cannot be rejected for IT labor. For H3, one has

$$\beta_3 - (\text{IT Labor Expenses} / \text{Non-IT Labor Expenses}) * \beta_4 = .2390 > 0.$$

Thus, there is support for H3 for IT labor.

As far as H3 is concerned for capital expenses, it can be seen that the marginal product of non-IT capital is negative. Further, given the standard errors of the estimation, it is asserted that IT capital is more likely to yield either slightly positive or no benefits, whereas non-IT capital will most probably have a negative effect, decreasing productivity. More formally,

$$\beta_1 - (\text{IT Capital Expenses} / \text{Non-IT Capital Expenses}) * \beta_2 = .00334 > 0.$$

Given the significance associated with the IT capital estimate however, H3 failed to be rejected H3.

Thus, these results from Prasad and Harker (1997) show that IT capital makes zero, and even perhaps slightly negative contribution to output. This result is significantly different from previous studies in the manufacturing sector (Lichtenberg, 1995; Brynjolfsson and Hitt, 1996), and seems to be more in conformity with those obtained in Parsons *et al.* (1993), the only formal study on IT in banking to date. While Parsons *et al.* report slightly positive contribution to IT investment, this analysis demonstrates zero or slightly negative contributions. It should be noted that the production function used in Prasad and Harker (1997) is assumed to be separable and that if this is not the case, then these results may not hold.

IT labor presents a very different picture than does IT capital. IT labor contributes significantly to output; its marginal product is at least 10 times as much as that of Non-IT labor (Prasad and Harker, 1997). Rather than make the simplistic conclusion from this that a single IT person is equivalent to 10 non-IT persons, it is better perhaps to speculate that this may simply reflect the fact that there is significant difference between the types of personnel involved in IT and non-IT functions. It is more interesting to compare the marginal product of IT Capital versus IT Labor. It is striking that while IT labor contributes significantly to productivity increases, IT capital does not. Thus, these results state that while banks may have over-invested in IT capital, there is significant benefit in hiring and retaining IT labor (Prasad and Harker, 1997).

This result and interpretation is consistent with the idea that aligning capital, rather than throwing technology at problems, is what affects efficiency. IT personnel are likely to be much more effective at ensuring that the implementation of technology does what it is meant to do. That is, it is our opinion that the management of IT has profound effects on efficiency. Banks that are able to manage their IT effectively are likely to be efficient; which is consistent with our fieldwork experiences. This is also consistent with the fact that today's high demand for IT

personnel is unprecedented in U.S. labor history. Figures from the Bureau of Labor Statistics show that while the overall job growth in the U.S. economy was 1.6% between 1987 and 1994, software employment grew in these years at 9.6% every year, and “cranked up to 11.5% in 1995”; the prediction is that over the next decade, we will see further growth in software jobs at 6.4% every year (Rebello, 1996).

The problems are actually likely to be subtler than these measures suggest. For example, IT personnel, while evidently valuable, may not be equally valuable. The point was driven home to us in a series of interviews in a major New York Bank. A Senior Vice President there lamented the fact that “The skills mix of the IT staff doesn’t match the current strategy of the bank,” and said that he “didn’t know what to do about it.” At the same bank, the Vice President in charge of IT claimed, “Our current IT training isn’t working. We never spend anywhere near our training budget.” IT labor is very short supply, and issues as basic as re-skilling the workforce cannot be addressed given the lack of sufficient IT labor in banking.

Other researchers have observed this dependence and under-investment in human capital in technologically-intensive environments. To quote Gunn’s (1987) work in manufacturing, “Time and again, the major impediment to [technological] implementation ... is people: their lack of knowledge, their resistance to change, or simply their lack of ability to quickly absorb the vast multitude of new technologies, philosophies, ideas, and practices, that have come about in manufacturing over the last five to ten years”. Another observation about the transitions firms need to make to gain from technology, again in the manufacturing context, comes from Reich (1984): “... the transition also requires a massive change in the skills of American labor, requiring investments in human capital beyond the capital of any individual firm.”

The evidence also suggests that the effects of management of IT are also being felt more broadly. Consider the *inclusive* model for managing branches, discussed in the preceding section. In this model, information technology and process redesign (popularly, *reengineering*) combine to remove from employees as many basic servicing tasks as possible. These tasks -- simple inquiries, transactions, and movement of funds -- can be automated or turned over to customers. Reengineering frees employees to concentrate more effort on activities that have potentially higher added value: customized transactions, and the provision of financial advice coupled with sales efforts. Second, information technology gives to each employee a full picture of each

customer's financial position and potential; this enhances sales efforts, enabling tellers and customer service representatives to suggest a fit between customers and services, and to refer the customers to employee-teammates with particular expertise in a product if that should become necessary. Challenges under the *segmented* model are less acute, yet still present. In this model, technology is used to simplify the majority of the jobs, to make them easier to learn and, therefore, to make turnover less costly. Only the high value-added, personal banking jobs have access to the broad range of information that might be useful in generating sales leads and opportunities.

In order for either model to function effectively, those responsible for designing IT must understand not only the purposes of the technology, but the capabilities and propensities of the workforce, and the likely effects of different choices in technology on employee and customer behavior. Further, IT staff must be able to assess the likely effects of different configurations of technologies and employment systems if they are to be able to contribute to strategic decisions around the deployment of IT.

Thus, these results are very consistent with Osterman's (1996) conclusion that "... as IT Capital prices fall, production becomes increasingly information-worker intensive." The results described in this section seem to confirm this: banks have over-invested in IT capital, and investment in IT labor has become necessary. Further, IT labor is the most profitable of all four types of investment--IT and non-IT capital and labor available to the bank. That is, the biggest challenge facing banks with respect to aligning capital lie not in the technology, but in people.

## **5.0 Aligning Production Processes**

As stated in the Introduction, production processes are often seen as "black boxes". If labor and capital are the contents of the "black box", then production processes define its architecture. By choosing a particular production technology, the choices of capital and labor are severely constrained. However, it is not enough to simply choose the appropriate level of inputs for a process, but rather it is necessary to figure out how to effectively use these inputs; i.e., how to design the box itself. It is in the design of the production process that these inputs are

transformed into effective inputs and then aligned with the output goals of the organization.

The intent of this section is to review the analysis of the data described in Appendix A in order to understand the role of production processes in the transformation of capital and labor into value for the firm. The preceding sections argued that the way in which labor and capital are managed independently may be closely related to X-efficiency in banking. The purpose in this section is to understand the role production processes have in the cause of this inefficiency.

Before we present the analysis, we give a formal description of a production process. A production process is the way in which work is organized and inputs are consumed in order to accomplish a specified task of producing outputs. For example, a process might be the way in which a checking account is opened. The inputs consumed are the labor (platform representative) and capital (information technology), and the outputs produced are the opening of the account in a way that is convenient for the customer (in terms of customer time involved and when they have access to their money). In order to understand, for example, the process of opening a checking account, there must be knowledge of the steps involved, the order of these steps, the way in which people are involved, and the role of technology. The process-level analysis looked at a process as the transforming mechanism from inputs to outputs as well as to identify the critical design issues that lead to greater value (Frei and Harker 1996, Frei et al, 1997). This section uses the definition of process efficiency in the context of retail banking; the next section will analyze two case studies in order to highlight and “give life” to the general conclusions regarding process efficiency discussed herein.

Before exploring the efficiency with which processes transform capital and labor into value for the customer and the bank, it is important to understand the role process design has on value creation. That is, processes can be designed to explicitly affect one or more value measures. For example, in order to improve the convenience of a process, the design can be altered to remove or shorten as many steps as possible. However, these adjustments might be at the expense of other value measures. Alternatively, a process can be designed to consume the least inputs (cost-focus) even at the expense of decreasing market penetration and hence, revenue. The point is that process design in and of itself can affect value creation. It is the intent of this section to review the research which addresses the extent to which process performance affects value creation for the data described in Appendix A – that is, to understand the combination of the design and the

efficiency with which that design transforms inputs to outputs.

The data analyzed in Frei and Harker (1996) and Frei et al (1997) consisted of details on eleven processes that represent the bulk of the work that occurs at a typical retail bank's branch. These processes span five products and represent opening of accounts, error correction on the part of the bank, and error correction on the part of the consumer. The intent of using these eleven processes was to reflect the bulk of the work performed in the branch environment. By choosing the five most typical products and their account opening and an exception (such as correcting a check posted twice), the aim was to capture enough data so as to reflect the branch's overall process performance. It should be clearly stated that the process metrics are for a subset of the overall set of work performed by the branch, albeit a representative subset as confirmed by discussions with many industry participants.

