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Profit Maximization in the Banking Industry: Early Adoption of Technology and its Effects on Efficiencies

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Section I--Introduction

Technological innovation has restructured the marketplace creating cost advantages in many industries. One industry that has experienced significant change is the banking industry. The widespread applications of Information Technology (IT) complemented with the adoptions of Automated Teller Machines (ATMs) have changed the face of the banking industry: by providing banks with the opportunity to improve certain operational efficiencies IT is giving them a competitive advantage in a consolidating industry. Brick and mortar banks are no longer an operational necessity. The banking industry through recent deregulations now has the ability to enter new and previously untapped markets with relatively low entry fees. Firms are now able to achieve a new level of profit maximization through reallocation of previously fixed costs, gains in efficiencies from both a cost and a profit standpoint, and raising revenues. With the passing of new legislation and the new capabilities of banking firms, the globalization of the industry has accelerated. Large urban banking firms are now flooding rural markets, which were once protected by geographical boundaries, and their in-market domestic shares of total deposits are dwindling. Increased profits generated from processing efficiencies and rising revenues have created the climate for increasing competition.

There are arguments that the early adoption of these technologies has created a first move advantage for these firms driving forward the best-practice frontier. If this is true, we would expect that these best-practice frontier firms have achieved a higher range of production output due to the early adoption of

technology, relative to other firms in their sector, where they have been able to lower per unit cost over a wider range of output and thereby gaining a competitive advantage. This competitive advantage allows the best-practice frontier firms to reap supernormal profits for short time period, maximizing their possible realized profit levels.

Section II of this paper details previous technological advances in the banking industry and their effects on operating efficiency and cost and will discuss the current technological achievements and practices. Section III focuses on specific technological influences such as ATMs, wireless communications, IT and Electronic banking. Section IV describes the impact of technology on profit maximization in the banking industry. Section V explores the effects of consolidation on the banking industry. Section VI will then comment on the importance of X-Efficiency and the effects of IT. Section VII provides a summary of the empirical analysis. Following the summary, Section VIII introduces the regression models and their construction. Section IX analyzes the regression results and Section X provides a conclusion of the study.

Section II—Technological Progression

Today's economy is quick to absorb recent developments and embrace technological progression. For instance, it took approximately 50 years for 25% of the United States population to engage in use of the automobile and electricity, whereas it took only 16 years to reach the same level of penetration for PC technologies.[1] The adoption rate proves to be exponential when only 7 years after

[1] Kumasaka (1999); Federal Reserve Bank of Dallas (1996)

the development of the Internet a quarter of American were online.[2] Americans are becoming more comfortable with the implementation of technology into their everyday routines. Previous developments like PC technologies have left consumers with an appreciation and need for speed, accessibility, and verifiable practices when it comes to their financial matters. All three of these qualities are key characteristics and goals of technological developments in the banking industry. Recent progressions in the last decades have driven the cost of information processing to fall sharply. For example in 1984 the cost to process one million instructions per second (MIPS) was $479 US and in 1998 that cost had been reduced to $3 US.[3]

The reduction of processing cost coupled with the rapid adoption rate has allowed banking firms to adopt new practices in order to keep profit levels high and keep pace with a changing marketplace, thereby maintaining the competitive advantage. Many regard this IT revolution as the Third Industrial Revolution.[4] If this exponential adoption rate continues to increase then there is high motivation to be in the best practice frontier and adopt cutting edge technologies as soon as possible in attempts to reap the greatest cost savings.

Technology allows firms to become more profit efficient by increasing processing speeds. Processing speeds concerning the applications of loans, credit scoring methods, and the transferring of account information from individual branches to the bank's general ledger. Banks estimated reserve needs are more

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[2] Ibid
[3] Kumasaka (1999); Federal Reserve Bank of Dallas (1997)
[4] The first industrial revolution being the invention of the steam engine and the spinning machine and the second being the birth of electricity.

accurately calculated in comparison to historical estimations[5], leaving more loanable funds to generate higher profits. As like many other innovations, firms may need to adopt IT in order to remain competitive.

More recently many firms are implementing various new technologies as part of their marketing approach to ensure that they do not lose any market share. Even firms that do not believe that this IT trend is lasting and feel the that the bubble will burst any minute, may still adopt limited amounts of technology in order to offer such financial services as an essential marketing tool.[6]

Section III—Specific Technological Influences in the Banking Industry

ATM

ATM technology has reduced the importance for strategic geographic placement of traditional brick and mortar bank offices and redefined the branching structure for firms across the industry.[7] ATMs generate more deposits and process a greater number of transactions without the expenditures of hiring personnel. More deposits and transactions meaning the deposits/transactions gained that would normally be lost due to the length of construction time necessary to establish a new branch. Additionally the potential for human error is greatly reduced, thereby increasing transaction efficiencies. From 1985 until

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[5] Monetary and Economic Studies, November 2001. The Forecasting method refers to using historical data and making predictions of consumer behavior to prepare for future transactions.