For each of the eleven processes, an efficiency score was determined using the analysis described in Frei and Harker (1996) and summarized in Appendix B. This analysis determines the efficiency with which each bank produces a set of outputs from a set of inputs. The categories of inputs and outputs for each process are shown in Table 3. For each process, the banks were ranked according to their efficiency score and thus each bank had up to eleven rankings (Frei and Harker 1996). These individual process ranks were then aggregated to a single process performance metric using the methodology described in Frei and Harker (1997) and summarized in Appendix B. The resultant process performance metric serves as an institutional aggregate process efficiency score. The aggregated score is then used to analyze the role of process efficiency in describing X-efficiency of a bank.

As can be seen in Table 3, the outputs for each process are convenience measures (time) and the inputs are related to cost (labor time and technology functionality). These are the only two value creation measures represented in the individual process analysis, as they are the only process-level measures that we were able to collect data on. The other value creation measures such as financial performance are at the bank level and thus are correlated with the aggregate process performance.

**Table 3. Summary of Process Inputs and Outputs**

	Inputs	Outputs
<i>Open Checking Account</i>	Activity Time: The amount of time bank personnel spend in the process	Customer Time: The amount of time the customer spends in the process
	Checking IT Functionality: The level of IT used in the process as indicated by a relative score	Check Cycle Time: The elapsed time from the start of the process until the customer receives their checks
		ATM Cycle Time: The elapsed time from the start of the process until the customer receives their ATM Card
<i>Open Small Business</i>	Activity Time	Customer Time
<i>Loan Account</i>	IT Functionality	Approval Cycle Time: The elapsed time from the start of the process until the customer hears about the approval
		Money Cycle Time: The elapsed time from the start of the process until the customer receives their money
<i>Open Certificate of Deposit</i>	Activity Time	Customer Time
<i>Open Mutual Fund</i>	IT Functionality	
	Activity Time	Customer Time
<i>Open Home Equity Loan Account</i>	IT Functionality	
	Activity Time	Customer Time
<i>Correct A Checking Double Post</i>	IT Functionality	Approval Cycle Time
		Money Cycle Time
		Customer Time
	IT Functionality	Correct Cycle Time: The elapsed time from the start of the process until the correction is completed

(continued)

**Table 3. Summary of Process Inputs and Outputs (continued)**

	Inputs	Outputs
<i>Correct A Home Equity Loan Double Post</i>	Activity Time	Customer Time
	IT Functionality	Post Cycle Time: The elapsed time from the start of the process until the correction is posted  Notify Cycle Time: The elapsed time from the start of the process until the customer is notified about the correction
<i>Correct A Small Business Loan Double Post</i>	Activity Time	Customer Time
	IT Functionality	Post Cycle Time Notify Cycle Time
<i>Redeem A Premature Certificate of Deposit</i>	Activity Time	Customer Time
	IT Functionality	Redeem Cycle Time: The elapsed time from the start of the process until the redemption is completed
<i>Stop Payment on a Check</i>	Activity Time	Customer Time
	IT Functionality	
<i>Replace A Lost ATM Card</i>	Activity Time	Customer Time
	IT Functionality	Replace Cycle Time: The elapsed time from the start of the process until the customer receives their new ATM card

### ***Does Process Efficiency Matter?***

While there is a significant body of theoretical (Morroni, 1992) and anecdotal (Davenport and Short, 1990) evidence on the importance of process management, there is very little statistical evidence that process management matters with respect to the “bottom line” of the institution. Using the language of Section 1, does the choice of a process p&P matter? The previous research shows that, while no individual process is correlated with firm performance, the aggregate measure of process performance affects firm performance (Frei et al, 1997, Table 4). In an attempt to determine the causes of the relation between process performance and firm financial performance, the previous study tested whether the consistency (i.e., the alignment) of process performance is more important than performance in and of itself.<sup>2</sup> To address this hypothesis, process variability was considered; i.e., the variability of the bundle of processes that are offered to the customers of the institution.

**Table 4. Firm Size, Process Performance, and Financial Performance**

<i>Dependent Variable</i>	<i>Constant</i>	<i>Assets (log)</i>	<i>Aggregate Process Rank</i>	<i>Adjusted R<sup>2</sup></i>
ROA	1.01	0.02	-0.02***	0.134

\*\*\* - Indicates significance at the 1% level

### ***Process Variation***

When an institution performs a set of processes for a customer, there is undoubtedly going to be variation in the level of inputs consumed and the value provided to the customer. Process variation is defined as the variation in performance across the eleven individual process performance scores for each bank. The fundamental question addressed in Frei et al (1997) is which is more important for a bank, to do a few things well and, hence, to do other things not so well, or to provide a reasonably consistent set of service delivery processes to the customer? What ultimately matters, occasional excellence or consistency? To address this question, the model from Table 4 was expanded to include process variation, as shown in Table 5. As can be

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<sup>2</sup> The previous study does not argue that consistently poor performance is a good strategy but rather evidence is presented in terms of an analytical model and empirical data that suggests that if there is an additional resource to be invested in a firm, then the investment should go to improving consistency rather than in moving a single process towards best in class (Frei et al 1997).

seen from these tables, the measure of process variation is also correlated with firm financial performance.

**Table 5. Firm Size, Process Performance, Process Variation, and Financial Performance**

<i>Dependent Variable</i>	<i>Constant</i>	<i>Assets (log)</i>	<i>Aggregate Process Rank</i>	<i>Process Variation</i>	<i>Adjusted R<sup>2</sup></i>
ROA	0.92	0.03	-0.01*	-0.03**	0.244

\* Indicates significance at the 10% level

With the demonstrated relation between process performance, process variation, and financial performance, Frei et al (1997) next tested whether process variation is more important than process performance, with respect to financial performance. To test this, banks were defined to have *good processes* if they had better than average aggregate process performance, and banks were defined to have *consistent processes* if they had lower than average process variation. Then dummy variables were introduced for *good* process performance and *consistent* process performance. Using these dummy variables instead of the continuous measures, the question of which matter more (in terms of financial performance) *continuous* processes or *good* processes could be addressed. By comparing the coefficients on *good* and *consistent* processes in Table 6, it was found that the coefficient on *consistent* is significantly greater than the coefficient on *good*. This analysis reinforced the analytical model presented in Frei et al (1997) by showing that when analyzing the relation between the process measures and firm performance, there tends to be a stronger financial return for banks with *consistent* processes than for banks with *good* processes. That is, on the margin, consistency may be more important than aggregate performance, but the analysis also clearly demonstrates the positive impact of improving along both lines. Considering both the analytical model and the data, it is concluded that process variability is a compelling contributor to overall firm performance. In addition, this is considered strong evidence to support the claim that for firms where customers interact across a bundle of processes, it is imperative to not take a single-process view (along the best-practices theme), but rather these processes need to be considered collectively when undergoing process improvement. This result is consistent with the argument in the service quality literature (Rust, Zahorik and Keiningham, 1995) that firms who set expectations and consistently meet them have more satisfied customers and are more profitable.

**Table 6. The Effect of Good and Consistent Processes on Financial Performance**

<i>Dependent Variable</i>	<i>Constant</i>	<i>Assets (log)</i>	<i>Dummy Variable for Aggregate Process Rank</i>	<i>Dummy Variable for Process Variation</i>	<i>Interaction term for process variables</i>	<i>Adjusted R<sup>2</sup></i>
ROA	0.73	0.01	0.15*	0.28***	-0.18	0.239

\* - Indicates significance at the 10% level

\*\* - Indicates significance at the 5% level

\*\*\* - Indicates significance at the 1% level

### ***What Drives Process Efficiency?***

To address the question of what drives process efficiency, one must first look at the characteristics of the banks with better process performance. From our fieldwork, we hypothesize that banks have better process performance when they have one person or a small group of people dedicated to managing across all of the processes “touched” by the consumer. That is, banks with a sort of “Industrial Engineering” function that spans the traditional business unit boundaries are, by definition, more likely to have a *process-focus*. Smaller banks are more likely to have this person since their operations are typically not as sprawling either geographically or in terms of span of control as the larger institutions. In larger banks, there was typically no such person, which explains some of the lower process performance (Frei 1996). Recalling Section 4 where we discussed the returns on capital, it was determined that there were significant positive returns on IT labor and that the types of labor offering this return were the system integrators. It is precisely this position, serving the role of the “Industrial Engineer”, that will help create a process focus in the organization. Thus, we posit that one of the explanatory factors for the positive returns on IT labor is the increased efficiencies that can be gained through a process focus.