[6] See Hawkins and Mihaljek

[7] See Spong and Harvey: The impact of consolidation based on interstate banking legislation, the Riegle Neal Interstate Act, has also played a vital role in redefining the branching system of the banking industry.

1997 there was a 300% growth in ATMs.[8] This surge is not only created through metropolitan areas but as well as in rural markets such as the states in the Tenth Federal Reserve District[9]. In 1996 the number of ATMs was 10,073 and had grown to 12,397 by the year-end 1997.[10] ATMs and their overwhelming popularity proved to be a great reduction in processing costs and an excellent alternative to branching. They also provided firms with another source of revenue via surcharges. In the Tenth District by 1997 more than 51% of all ATMs were placing an average surcharge of $1.13 on transactions.[11] Surcharging has increased the profitability of ATMs. The purchasing and maintenance costs of ATMs have also decreased. These two trends prompted banks to actively search for new locations to place them. High trafficked areas such as shopping complexes, convenience stores, and gas stations have become excellent locations. ATMs increase operating efficiencies by increasing the geographical locations where consumers can make transactions. Consumers are no longer limited to traditional 9 to 5 hours to make withdrawals and deposits and have increased the speed at which these transactions transpire. The net result is more opportunities with greater efficiency leading to higher profits.

ATMs have helped to reduce the geographical boundaries existing in the banking industry but Wireless communications have removed almost all geographical boundaries concerning the processing of information. Cellular

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[8] Ibid
[9] The states that compose the Tenth District: Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma and Wyoming
[10] Visa/Plus ATM Product Office was original source of information which was gathered by Spong and Harvey
[11] Ibid

technology has developed to the extent in which the Internet can be accessed from a personal mobile cellular phone granting access to countless information sources regardless of any physical location. This phenomenon has come to be called M-Commerce (M standing for Mobile) similar to its technological counterpart E-Commerce (E standing for Electronic). The virtual marketplace is in a unique position to offer many new financial services, diversifying a firm's products and creating a need for specialization. Most importantly the M-Commerce and E-Commerce have provided firms access to a variety of new delivery channels.

Internet

The most recent and rapidly growing delivery system is through Internet websites, which have several different levels of functionality. The first of these levels is a general entry level where consumers are able to access general information concerning the bank's products, interest rates, and news. In the Tenth District the number of banks that utilized a general entry level website grew from 78 in the first quarter of 1997 to 157 by the first quarter of 1998.[12] The other forms of website functionality range from basic to advanced. At the basic level consumers are able to receive information on loans, access loan payment calculators, and even download loan applications. The intermediate website adds some advanced features including online account balances, online applications for deposit accounts, and more importantly online loan applications. The most advanced versions of banking websites include a full range of bank functionality

[12] A quarterly survey by Richard Sullivan, Banking Studies and Structure Department, Federal Reserve Bank of Kansas City.

with all of the previous tools discussed plus the abilities for interaccount transfers and online check writing.

E-Commerce establishes a direct connection between consumers and producers eliminating the necessity for middlemen, thus the volume of direct transactions between consumers and producers has increased as well.[13] Online loan applications lead to a larger pool of loans for loan officers to select from, ideally selecting those of which that have the lowest default rate and ultimately generate more profit for the firm. This simplified distribution channel allows for frequent price revisions and may lead to the emergence of a "perfect" market without any market friction.[14] Thus, this new application of IT should lead to efficiency gains reducing unit costs.

The IT revolution has produced many new financial services that firms from different financial sectors (banking, investments, etc) can offer (See Table 1).

[13] Monetary and Economic Studies November 2001
[14] Ibid

Table 1—New IT Applications

Wireless Application Protocol
Wireless Joint Ventures and Alliances
E-Payments
Derivatives
Financial Engineering
New Delivery Systems
Automated Billing
Automated Customer Service
Automated Bill Collection
Digital Ids
Voice Recognition
Smart Cards
Public Key Infrastructures
Third Generation Wireless Technologies
Point of Sale Technologies
Insurance Database Technology
Unified Messaging

The most influential of these technologies is the development of derivative software. Derivative software provides an electronic assessment of a firm's ability to handle risk. This new financial tool allows risk to be reallocated to parties most willing and able to assume the risk, thereby including more

investment in real assets and fostering the development of banking and financial markets in general.[15]

Technology is the driving force behind the financial industry right now creating more product development opportunities and facilitating the growth of the industry. The introduction of new products stimulates the entry of many new firms into the financial markets, which traditionally used to be dominated by the banking industry. This creates a more competitive banking industry that reduces price to gain market share.