From the data, we know that smaller banks tend to have slightly better aggregate process performance and significantly more consistent processes (Frei 1996). We have already mentioned the existence of the system integrator with a process-focus in small banks as a partial explanation for this performance. In addition, small banks have not likely undergone as many mergers or made as many technology upgrades and thus, have had a chance to have their processes develop in a coherent, consistent manner.

Beyond the role of a systems integrator or systems architect, another hypothesis for what

drives process efficiency lies in the degree of technological sophistication of the organization. By analyzing the correlation of technology functionality with process performance, we would expect that increased functionality would lead to improved process performance. However, just the opposite result is found (Frei 1996). This counter-intuitive result is due to the fact that functionality was used as an input for each of the process performance models (see Table 3 and Frei and Harker, 1996) and, since a process is more efficient if it consumes fewer inputs, there will be a negative relationship between functionality and process performance. However, there is a competing effect at work, because we also expect that processes that use more technology will have better outputs (e.g., cycle time) as a result. The data shows that the net effect of these two competing forces is a significantly negative relationship between technology and process performance (Frei 1996). Our interpretation of this result is that, on average, banks are not utilizing their technology as effectively as they can, in terms of enhanced value for the customer. This will be further evidenced in the next section where we show an example of a bank that uses very little of its available technology functionality in its process design.

In summary, it has been shown that the alignment of production processes, similar to labor and capital management, clearly affects firm performance. Specifically, the relationship between a collection of customer service delivery processes and firm performance has been demonstrated. Thus, we conclude that the way in which a firm chooses their production process pEP, and the way in which they manage the transformation of inputs into effective inputs, will affect firm performance. That is, much of the success of the efficient banks in the sample may not be due to clever strategies, creative human resource practices, or exotic technology. Rather, it is our opinion that it is the basic “blocking and tackling” of aligning the service delivery systems with the chosen strategy of the bank, and effectively creating the inputs needed for this bundle of processes that distinguish the high from low achievers. Thus, in our opinion, the “devil” seems truly to be in the “details”. The next section describes two case studies of banks in our sample that illustrate this point.

## **6.0 Aligning Inputs with Strategy**

The previous three sections have summarized research that demonstrates the role of alignment (i.e., consistent management practices) in explaining the relative efficiency of retail banks. It has been our experience that the best performing banks are those in which their management practices are aligned with their strategy<sup>3</sup>. Ideally, we would have been able to develop a fully specified version of the model presented in the Introduction to estimate the impact of alignment on overall performance of the bank. However, such a model would require a panel data set in order to generate any results of significance; this work is left for future research as we develop a deeper set of data for the industry. At the present time, our only recourse is to explore this relationship by considering the patterns that emerged through statistical analysis of the cross-sectional data along with the results of the extensive field-based studies. Two case studies are used as representative examples to illustrate how the alignment of management practices occurs and why it matters.

Porter (1980) suggests that there are two generic strategies that can be pursued: differentiation and cost control. From our fieldwork, we have found that banks are either leaning towards a total sales environment where every action is geared toward knowing the customer and determining how to best fulfill their needs, or towards the mass-market approach which emphasizes highly standardized practices for customer segments. The first strategy typically involves greater cost but also produces greater revenue than the second. In this section, we will show how the management practices ideally interact for each strategy and then conclude with two case studies that illustrate the affect of this interaction.

### *Differentiated Strategy*

As mentioned above, the differentiated strategy that we found in our fieldwork consisted of an empowered workforce, enabled with the information necessary to satisfy the needs of their customers. In terms of labor practices, the implementation of this strategy clearly benefits from the inclusive labor model, which requires training focused on the customer, broad cross-training across job categories, incentives for group performance, and enhanced discretion in terms of interacting with the customer. Not surprisingly, when employees are given greater flexibility to

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<sup>3</sup> It is interesting to note that we found no dominant strategies in our fieldwork. Thus, it is not a single strategy that affects performance but rather, the way in which a particular strategy is implemented which affects performance.

emphasize the customer, there is greater customer satisfaction and higher cross-sell ratios (see Section 3).

How do these labor practices interact with capital and the choice of production processes? When empowering the employees and training them to emphasize the customer's needs, the employees need relationship information on the customer. If the customer has several accounts with the bank, some of which reside on different information systems, the employee needs the ability to take a holistic view of the customer's accounts. No matter how empowered an employee is, without the necessary information technology, they will have a difficult time understanding the customer's full relationship with the bank. In addition, in order for the bank to make use of their technology investment, they need to ensure that the employees are effectively using the available information; this requires a process design that takes advantage of the available labor and technology. However, the process design must also take into account what the customer values, which is typically convenience in terms of time required for them to complete the transaction. The best way to allow for customer convenience is to determine the steps that do not add value to the customer, and to perform these steps when the customer is no longer immediately involved in the process.

### ***Cost Containment Strategy***

The cost containment strategy that we found in our fieldwork consisted of a specialized workforce focused on operational efficiencies. In terms of labor practices, this strategy clearly benefits from a segmented labor model that requires training focused on the tasks an employee performs, incentives for individual performance, and limited discretion in terms of interacting with the customer. This strategy emphasizes the need to efficiently perform repetitive tasks.

How do these labor practices interact with capital and process designs to enforce the cost containment strategy? When training the employees for the tasks they will be performing, the employees need technological support for as many of the open-ended tasks as possible. For example, if an employee is required to attempt a cross-sell to a customer after completing the account opening process, the bank cannot rely on the employee's feel for the customer's situation but rather, needs to support the employee with cross-selling prompts that will guide any employee through the process. Not only does this ensure consistent sales processes, but it also allows any employee to serve any customer. By supporting the employees with the necessary technology,

banks can limit the amount of training necessary and can avoid the drain on resources that specialization requires.

Under the cost containment approach, banks design their production processes with the efficient use of the employees in mind. This focus on labor efficiency means that there is more than likely the specialization of tasks and thus, more hand-offs than in the differentiated model. However, such “Taylorism” also produce greater utilization of the employees. Firms utilizing this approach will require less labor and will have processes that do not emphasize relationship building to the extent of the differentiated strategy. We expect this approach to require less cost, but to produce less revenue as it is the relationship building that typically leads to cross selling.

We have described the ideal settings in order for banks to implement two of the more popular strategies noted by Porter (1980). Consider now two banks that have chosen a cost and differentiation strategy, respectively. The first bank has attempted to implement the differentiation strategy and has been very successful. We will illustrate the specific design issues and management practices that have led to this success. The second case study is of a bank attempting to implement the cost containment strategy that has fallen short in their implementation across a number of dimensions. We will isolate some of the problems in their implementation and show how these problems ultimately relate to the misalignment of labor, capital, and service delivery processes with their chosen strategy. The relevant relative metrics for each of these banks is described in Table 7.

**Table 7. Bank Performance Metrics**

	Bank A	Bank B
IT Functionality	average	more than average
Aggregate Process Performance	better than average	worse than average
Process Noise	better than average	better than average
Customer Satisfaction	better than average	worse than average
Financial Performance	better than average	worse than average
Cross-Sell Ratio	better than average	worse than average

***Bank A***

The indications of success for Bank A are the above average measures of financial performance, customer satisfaction, and cross-sell ratios. The bank utilized an average amount of technology in order to produce these results. The first indication of how they went about

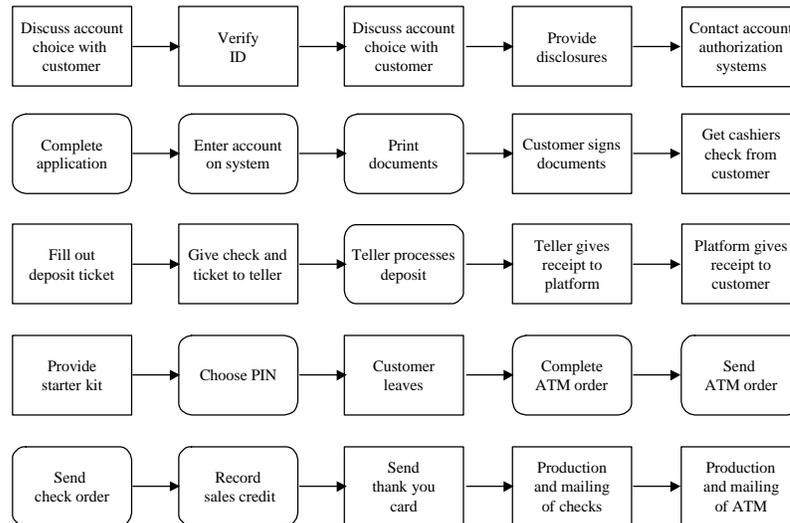
achieving these results is that they had well above average aggregate process performance. That is, when looking at their collection of customer service delivery processes, they were one of the most efficient banks in terms of producing value for the customer at the encounter level. Even more importantly, they achieved this high aggregate process performance by having consistently good practices. That is, they did not have some great processes and some mediocre ones, but rather, had a consistently high level of service.

In order to illustrate how they managed this consistent level of service, we have reproduced the open checking account process map in Figure 1. This process is quite representative throughout our sample of the type of “process thinking” that occurs in the banks. Each of the steps in the process is either a square or an oval, which represents that a step was performed manually or was performed with a computer (what we call an on-line step), respectively. Although this bank has an average level of technology functionality available, they have an above average number of on-line steps in their process. That is, they are better at using their available functionality than most banks. In addition, by inspecting all eleven of their processes, we note that a consistent level of technology is used throughout each process. Thus, they efficiently used their available technology across all processes.

In addition to Bank A being much better than average at effectively using their information technology, they also were very cognizant of how much of the customer’s time is required in the process. For example, when opening a checking account (Figure 1), several steps can be done after the customer leaves, as they do not require the customer’s involvement nor do they add value to the customer. An example of a step in a process that does not add value is sending the check order to the vendor. Every bank needs to do this, but from the perspective of the customer, there was no value added by performing this task in their presence (and thus potentially wasting their time). For the open checking account process, these non-value-added steps include writing a thank you card, sending the checks and ATM orders to the appropriate vendors, recording the sales credit, and filing documents. To perform these steps while the customer is in the branch does not benefit the customer. In most banks that we studied, there seemed to be an almost random decision as to when these steps were performed. That is, for most banks, some of these steps were performed before the customer left for one process, but after the customer left for another process. Clearly, if a step provides no benefit or potential benefit to the customer,

then it should be performed after the customer leaves the branch. The only argument against this type of process design is that there may be a potential benefit to the customer staying in the branch as long as possible in order to extract more information from them and/ or to sell them an additional product as a result of this greater understanding; however, we found no evidence of such a benefit in the analysis of the cross-sell numbers in our data set. As can be seen in Figure 1, Bank A performs all of these non-customer-value-added steps after the customer has left the bank and thus, is cognizant of their customer's time.

In addition to Bank A's efficient use of technology and customer's time, their model of employment practices most closely resembles the inclusive model. That is, the employees were empowered to satisfy their customers (e.g., to waive checking fees), were cross-trained to cover all the needs of the customer, and received training focusing specifically on satisfying their customer's needs (as opposed to focused on the tasks they needed to perform). It is the combination of the efficient and consistent uses of technology, processes, and labor practices that produced the above average results for this bank.



**Figure 1. Open Checking Account Process for Bank A**

**Bank B**

In contrast to the situation in Bank A, where the management practices were aligned with the strategy to produce above average results, Bank B is an example of a bank with below average results. All three of the outcomes, financial performance, customer satisfaction, and

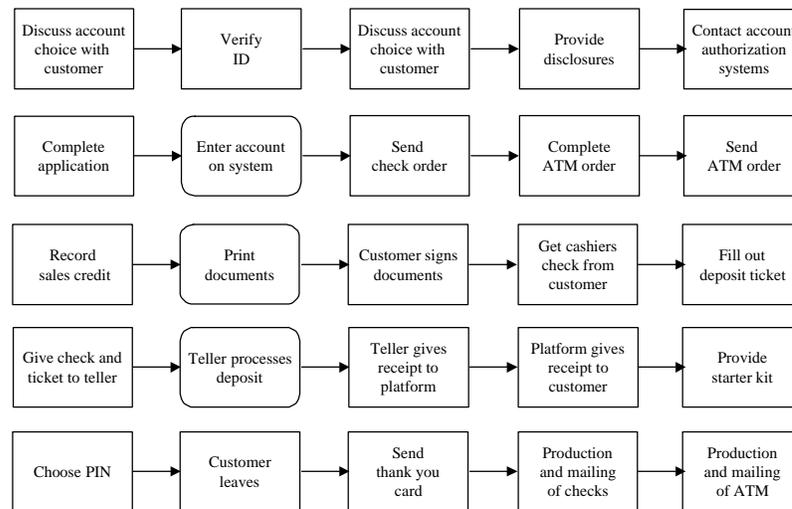
cross-sell measures, were below average. We again look at the areas of technology, processes, and labor to see if there is an explanation for this poor performance. In terms of technology, we again found a consistent use of technology (a similar proportion of on-line steps in each process), but the proportion of on-line steps was quite small (see Figure 2 for an example). This is troublesome considering the fact that this bank actually has more technology available than Bank A (see Table 7). Thus, by not making use of their available technology, Bank B is effectively under-utilizing their resources, thus providing a partial explanation for their poor financial performance.

While Bank B has better than average process consistency, it is consistently of a very low quality (see the low aggregate process performance in Table 7). While we have found that consistent processes are very important in terms of driving performance, it is still necessary to have an acceptable level of quality in these practices. To illustrate the specific management practices that are causing the bank's poor process performance, consider the way in which Bank B managed the customer's time in the open checking account process, as depicted in Figure 2. Four of the five non-value-added steps (described above as writing a thank you card, sending the checks and ATM orders to the appropriate vendors, recording the sales credit, and filing documents) are performed before the customer leaves the bank. By performing these steps in the presence of the customer the bank is either assuming that they will gain some benefit from keeping the customer in the office longer or, more likely, has not carefully thought out the precise role of the customer in the process. The most common argument for keeping a customer in the office longer is so that the bank has an ability to sell more of their products. However, it is not clear that if a customer is waiting for documents to be filed that they will be more likely to buy additional products. However, due to the very low cross-sell ratio of Bank B, we suspect that the rather than attempting to add value to the customer through performing these steps in the presence of the customer, the bank has not given much thought to the customer's involvement in the process. This inattention to process design will ensure that regardless of which strategy a bank is attempting to follow, they will have a difficult time aligning their management practices to match the strategy.

In addition to Bank B inefficient use of their technology and poor management of customer time, they also did not have evidence of a clear approach for creating an effective labor

force. That is, there was evidence of both the inclusive as well as segmented model which, in effect, means that neither model was present. Specifically, this bank emphasized a great deal of cross training even though their employees were given highly specialized tasks and were afforded little empowerment. Thus, the bank did not exhibit a clear alignment of labor practices with their strategy. In addition, while there was a great deal of technology functionality available, it was not of the sales-support type (e.g., cross-sell prompts) that we would expect for a specialized group of workers. After viewing the technology implementation, process design, and human resource practices, it is not surprising that Bank B has poor overall performance.

Therefore, these two banks illustrate the importance and challenge in aligning labor, capital and production processes with the overall strategy of the institution. These banks were carefully selected to represent common themes that we saw across all of the banks in our sample. That is, we saw strong evidence of the connection between the management of a firm’s resources and the strategy they were apparently trying to implement. If these practices were aligned with the strategy, as was the case with Bank A, then the bank’s performance was generally very good. If these management practices were not aligned with the strategy, as was the case with bank B, then there was typically poor performance.



**Figure 2. Open Checking Account Process for Bank B**

Table 8 summarizes the findings from comparing these two representative banks. What is both striking and disturbing is the simplicity of these findings. No one strategy, labor management practice, or technological breakthrough is the cause of X-efficiency. Rather, it is the

basic “blocking and tackling” of management. What seems to separate the good and bad performers is simple: *the ability of management to create and execute a set of HRM, IT, and process design practices that are aligned with the overall strategy of the institution.*

**Table 8. Elements of a Carefully Aligned Strategy**

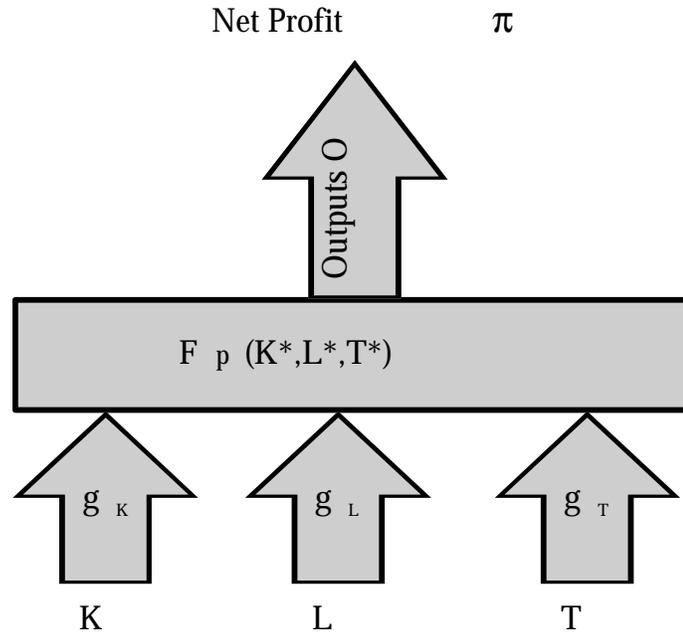
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<b>Technology</b>
<ul style="list-style-type: none"><li>• Consistent use of technology across processes</li><li>• Processes effectively use the available IT functionality</li><li>• Available functionality was appropriate for the given strategy</li></ul>
<b>Process Design</b>
<ul style="list-style-type: none"><li>• Consistent process performance in terms of individual process efficiency</li><li>• High level of aggregate process performance</li><li>• Non-value added steps performed after the customer has left</li></ul>
<b>Human Resources</b>
<ul style="list-style-type: none"><li>• Consistent employment model</li><li>• Appropriate employment model for the given strategy</li></ul>