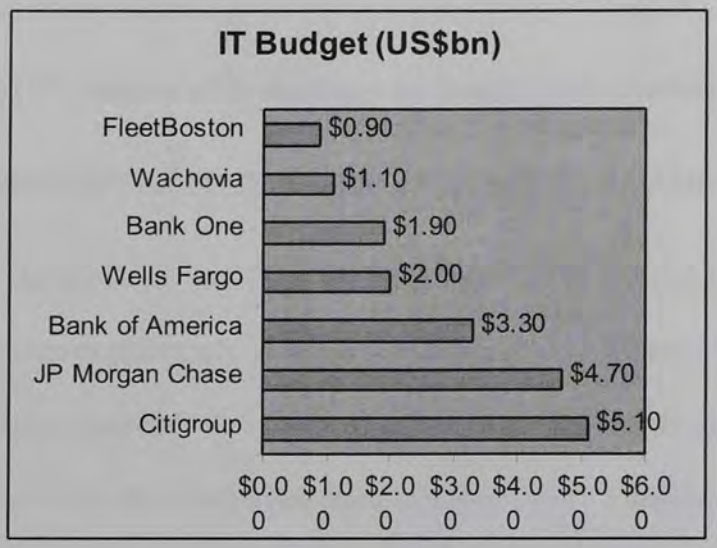
Current Trends

Despite the recent recession in the U.S. economy, banks will increase their spending on IT by more than 4% compared to 2001.[16] According to the managing director at Celnet, Octavio Marenzi, "banks have continued to increase their IT budgets, even while many other industries are holding back."[17] Banks' primary existence is founded on the assimilation and processing of information needed to carry out financial transactions between two or more parties. IT spending is now a necessary expenditure in becoming more efficient in these transactions. The consolidating market is increasing competition and requiring firms to evolve into a more efficient entity and IT spending paves the road. Firms are spending various amounts of their budgets on IT. There seems to be no real pattern or similarity behind the variation, thus the discrepancies have been classified as

[15] See Hawkins and Mihaljek
[16] According to a recent publication from Celnet Communictaions www.celnet.com
[17] Ibid

managerial decisions. (See Chart 1 for various IT budgets for 6 leading firms).[18]

Chart 1 – Variation of IT Budgets (2002)



The variation of Bank Holding Companies' (BHC) IT budgets range from $900mil to upwards of $5.1 billion dollars.[19]

On November 12, 2002 Governor Olson's speech, *The Banking Industry in 2002 after a Decade of Change,* which he gave before the First Annual Convention of the Ohio, Banker League in Columbus, Ohio analyzes a decade of change in the Banking Industry:

> "We experienced unprecedented change, from innovation in market practices to new technologies that created new products and financial vehicles. In the process we also spawned a new generation of more sophisticated and rigorous risk management practices. The expansion of securitization and derivative markets allowed for management and transfer of risk, which in turn created opportunities for banks to specialize increasingly in those phases

[18] Chart 1 expenses indicate the firm's commitment to IT and would be best expresses as a percentage of their total expenses.
[19] Ibid

of the financial intermediation process in which they have an advantage."[20]

Section IV—Impact of Technology on Profit Maximization

Traditional Micro Theory of Cost Curves and the Banking Industry

The application of IT in the Banking Industry has restructured the short run cost curves and thusly changed the long term cost curves as well. Traditional Micro theory contends that firms are subjected to U-Shaped cost curves. Theory states that in the short run when there is a fixed level of capital a firm can begin to lower the average cost (AC) per unit by spreading the fixed costs over a large base. Average variable cost experiences a period of decline followed by a rise due to increasing marginal costs per unit due to marginal productivity of capital and labor. In response to the diminishing productivity of capital there becomes a proportional increase in the marginal cost per unit. Once the marginal cost per unit exceeds the average cost per unit the AC will start to rise, hence the U-Shaped AC. If the level of capital was no longer fixed and it instead was to increase then the average variable cost per unit would decrease for higher levels of output. The decrease in the variable cost per unit would then be interpreted as that firm's improvement in cost efficiency.

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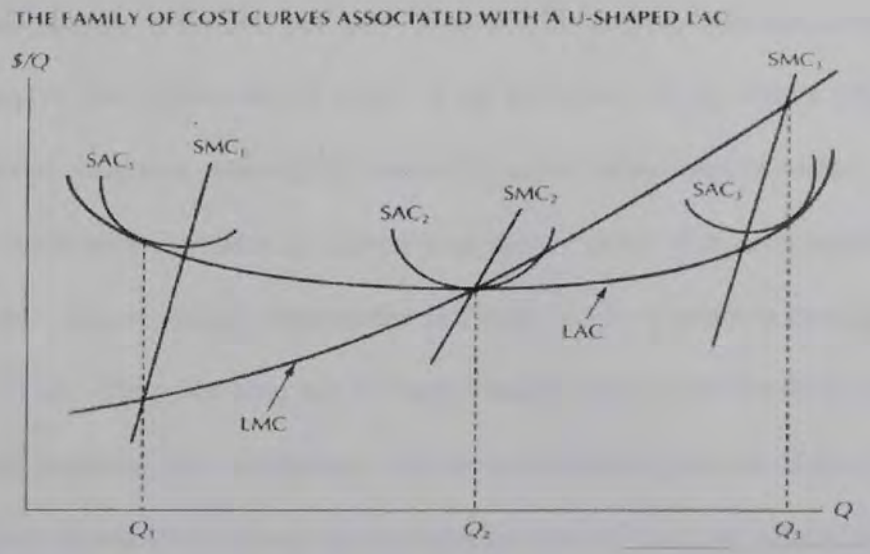
[20] For a complete copy of Govern Olson's Speech See the Federal Reserve Board ***The Banking Industry in 2002 after a Decade of Change.***

Figure A.1[21]



Referring to Figure A.1, there are three short run average cost curves (SAC) in the shape of Us each with its own corresponding level of capital. Collectively the SACs form the long run average cost curve or LAC. When the level of capital increases and the SAC decreases micro theory states that the firm is experiencing economies of scale. Using the LAC as your reference, the economies of scale are visually represented by the downward sloping LAC from Q_1 to Q_2.

Traditionally, economies of scale exist when long run average costs decline as output rises, and larger firms will be more efficient then smaller firms.[21] The larger firms, leading the industry, that are most efficient are said to be on the best practice frontier. There comes a point when given the technology

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[21] See Byrns and Stone *MicroEconomics Fifth Edition.*

of the capital that increasing the level of capital will not result in a reduction of AC per unit. This scenario is referred to as constant economies of scale where there is no change in the AC per unit. It would be possible that improving the technology of the capital would result in an extension of the firm's range of economies of scale thus delaying the onset of constant economies of scale. When the SAC rises with increases in capital then theory states that diseconomies of scale exists. This is visually represented in Figure A.1 by a positive sloping LAC from Q_2 to Q_3. Thus, the long run average variable cost curve has three phases: decreasing, constant, and increasing. The most important position of the firm is the range of output levels along the constant portion of the LAC where average costs are at a minimum and capable of being constant.

When applying these cost functions to the Banking Industry the entire graph can represent the cost behavior of one individual BHC for a given level of IT. Q can be referred to as the number of loans issued by the BHC and \$/Q would represent the cost associated with each level of loans issued. Each SAC can be thought of as a branch of that particular BHC and the cost associated with generating one more loan at a given branch with a given level of capital is represented by the SMC. The summation of all the branches for the BHC is comparable to the long-run cost relationship. The additional cost of generating one more loan at a given level of capital is represented by the LMC.

For a branch to issue loans there needs to be a certain level of deposits. Therefore when the bank increases the amount of loans issued there needs to be a corresponding increase in the branch's level of deposits to support the loan

growth. To generate more deposits the branch must become more attractive to the consumer or its distribution channels must reach a larger market base. The bank's primary source of deposits is its local market. In order to attract more deposits in the local market, the bank could hire more personnel in attempts to intensify their production or the bank could adjust its rates. Each branch has two primary rates, deposit and loan, that together serve as a proxy of the branches attractiveness. The loan rate less the deposit rate produces a value referred to as the Net Interest Margin (NIM). To increase the attractiveness of a branch the management can shrink the NIM. Shrinking the NIM implies that the branch is either decreasing the loan rate, increasing the deposit rate, or both. Whether hiring more personnel or shrinking the NIM either approach will result in an increase of per loan costs.

Besides the need to generate deposits, increasing the level of loans has certain risk ramifications. Assuming that a branch wishes to maintain a given level of risk then there needs to be proportional increase in low risk investments such as securities to counteract the increasing levels of higher risk loans thus balancing the portfolio. However because the rates of securities are generally lower the branch will bear the opportunity cost of the forgone interest that could be potentially earned on a loan of higher risk. This opportunity cost will increase the cost per loan issued. Thus both, attractiveness and risk, measured respectively in NIM and Securities can cause a shift in the SAC for a branch.