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### **What Makes a Bank Efficient?**

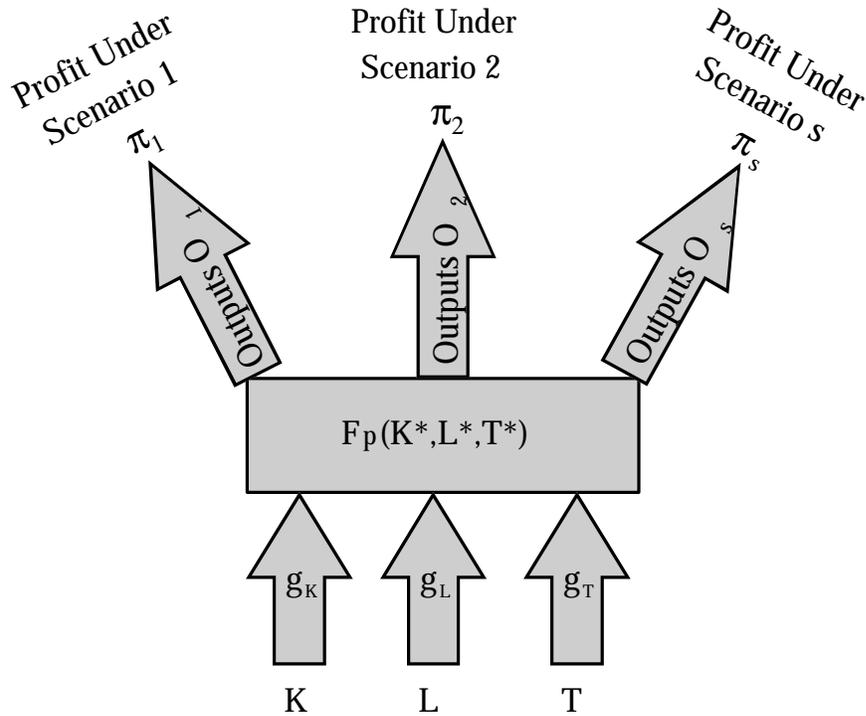
This paper, through a review of previous analyses of retail banking efficiency (all using the common data set described in Appendix A), paints a picture of what drive X-efficiency in this industry. The good news (or bad news, depending on your perspective), is that there is simply no “silver bullet”, no one set of management practices, capital investments and strategies that lead to success. Rather, it appears that the “Devil” is truly in the details. The alignment of technology, HRM, and capital investments with an appropriate production “technology”, as depicted in Figure 3, appears to be the key to efficiency in this industry. To achieve this alignment, banks need to invest in a cadre of “organizational architects” that are capable of integrating these varied pieces together to form a coherent structure. In fact, several leading financial services firms have realized the need for such talents and are investing heavily in senior managers from outside the industry (most notably, from manufacturing enterprises) to drive this alignment of technology, HRM, and strategy.



**Figure 3. Alignment of Practices Given a Strategy**

The challenge, therefore, is not to undertake any one set of practices but rather, to develop senior management talent that is capable of this alignment of practices. Unfortunately, this task is quite complex. As described in the Introduction, bank management faces discrete choices of production processes and the input transformation functions. It seems that these choices are far from “convex”; a little more technology, a mix of HRM practices, etc. seems to have little effect. As illustrated by the differences between Banks A and B in the previous section, one must choose very carefully among all of the components depicted in Figure 4, or fall behind.

While this alignment may be a problem for those currently in the industry, a longer-term and broader perspective may ask, “So what?” With the increasing deregulation of the financial services industry, those that are capable of successfully aligning business practices will succeed, and others will perish. In the end, the results reported herein have nothing to add to the current policy debates concerning the future of this industry.

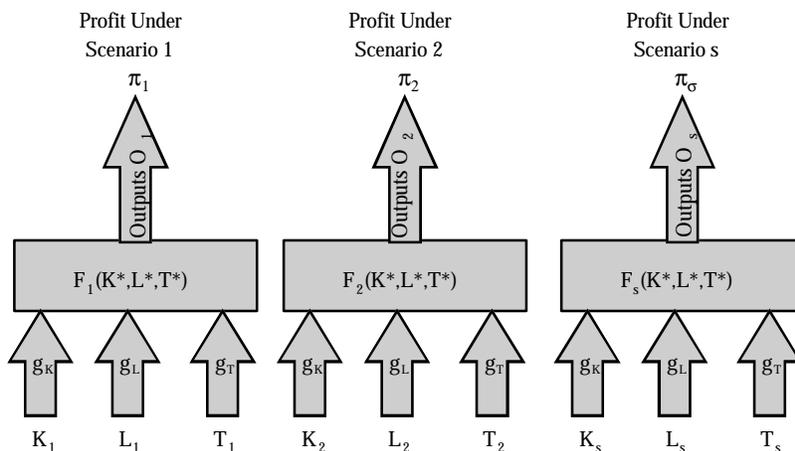


**Figure 4. Alignment of Practices Given Multiple Strategies**

The problem with this argument is depicted in Figure 4; the rapid pace of evolution in the banking industry fueled by deregulation, technological innovation, and changing consumer tastes create a complex dynamic system. The many and varied future scenarios concerning deregulation and technological innovation lead to the inability to focus on alignment; on which scenario or scenarios should one focus? If one could settle on a given strategy, then, sooner or later, well-managed firms will achieve the alignment depicted in Figure 4. However, the future direction of the industry is subject to a tremendous degree of uncertainty. For example, we collected a variety of strategy-related data as part of this study. As described by Hunter (1996a) in the context of human resources, most banks simply could not articulate a consistent and coherent strategy for the future. In numerous visits with the banks that were a part of the study, we would feed back the data they had given to us in order to check its validity. When we would come to the strategy-related questions in the survey, someone in the bank, usually at a senior management level, would state something like “This is wrong; this CAN’T be our strategy!” We would then tell them who provide this data (always another senior manager), and we would become embroiled in a real-time debate over defining the strategy of the bank!

The tension we experienced in the banks over forming a strategy for the future reflects the tension between investing in the perfection of the alignment of labor, capital and production processes for today's strategy versus the investment in a portfolio of alternative future strategies. This tension is both quite typical and quite real in the banking industry. Given the inability to control the use of the varied distribution channels (ATMs, branches, etc.), banks are either investing in all channels simultaneously or undertaking fairly radical changes to their service offerings in order to deal with this proliferation of services. Thus, bank managers face a crucial decision as to missing the "correct" strategy for the future versus living with misaligned systems that they know to be inefficient.

Given this uncertainty, the removal of inefficient firms may take quite a while to occur. Furthermore, if we are correct in our assessment that a major cause of X-inefficiency in the industry is the misalignment of management practices, and given that X-inefficiency is a major cause of inefficiency in banking in general, the necessity for integrated financial services organizations to "hedge their bets" on the future may be a major cause of persistent inefficiency in the banking industry. Clearly, alignment would be simpler and occur more rapidly in a industry made up of many "niche" players, each focusing on a likely future scenario, as shown in Figure 5. Such movement to dis-integrate financial services are already underway in most banking organization when one considers how business units like credit cards and trust are run as completely separate operations.



**Figure 5. Multiple Alignments of Multiple Strategies**

Thus, the alignment hypothesis is a crucial link in understanding the potential benefits of

industry restructuring. If alignment is as difficult as it appears from the current study, it is possible that increased mergers of dissimilar businesses, as measured by their misalignment of the production processes of the organization, may increase X-efficiency. However, the reverse is possible. The only way to know for sure is to develop, based on the cross-sectional data set described in Appendix A, a panel data set that can be used to assess how organizations are adapting their management practices to align themselves with the future of the industry; this is the goal of our future research.