Impact of IT on Banking Costs

For a specific banking firm, total costs consist of both fixed and variable costs. There are variable costs per transaction including the tellers and other personnel's hourly wages as well as many costs associated with office supplies and necessary paper goods required for proper documentation, not to mention a large array of fixed costs such as rent, insurance, utilities, salaries, etc. In theory, the emergence of IT, Electronic Banking, and wireless communications have reduced these variable costs and replaced them with the fixed costs of integrating into an electronic infrastructure. The initial capital investment that is required to increase IT applications can be allocated over a larger base and raises AC per unit. However, with an increase in IT we would also expect to see a reduction in hourly wage expenses for the same level of output as well as a reduction in administrative overhead costs such as office supplies; variable cost per unit would decline and AC per unit would not change. At this time there will be economies of scale and best-practice firms will be driving the cost frontier towards operating at the minimum efficient scale of production. Once the IT fixed costs can be recovered then there will be a greater range of output levels at which there will be an absence of economies of scale and the optimal range for output levels will increase as the firm's U- shaped curve shifts downward and right. At this time best-practice frontier firms, firms that have increased their IT, will have a gained competitive advantage in the form of cost savings and will reap high profits. That is to say that the increased application of IT for these firms have allowed them to gain more deposits without increasing their AC per unit.

It appears that technological progress in the banking industry has allowed higher output levels from given resources.[22] In the 1980's the optimal scale of production was estimated to be $100 million to $10 billion and in the 1990's that optimal scale swelled to $10 billion to $25 billion reflecting the economies of scale.[23] The conclusion is that firms that operate with a higher level of technology are going to gain a competitive advantage by being both more cost efficient and reach higher levels of loan output, supported by the gained deposits, for their given resources thus gaining them higher profits.

Impact of IT on Profitability

In theory increased levels of IT are making firms more efficient and because of that they are achieving higher levels of profit maximization. Profit maximizing managers can change their resource mix, combinations of labor and capital, in the long run to realize production efficiency so that for any given level of output production costs are minimized, equivalently maximizing total output for a given total cost.[24]

For a given set of values for loans and deposits including both quantity and price the profit for a given SAC could be maximized with the adoption of new IT applications technology; new technologies are expected to cause a shift to the right and down in the SAC. It is expected that the new IT applications of technology will allow the branch to expand its market over a greater geographical area and provide greater access in their immediate market by intensifying their distribution channels.

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[22] ibid
[23] Monetary and Economic Studies November 2001

In theory increased levels of technology would increase the level of deposits without increasing the AC per unit thus creating an increased range of deposit quantities that a bank could reap benefits before the break-even quantity. However, there are other possible outcomes where the increased spending on IT fails to produce efficiency or achieve market penetration gains and thus resulting in loss as is true for any capital investment. The following case is the only scenario that would result in increased profitability.

Case [25]-- Referring to Figure A.2, suppose that bank j is an individual branch of a BHC. If the market price P_{mkt} of a loan is greater than the minimum of bank j's average total cost (ATC) curve, then bank j maximizes its short run (SR) profits when issuing a level of loans that satisfies the condition: marginal revenue equals marginal cost (MR = MC). In this case, bank j's SR profits at Q_j^*, the quantity of loans that satisfy MR = MC, are positive and equal to [Pmkt - $ATC(Q_j^*)$] x $Q_j^* > 0$, where $ATC(Q_j^*)$ denotes average total cost of issuing loans at the Q_j^* loan level. If competing banks adopt the new technology then bank j may be forced to lower P_{mkt} until it equals the ATC. Note that if P_{mkt} of the loan equals the minimum of the ATC curve ($P_{mkt} = ATC(Q_j^*)$), then bank j's SR economic profits at Q_j^* are zero and bank j is said to be at its SR break-even point.

The aggregate effect of IT implementation in all of the branches would result in a downward shift of the LAC, which represents the lowered cost of the BHC. (See Figure A.2).

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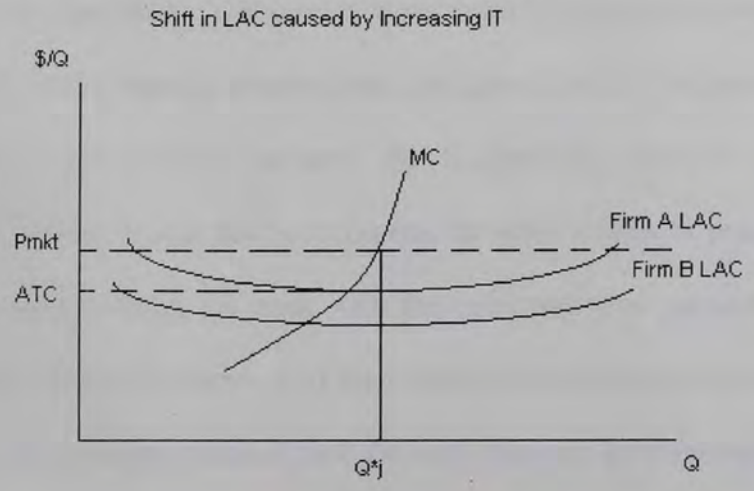
[24] See Byrns and Stone *MicroEconomics Fifth Edition.*

Figure A.2



The decrease in the LAC of a BHC would drive that particular BHC to the front of the cost frontier and thus classify the BHC as a member of the best practice frontier. Referring to Figure A.2, and assuming that Firm A has not experienced increased levels of IT and Firm B has, the difference between the cost associated with Firm A and the cost for Firm B would represent a gained competitive advantage attributed to the increase of IT. This result of a gained competitive advantage, in theory, is caused by the increased application of technology/IT among the branches of a given BHC. Either expanding your

[25] See Byrns and Stone *MicroEconomics Fifth Edition.*

market over a larger geographical area or intensifying current distribution channels raises the BHC profitability.

IT and Market Expansion

Historically, banks have been limited to a confined geographical area by interstate banking laws. These restrictions restrict branching strategies and have limited the market base in which a bank can gain deposits. In hopes of creating a more completive banking industry the Riegle-Neal Interstate Banking and Branches Efficiency Act has been enacted to allow banks to practice interstate banking thus providing the bank with the opportunity of gaining more market penetration. Due to the removal of these interstate banking barriers advancements in IT and the implementation of new delivery channels have restructured banking firm's average cost curves by increasing the optimal scale. The passing of the Riegle-Neal Interstate Banking and Branches Efficiency Act has undoubtedly changed the increased optimal scale where average costs are minimized. The rapid change of IT and the recent sharp drop in the cost of computer hardware has shifted the average cost curve.[26] In other words banks' cost curves are experiencing a greater range of the quantity of loans issued where the AC per loan is constant. The optimal scale has increased also because of the banking firms' successful cultivation of alternate delivery channels supermarkets, E-Commerce, and M-Commerce, permanently altering the cost of production.[27]

[26] Ibid
[27] Ibid

Before the enactment of the Riegle-Neal Act it was far more costly to set up separately capitalized banks in different states to deliver their financial products.[28] Due to the success of ATMs reducing branching expansion costs we would expect that for the same fixed level of expansion costs using an ATM approach versus a branching approach a firm would generate more deposits. Using the ATM method as a means of expansion, for a given price, profits should increase. Yet as firms adjust to their new size competitors will drive prices down to gain profit share until a new equilibrium can be achieved. Alternatively, market penetration can also be gained through achieving greater levels of capital through consolidation.

Section V—Consolidation

In response to the interstate banking legislation, consolidation has quickly transformed the industry. Consolidation creates a more specialized staff to handle transactions for an increasing number of customers and activities while providing a more innovative and efficient operating framework.[29] Willis and Van allengham (1998) find that community mergers in a rural environment with market overlap have the potential for cost savings and improved profitability. The consolidation allows the firm to spread fixed technological and administrative overhead cost over a larger consumer base. The results of the community merger study showed that in-market mergers of small banks have usually been successful from both a profitability standpoint and efficiency perspective.[30] Assuming that smaller firms have a lesser quantity of quality management personnel and have

[28] Federal Reserve Board of San Francisco, *Efficiency of U.S. Banking Firms*
[29] See Spong and Harvey

the greatest potential to improve their delivery channels we assume that the larger firms have a greater level of management experience. The cost savings and improved profitability are expected because small banks have the greatest room for improvement regarding managerial efficiency or X-Efficiency. Traditional economic theory suggests that the newly reached additional profits will be competed away but they have not been because there has been an ongoing innovation stemming from technological cost advantages that continues to generate profits.[31]

Assuming that the acquiring firm has loan officers that are capable of handling an increased market base mergers reduce costs by permitting the two banks to reduce data processing and administrative overhead and by allowing loan officers to service larger loan portfolios, thus creating more profit. Due to these changes bank mergers are resulting in operating cost savings. For example, merged banks cut annual total non-interest expense by 0.04%; meaning that if a bank earns 1% return on an asset (ROA) the average cost savings translate in a 4% increase in ROA.[32]

In a previous study Jalal Akhavein, Allen Berger, and David Humphrey (1997) examined the effects of mega mergers on efficiency and prices based upon a bank profit function. Their findings were that merged banks experience a statistically significant 16-percentage point average increase in profit-efficiency