For now, the results of this research can be summarized with reference to the wisdom of the ages. For a banker, like an architect, the following advice holds:

Three things are to be looked to in a building:  
that it stand on the right spot;  
that it be securely founded;  
that it be successfully executed.<sup>4</sup>

### *Acknowledgments*

This research was supported by the Wharton Financial Institutions Center through a grant from the Sloan Foundation. The comments of Tony Santomero, Kathleen (Holmes) McClave, Erik Brynjolfsson, Lorin Hitt, and many others on all or portions of the research reported herein are warmly acknowledged. Of course, all errors and omissions are the responsibility of the authors.

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<sup>4</sup> Johann Wolfgang von Goethe, *Elective Affinities* (1808), Book I, Chapter 9.

## **Appendix A: Structure of the Wharton/Sloan Retail Banking Study**

The retail banking study is an interdisciplinary research effort at the Wharton Financial Institutions Center aimed at understanding the drivers of competitiveness in the industry, where competitiveness means not simply firm performance but the relationship between industry trends and the experiences of the retail banking labor force. In the exploratory first phase of a study of the United States retail banking industry during Summer 1993 through Fall 1994, a research team conducted open-ended and structured interviews with industry informants, and shared its impressions with these informants at a number of conferences. The broad agenda for the retail banking study entails furthering the understanding of competitiveness in the industry.

The team interviewed top executives, line managers in retail banking, human resource managers, executives responsible for the implementation of information technology, retail bank employees, and industry consultants. The first phase featured site visits to thirteen U.S. retail bank headquarters, and interviews with numerous other managers and employees in remote and off-site locations. The interviews began with very general questions, and the questions increased in specificity as the research progressed. In this phase of the study, the team collected data through the use of two waves of structured questionnaires in seven retail banks. The team's analysis of the data in these questionnaires was then presented to management teams in six of the seven banks, and used as the basis for the second phase, a large-sample survey.

The second phase of the study entailed a detailed survey of technology, work practices, organizational strategy, and performance in 135 U.S. retail banks. The team sought to survey a group of banks that could yield the broadest coverage of trends in human resources, technology, and competitiveness in the industry. The survey focused on the largest banks in the country and was not intended as a random sample of all U.S. banks. In the end, the approach gained the participation of banks holding over 75% of the total assets in the industry in 1994. The process began by compiling a list of the 400 largest bank holding companies (BHCs) in America at the beginning of 1994. Merger activity, and the fact that a number of BHCs had no retail banking organization (defined as an entity that provides financial services to individual consumers), reduced the possible sample to 335 BHCs. Participation in the study was confidential, but not anonymous, enabling the team to match survey data with data from publicly available sources.

Participation in the study required substantial time and effort on the part of organizations. Therefore, commitment to participation was sought by approaching the 70 largest U.S. BHCs directly, and, in the second half of 1994, the participation of one retail banking entity from each BHC was requested. Fifty-seven BHCs agreed to participate. Of these, seven BHCs engaged the participation of two or more retail banks in the BHC, giving us a total of 64 participating retail banks. Multiple questionnaires were delivered to each organization in this sample. Questionnaires ranged from 10 to 30 pages, and were designed to target the “most informed respondent” (Huber and Power, 1985) in the bank in a number of areas, including business strategy, technology, human resource management and operations, and the design of business processes. The team made a telephone help line available to respondents who were unsure of the meaning of particular questions. Questionnaires to four top managers were delivered: the head of the retail bank, the top finance officer, the top marketing officer, and the top manager responsible for technology and information systems. These banks received questionnaires for one manager of a bank telephone center, and for one branch manager and one customer service representative (CSRs) in the bank’s “head office” branch, defined as the branch closest to the bank’s headquarters. In addition, an on-site researcher gathered data about all business process flows in the head-office branch. Identical questionnaires were mailed to five more branch managers; the instructions to the bank were to choose the sample branches so that if possible data was received from two rural, two urban, and two suburban branches. Questionnaires were also mailed to CSRs in those branches. In these questionnaires, the CSRs themselves mapped processes associated with home equity loans, checking accounts, certificates of deposit, mutual fund accounts, and small business loans.

In order to facilitate the creation of process maps via the mailed survey, a worksheet was developed for the CSRs to fill out. These worksheets, a sample of which is shown in Frei 1996, list the majority of potential steps required in the process so that the CSR need only indicate the order of the step, the person responsible for its execution, the type of technology involved, and the amount of time the step takes. Adequate space was provided for the addition of steps unique to an institution.

In late 1994, survey questionnaires were mailed to top executives of the 265 next largest BHCs, and followed with a telephone call requesting the participation of one of their retail

banking organizations. Sixty-four of these BHCs agreed to participate in the study, and four of these engaged the participation of two or more retail banks in the BHC, so that a total of 71 participating retail banks in the mailed survey. For this group of banks, the head of the retail bank was surveyed, and many of the questions directed to the other top managers were consolidated into this survey. Prior interviews had suggested that for banks of this size, the head of retail was able to answer this broader set of questions accurately. For this sample, questionnaires were mailed to one telephone center manager, one branch manager, and one CSR in the head office branch. The telephone help line was also available to respondents in this sample.

All together, the entire survey of retail banking covers 121 BHCs, and 135 banks, which together comprise over 75% of the total industry, as measured by asset size. The scope and scale of this survey make it the most comprehensive survey to date on the retail banking industry.

## **Appendix B: Analytical Approach for the Study**

One way of understanding the goal in the process analysis performed on the data in Appendix A project is to view it as an attempt to use a process view as the basis for understanding how IT and human resources interact to move firms to the boundary of the performance frontier. When estimating the performance of processes, the first consequence to note is that there are usually multiple outputs. These multiple outputs preclude the use of standard statistical regressions involving a single dependent variable. The estimation methods used in the previous analysis and referenced in this paper deal with these multiple outputs by using deterministic frontier estimation. Specifically, Data Envelopment Analysis (DEA) is used to determine relative performance amidst multiple inputs and outputs. Charnes, Cooper, and Rhodes (1978) introduced DEA as a new way to measure efficiency of decision-making units (DMUs). Since then, there have been over 400 articles that have used variations of DEA in analyzing performance (see Seiford, 1990). See Fare, Grosskopf and Knox Lovell (1994) for an introduction to DEA.

The original DEA method determines the relative efficiency measure for a DMU by maximizing the ratio of weighted outputs to inputs subject to the condition that similar ratios for every DMU not exceed one. The result is a set of efficiency scores between zero and one as well as a set of reference DMUs whose performance is better than the existing DMUs using the same scale. This method has come to be known as the output-oriented method, as its efficiency score is determined by holding inputs constant and assessing to what extent outputs could potentially be improved. The input-oriented DEA is identical to the output-oriented method except that the objective is to minimize the ratio of weighted inputs to outputs subject to the condition that similar ratios for every DMU not go lower than one. The result is a set of efficiency scores greater than or equal to one. In this case, an inefficient DMU has a score determined by the amount that inputs can potentially be decreased without changing the outputs. Many extensions have been made to the oriented methods described above, including multiplier weight flexibility (Dyson and Thanassoulis, 1988), stochastic frontier (Sueyoshi, 1994; Land, Knox Lovell, and Thore, 1993), categorical outputs (Rousseau and Semple, 1993), and non-linear frontier estimation (Sengupta, 1989; Charnes *et al.*, 1982). A third method was developed by Ali and

Seiford (1993) which actually builds the efficient frontier in its solution and determines its relative efficiency score by the distance that a DMU is from its associated hyperplane. Again a single linear program is required for each DMU, rather than optimizing a ratio of inputs and outputs, the objective is to determine the coefficients of the hyperplane that will get closest to the current DMU without moving past any other DMU. The result is a distance of each DMU from its associated hyperplane, with a distance of zero implying that it is on the frontier. Each of the above methods is described in detail in Frei and Harker (1996).

The limitations of the oriented methods are precisely in their orientation. That is, they apply only in instances when it is reasonable to hold either inputs or outputs constant. The limitation of the hyperplane method is that the distance measure is taken from a DMU to its associated hyperplane even if that hyperplane is not the closest point on the frontier. The method extends the hyperplane method by determining the shortest distance from a DMU to the entire frontier. In addition, the concept of the observable portion of the frontier is introduced which yields efficiency scores based on the distance from the section of the frontier in which the associated scale has actually been realized.

To overcome these limitations, Frei and Harker (1996) have introduced new DEA-like methods for the calculation of process efficiency. These methods allow the comparison of both the quality and cost of a process. Thus, a high-quality, high-cost and a low-quality, low-cost process can both be considered efficient using this method. These efficiency metrics can then be studied in relation to the HR and IT practices in the banks to ascertain their relative efficiency. Thus, this frontier estimation technique, along with standard data analysis/ statistical methods, provides the analytic backbone for our investigation.