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[30] Ibid
[31] See Berger and Mester
[32] See Simon Kwan Federal Reserve Board of San Francisco- Economic Letter *A New View on Cost Savings in Bank Mergers.*

rank relative to other large banks.[33] They found the cause of this increase to be increasing revenues primarily driven from the crossover from securities to loans.[34] Loans are a much more profitable product that generate far more revenue than securities. Their findings supported their hypothesis that mega-mergers allows a bank to diversify the loan portfolio and reduce the risk of the portfolio; thereby increasing the loan portion of their portfolio relative to securities and reducing the risk exposure. This in turn allows the consolidated bank to issue more loans for roughly the same amount of equity capital, raising profits on average. Now the bank has more loanable funds that the firm can lend at a more profitable rate.

We would also expect then that the mergers would result in increased cost efficiencies. However, Allen Berger and Loretta Mester (2001) in their study, *Explaining the Dramatic Changes in Performance of U.S. Banks: Technological Change, Deregulation, and Dynamic Changes in Competition*, examine efficiencies and mergers. Their conclusions were that during 1991-1997, cost productivity worsened while profit productivity improved substantially, particularly for those banks, which engaged in mergers.[35] Traditionally we would expect to see some cost saving, improvements in the firms cost efficiency that could be directly attributed to the merger. However the data does not support the improvement in cost efficiency; instead the data suggests that cost actually worsened after mergers. The study also states that profit productivity improved; if profits increased while costs increased than we assume that revenues gained

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[33] See Akhavein, Berger, and Humphrey *The Effects of Mega mergers on Efficiency and Prices: Evidence from a Bank Profit Function*
[34] Ibid

from merger were greater than the cost increases.[36] The study has a strong impact because it demonstrates that previous studies that examined the performance of banks that excluded revenues were reflecting an inaccurate picture and could be misleading.

This trend of consolidation has removed some of the least efficient and non-productive bank managers in turn driving the entire industry closer to the best practice frontier. This process continues as a new technology develops; the early adopters again reap the greatest benefits for a limited time. Basically, firms that are early adopters of a new technology temporarily earn higher profits but those abnormal returns are competed away as the technology is distributed throughout the whole industry.[37] The banking industry has had several innovations that have earned substantial profits for considerable time periods, even though different firms have the potential to achieve these profits. Thus it is a managerial imperative to be informed of the latest cutting edge technology and make sound decisions as to when to adopt these technologies. Adoption of a new innovation can make the difference in earning supernormal profits or becoming a laggard and facing the pressures of a consolidating industry. Berger argues that small banks (assets below $300 million) were not able to adapt quickly to changes in technology, regulations, and competitive conditions and this drove them further away from the best practice frontier.[38] If this argument is true then early adoption

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[35] See Berger and Mester *Explaining the Dramatic Changes in Performance of U.S. Banks: Technological Change, Deregulation, and Dynamic Changes in Competition.*
[36] The study examines the effects of merger in the short run and there is no clear argument or evidence about gained efficiencies in the long run.
[37] Ibid
[38] Ibid

of technology will drive a firm towards the best practice frontier, whether the firm is large or small. It just so happens that in his study he found that larger firm (assets above $300 million) had a competitive advantage over small banks because they were financially able to capitalize on innovation. The search for efficiency motivates banks to merge as they seek profit gains from increasing efficiency in administrative costs, also known as X-Efficiency.[39]

Section VI—X Efficiency and its Role in IT Implementation

The gained cost efficiencies in the individual branch are the offspring of gained operational efficiencies and managerial decisions related to implementation and intensity of IT applications. X-Inefficiency refers to deviations from the cost-efficient frontier or best practice frontier that depicts the lowest production cost for a given level of output. [40] This stems from technical inefficiency, which measures the degree of friction and waste in the production process. The goal of reaching a profit maximization level may be not be easily achieved through cost efficiencies, but perhaps improvements in a firm's X-Inefficiency will have a greater effect on performance. Different management teams have the ability to make a firm more or less X-Efficient by implementing new business strategies. These changes tend to occur most effectively and frequently through consolidation. When a best-practice frontier firm acquires another less efficient firm the inadequate management is replaced by a superior group of personnel who then assimilate successful management techniques and superior technology into the operation thereby transforming an inefficient

[39] See Stephen Martin. *Industrial Economics: Economic Analysis and Public Policy.*

operation into a situation where profit can be achieved. Assuming the acquired firm is technologically inferior to the acquirer, profit gains are achieved not through the generation of new revenues, but from the superior management of capital, labor, and technology.