In determining an institution's composite process performance in the studies referenced in this paper, each process was considered as a round of competition between institutions. Thus when one bank performed better than another for a given process, that bank had won one round of head-to-head competition. By viewing process performance across institutions, a "tournament" ranking scheme was used as the basis for evaluation. The tournament is a set of head-to-head competitions between institutions where a head-to-head competition consists of performance across a common process. Two difficulties arise when viewing processes as competitions between banks. First, if two banks have no processes in common then they are not

competing against one another and thus there is “missing data” in the tournament ranking methodology. Fortunately, this situation has appeared in the literature and is easily overcome by using the missing data correction developed by Harker (1987). The second problem, however, is far more complicated and has not been previously addressed in the literature. That is, what happens when one bank is better than another in all rounds of competition? In the existing literature, there is always an assumption that if participants compete against each other then they each win at least one of the matches. This has in it the assumption that each participant has a positive probability or chance of winning a future match. However, in the situation evaluated in the referenced studies, these scores do not reflect a future probability of winning, but rather represent past performance. Thus, in the existing methods there is no likelihood of one institution “winning” all of the matches, as there always is a positive probability of an institution winning a future match. However, in the retail-banking situation it is quite likely that one institution will dominate another across all of their common processes and thus this needs to be accommodated. A methodological extension to existing methods was developed to achieve this in Frei and Harker (1997).

The methodology in Frei and Harker (1997) allows the generation, for each institution, of a composite process performance score by comparing processes. This composite score determines which institutions have better process performance and allows for analysis to determine what drives this performance. The use of this composite score as the measure of an institution’s process performance indicates that the institution is viewed as a collection of processes. The collected data on a representative sample of these processes leads to the assumption that the performance of this sample is representative of the performance of the institution as a whole. The result of this methodology is an ordinal rank of each institution which then allows for the comparison of one institution with another based on relative aggregate process performance.

## References

- Ali, A. I. and L. M. Seiford (1993), "The mathematical programming approach to efficiency analysis," in H. O. Fried, C. A. Knox Lovell and S. S. Schmidt (eds.), *The Measurement of Productive Efficiency* (New York: Oxford University Press).
- Arthur, J. (1994), "Effects of human resources system on manufacturing performance and turnover," *Academy of Management Journal* 37(3), 670-687.
- Baily, B. A., C. Kriebel, and T. Mukhopadhyay (1991), "Information technology and business value: an analytical and empirical investigation," University of Texas at Austin Working Paper (Austin, TX).
- Barney, J. (1991), "Firm resources and sustained competitive advantage," *Journal of Management* 17, 99-120.
- Beatty, S. E. and B. E. Gup (1989), "A guide to building a customer service orientation," *Journal of Retail Banking* 11(2), 15-22.
- Becker, B. and B. Gerhart (1996), "The impact of human resource management on organizational performance: progress and prospects," *Academy of Management Journal* 39, 779-801.
- Benston, G. J., G. A. Hanweck, and D. B. Humphrey (1982), "Scale economies in banking: a restructuring and reassessment," *Journal of Money, Credit and Banking* 14, 435-450.
- Berger, A. N., D. Hancock, and D. B. Humphrey (1993), "Bank efficiency derived from the profit function," *Journal of Banking and Finance* 17, 317-348.
- Berger, A. N. and D. B. Humphrey (1992), "Measurement and efficiency issues in commercial banking," in Z. Griliches (ed.), *Output Measurement in the Services Sector: National Bureau of Economic Research Studies in Income and Wealth* (Chicago, IL: University of Chicago Press).
- Berger, A. N., W. C. Hunter, *et al.* (1993), "The efficiency of financial institutions: a review and preview of research past, present and future," *Journal of Banking and Finance* 17, 221-250.
- Blackwell, D. W., J. A. Brickley, *et al.* (1994), "Accounting information and internal performance evaluation: Evidence from Texas banks," *Journal of Accounting and Economics* 17(3), 331-358.
- Bohn, R. (1995), "Noise and learning in semiconductor manufacturing," *Management Science* 41, 31-42.
- Brynjolfsson, E. (1993), "The productivity paradox of information technology," *Communications of the ACM* 35, 66-67.
- Brynjolfsson, E. and L. Hitt (1993), "Is information systems spending productive? New evidence and new results," Working Paper, Coordination Laboratory, MIT (Cambridge, MA).
- Brynjolfsson, E. and L. Hitt (1996), "Paradox lost? Firm-level evidence on the returns to information systems spending," *Management Science* 42, 541-558.

- Charnes, A., W. W. Cooper, and E. Rhodes (1978), "Measuring the efficiency of decision making units," *European Journal of Operational Research* 2, 429-444.
- Charnes, A., W. W. Cooper, L. Seiford, and J. Stutz (1982), "A multiplicative model for efficiency analysis," *Socio-Economic Planning Sciences* 16, 223-224.
- Cutcher-Gershenfeld, J. (1991), "The impact on economic performance of a transformation in workplace relations," *Industrial and Labor Relations Review* 44, 241-60.
- Davenport, T. H. and Short, J. E. (1990), "The new Industrial Engineering: information technology and business process redesign," *Sloan Management Review* 31, 11-27.
- Delaunay, J.C. and J. Gadrey (1992), *Services in Economic Thought: Three Centuries of Debate* (Boston, Kluwer).
- Delery, J. and H. Doty (1996), "Modes of theorizing in strategic human resource management: Tests of universalistic, contingency, and configurational performance predictions," *Academy of Management Journal* 39 802-835.
- Donnelly, J., James H., J. L. Gibson, *et al.* (1989), "The behaviors of effective bank managers," *Journal of Retail Banking* 10(4), 29-37.
- Dyson, R.G. and E. Thanassoulis (1988), "Reducing weight flexibility in data envelopment analysis," *Journal of the Operational Research Society* 39, 563-576.
- Fare, R., S. Grosskopf, and C. A. Knox Lovell (1994), *Production Frontiers* (Cambridge, England: Cambridge University Press),
- Frei, F. X. (1996), *The Role of Process Designs in Efficiency Analysis: An Empirical Investigation of the Retail Banking*, unpublished Ph.D. dissertation, The Wharton School, University of Pennsylvania (Philadelphia, PA).
- Frei, F. X. and P. T. Harker (1996), "Projections onto efficient frontiers: theoretical and computational extensions to DEA," Working Paper, Wharton Financial Institutions Center, The Wharton School, University of Pennsylvania (Philadelphia, PA).
- Frei, F. X. and P. T. Harker (1997), "Measuring aggregate process performance using AHP," forthcoming: *European Journal of Operational Research*.
- Frei, F. X., R. Kalakota, A. Leone, and Marx, L. (1997), "Process variation as a determinant of service quality and bank performance: Evidence from the retail banking study," Working Paper, Operations Group, The Simon School of Business, University of Rochester (Rochester, NY).
- Frei, F. X., P. T. Harker, and L.W. Hunter (1994), "Performance in consumer financial services organizations: framework and results from the pilot study," Working Paper, Wharton Financial Institutions Center, The Wharton School, University of Pennsylvania (Philadelphia, PA).
- Fried, H. O., C. A. K. Lovell, *et al.* (1993), "Evaluating the performance of U.S. credit unions," *Journal of Banking and Finance* 17, 251-266.
- Griliches, Z. (1992), *Output Measurement in the Services Sector: National Bureau of Economic Research Studies in Income and Wealth* (Chicago, IL: University of Chicago Press).

- Gunn, T. G. (1987), *Manufacturing for Competitive Advantage* (Cambridge, MA: Bollinger).
- Hancock, D. (1991), *A Theory of Production for the Financial Firm* (Boston: Kluwer Academic Press).
- Harker, P. T. (1987), "Incomplete comparisons in the Analytic Hierarchy Process," *Mathematical Modeling* 9, 837-848.
- Hitt, L. and E. Brynjolfsson (1996), "Productivity, business profitability, and consumer surplus: three different measures of information technology value," *MIS Quarterly* (June), 121-142.
- Hoch, I. (1962), "Estimation of production function parameters combining time-series and cross-section data," *Econometrica* 30, 34-53.
- Huber, G. P. and D. J. Power (1985), "Retrospective reports of strategic-level managers: guidelines for increasing their accuracy," *Strategic Management Journal* 6, 171-180.
- Hunter, L.W. (1996a), "When fit doesn't happen: The limits of business strategy as an explanation for variety in human resource management practices," presented at the Academy of Management Annual Meeting, Cincinnati, Ohio, August 1996.
- Hunter, L.W. (1996b), "Lousy jobs: why do organizations choose human resource practices that reinforce the position of the working poor?" presented at the Academy of Management Annual Meeting, Cincinnati, Ohio, August 1996.
- Hunter, L.W. (1997), "Transforming retail banking: Inclusion and segmentation in service work," Working Paper, Wharton Financial Institutions Center, The Wharton School (Philadelphia, PA).
- Hunter, L.W. and L. Hitt (1997), "Technology, human resources, and productivity in bank branches," Working Paper, Wharton Financial Institutions Center, The Wharton School (Philadelphia, PA).
- Huselid, M. A. and Brian E. Becker (1996), "Methodological issues in cross-sectional and panel estimates of the human resource - firm performance link," *Industrial Relations* 35, 400-23.
- Huselid, M. A. (1995), "The impact of human resource management practices on turnover, productivity, and corporate financial performance." *Academy of Management Journal* 38, 635-72.
- Ichniowski, C. (1992), "Human resource practices and productive labor-management relations," in D. Lewin, O. S. Mitchell and P. D. Sherer (eds.), *Research Frontiers in Industrial Relations and Human Resources* (Madison, WI: IRRRA).
- Ichniowski, C., K. Shaw, and G. Prennushi (1994), "The impact of human resource management on productivity." Working Paper No. 5333, National Bureau of Economic Research (Cambridge, MA).
- Lado, A. A., and M. C. Wilson (1994), "Human resource systems and sustained competitive advantage: a competency-based perspective," *Academy of Management Review* 19, 699-727.

- Land, K. C., C.A. Knox Lovell, and S. Thore (1993), "Chance-constrained data envelopment analysis," *Managerial and Decision Economics* 14, 541-554.
- Leibenstein, H. (1966), "Allocative efficiency versus 'X-inefficiency,'" *American Economic Review* 56, 392-415.
- Leibenstein, H. (1980), "X-efficiency, intrafirm behavior, and growth", in S. Maital and N. Meltz (eds.), *Lagging Productivity Growth* (Cambridge, MA: Ballinger Publishing), 199-220.
- Levine, D. I. (1995), *Reinventing the workplace: how business and employees both win* (Washington, D.C.: Brookings Institution).
- Lichtenberg, F. R. (1995), "The output contributions of computer equipment and personnel: a firm-level analysis," *Economics of Innovation and New Technology* 3.
- Long, R. H. (1988), "High-performance bank culture," *Journal of Retail Banking* 10(3), 13-22.
- Loveman, G.W (1994), "An assessment of the productivity impact of information technologies," in T.J. Allen and M. S. Scott Morton (eds.), *Information Technology and the Corporation of the 1990s: Research Studies* (Cambridge, MA: MIT Press).
- MacDuffie, J. P. (1991), "*Beyond mass production: flexible production systems and manufacturing performance in the world auto industry*," Unpublished Ph.D. Dissertation, Massachusetts Institute of Technology (Cambridge, MA).
- MacDuffie, J. P. (1995), "Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world auto industry," *Industrial and Labor Relations Review* 48 (2), 197-221.
- MacDuffie, J. P. and T. A. Kochan (1991), "Does the U.S. underinvest in human resources? Determinants of training in the world auto industry," *Fifty-First Annual Meeting of the Academy of Management*, Miami Beach.
- Mefford, R.N. (1986), "Introducing management into the production function," *The Review of Economics and Statistics* 68, 96-104.
- Mester, L. (1987), "A multiproduct cost study of savings and loans," *The Journal of Finance* 42, 423-45.
- Milgrom, P. and J. Roberts (1990), "The economics of modern manufacturing: technology, strategy, and organization," *American Economic Review* 80, 511-528.
- Milgrom, P. and J. Roberts (1995), "Complementarities and fit: strategy, structure, and organizational change in manufacturing," *Journal of Accounting and Economics* 19, 179-208.
- Morrison, C. J. and E. R. Berndt (1990), "Assessing the productivity of information technology equipment in the U.S. manufacturing industries," National Bureau of Economic Research Working Paper 3582.
- Morroni, M. (1992), *Production Process and Technical Change* (Cambridge, United Kingdom: Cambridge University Press).
- Mundluk, Y. (1961), "Empirical production function free of management bias," *Journal of Farm*

- Economics* 43, 44-56.
- National Research Council (1994), *Information Technology in the Service Society* (Washington, DC, National Academy Press).
- Nelson, R. and S. Winter (1982), *An Evolutionary Theory of Economic Change* (Cambridge, MA: Harvard University Press).
- Osterman, P. (1994), "How common is workplace transformation and who adopts it?" *Industrial and Labor Relations Review* 47 (2), 173-188.
- Osterman, P. (1986), "The impact of computers on the employment of clerks and managers," *Industrial and Labor Relations Review* 39, 175-86.
- Osterman, P. (1987), "Choice of employment systems in internal labor markets," *Industrial Relations* 26, 46-67.
- Parsons, D., C. C. Gotlieb, and M. Denny (1993), "Productivity and computers in Canadian banking," in Z. Griliches and J. Mairesse (eds.) *Productivity Issues in Services at the Micro Level* (Boston, MA: Kluwer Academic).
- Parsons, C. K., R. C. Liden, *et al.* (1991), "Employee response to technologically-driven change: the implementation of office automation in a service organization," *Human Relations* 44, 1331-1356.
- Pfeffer, J. (1994), *Competitive Advantage Through People* (Boston, MA: Harvard Business School Press).
- Porter, M. E. (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competition* (New York: Free Press).
- Prasad, B. and P. T. Harker (1997), "Examining the contribution of information technology toward productivity and profitability in U.S. retail banking," Working Paper, Financial Institutions Center, The Wharton School, University of Pennsylvania (Philadelphia, PA).
- Pine, B. J. (1993), *Mass Customization: The New Frontier in Business Competition* (Boston, Harvard Business School Press).
- Rebello, K. (1996), "We humbly beg you to take this job. Please.," *Business Week* (June).
- Reich, R. B. (1984), *The Next American Frontier* (New York: Penguin Books).
- Rosenberg, N. (1982), *Inside the Black Box: Technology and Economics* (Cambridge University Press, Cambridge, United Kingdom).
- Roth, A. V. and M. v. d. Velde (1991a), "Customer-perceived quality drives retail banking in '90s," *Bank Management* (November), 29-35.
- Roth, A. V. and M. v. d. Velde (1991b), "The retail technology," *Bank Management* (December), 14-19.
- Roth, A. V. and M. v. d. Velde (1992), *World Class Banking: Benchmarking the Strategies of Retail Banking Leaders* (Chicago, IL: Center for Banking Excellence, Bank Administration Institute).
- Rousseau, J. J. and J. H. Semple (1993), "Categorical outputs in data envelopment analysis,"

- Management Science 39, 384-386.
- Rust, R.T. and R. Metters, "Mathematical models of service," *European Journal of Operational Research*, 91, 427-439.
- Rust, R. T., A. J. Zahorik, and T. L. Keiningham (1995), "Return on quality (ROQ): Making service quality financially accountable," *Journal of Marketing*, 59, 58-70.
- Scazzieri, R. (1993), *A Theory of Production* (Oxford, United Kingdom: Clarendon Press).
- Schumpeter, J. A. (1939), *Business Cycles* (New York: McGraw Hill).
- Seiford, L. M. (1990), "A bibliography of Data Envelopment Analysis," Working Paper, Department of IEOR, University of Massachusetts at Amherst (Amherst, MA).
- Sellers, B. L. (1992), "The bonus onus: devising a fair plan," *Bankers Monthly* 109(5), 27-29.
- Sengupta, J.K. (1989), "Nonlinear measures of technical efficiency," *Computers & Operations Research* 16, 55-65.
- Steiner, T. D. and D. B. Teixeira (1990), *Technology in Banking: Creating Value and Destroying Profits* (Homewood, IL, Irwin).
- Sueyoshi, T. (1994), "Stochastic frontier production analysis: measuring performance of public telecommunications in 24 OECD countries," *European Journal of Operational Research* 74, 466-478.
- Tainio, R., P. J. Korhonen, *et al.* (1991), "In search of explanations for bank performance -- some Finnish data," *Organization Studies* 12(3), 426-450.
- Walton, R. E. (1985), "From control to commitment in the workplace," *Harvard Business Review* 63, 76-84.
- Wright, P. M. and G. C. McMahan (1992), "Theoretical perspectives for strategic human resource management," *Journal of Management* 18, 295-320.
- Zuboff, S. (1985), "Automate/informate: the two faces of intelligent technology," *Organizational Dynamics* Fall, 5-18.