Financial tools like derivatives, made possible through IT technology, and the increased diversification of portfolios have reduced the risk in the banking industry and thus increased profit efficiency. The early adoption of derivative technology has allowed firms to manage their risk more efficiently. We would then assume that losses are being minimized and profits gaining. The diversification of the portfolios can primarily be attributed to merger activity, which then translates into higher returns on a firm's portfolio ultimately increasing profits. Increasing risk results in increasing losses and conversely lower risk means higher profits. As firms reduce their individual risk and thereby enhance their optimal portfolios, by increasing the number of loans (risk-reduced) relative to the number of securities (low-risk investments) the firm is able to capture more profits. Both decisions regarding adoption of technologies and risk management can be linked to managerial decisions. Thus deviations in these decisions from the best practice frontier could be classified as an X-Efficiency.

Section VII—Summary

Due to a superior infrastructure advancements in technology have created the possibility for more efficient operations and production in the banking industry. ATMs were the beginning of a new era in banking and have paved the

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[40] As defined in a Federal Reserve Bank of San Fransico Economic Letter, *Efficiency of U.S. Banking Firms-An Overview, Februrary 28, 1997.*

road for the emergence of the E and M-Commerce marketplaces, where consumers are more interactive and informed about their financial institutions. Traditional banks are competing with vast financial intermediaries who are entering a more specialized market place due to the overwhelming forces of consolidation and increases in competition. Globalization and consolidation have forced remaining firms to become more efficient in every aspect of their operations including X-Efficiency. In order to maximize profits, management teams must be willing to accept and utilize the latest cutting edge technology to remain in the best practice frontier. If firms fail to realize the importance and value of the early adoption of technology, their profit share will be competed away and they will be rendered unsuccessful.

This study investigates whether or not there is a competitive advantage to be gained in the banking industry due to an increasing level of IT. This will be measured through two distinct models that will identify any significant effect on the level of deposits and efficiency through changes in IT performance. If the model shows that higher levels of IT generate a greater total dollar amount of deposits then the argument can be formed that IT performance can shift the LAC curve creating a competitive advantage when setting prices.

Section VIII—Data and Regression Models

There are two empirical ways in which we can approach the impact of IT on the banking markets. The first is referred to as the Market Penetration Model.

Theoretically IT should help banks gain market share or market penetration in the market for deposits.

Market Penetration = f(Technology, Market Strategy, Facilities/Branches)

In order to analytically evaluate the model we need to create proxies for Technology, Market Strategy, and Facilities. To model Market Penetration, the Deposit Market Share (DMS) of a BHC will act as a proxy. To measure the technology of banks we will be using an index that measures the functionality of their website. It is expected that a higher level of website functionality will result in increased gains of market share. Market Strategy will be divided into two sub categories, rates and risk. Rates will be identified through a variable Net Interest Margin (NIM) and risk will be measured on the basis of the amount of securities invested by a BHC. Theoretically we would expect that as NIM shrinks the attractiveness of that particular branch to consumers' increases. Thus the bank would gain more deposits because of their more attractive rates. We would expect that an increase in securities would be the resultant of increased levels of loans. In order to gain the additional funds necessary to meet the loan and security needs, the BHC needs more funds. Thus it is expected that there exists a positive relationship and that an increase in risk management and market strategy will result in an increase in Market Penetration or DMS. The final component of Market Penetration, Facilities/Branches, has a positive effect. More branches and

facilities operated relative to other BHCs in the market place would result in a gain of market share. Assuming that the number of ATMs and branches are proportional ATMs have been grouped together with traditional brick and mortar buildings, under the heading OFFICES as a proxy for facilities.

The second model called the Efficiency Model operates under the pretense that

Efficiency = f(Technology, X-Efficiency, Diminishing Marginal Productivity of Labor).

The proxy Employee Deposit Efficiency (EDE) reflects dollars deposited per employee. Technology will once again be identified by the functionality of a BHC's website and it is expected that increase in technology will have a positive effect on Efficiency. Decreased levels of X-Efficiency are believed to increase the level of deposit efficiency. A measure of the BHC's ability to generate income relative to its cost and the rates at which loans and deposits are transacted will be a proxies for X-efficiency denoted as by the Efficiency Index (EFF) and NIM respectively. The EFF is an index calculated by the FDIC to measure the efficiency of a BHC. A more detailed description of how this index is calculated will be discussed later. It is expected that both EFF and NIM will have a negative relationship with the Efficiency Model. Whereas a lower value of NIM suggests high deposit rates or lower loan rates, either case we expect an increase in deposit gains, hence the negative relationship. To provide a proxy for the Marginal

Productivity of Labor the variable DENSITY was created to measure the amount of employees per branch for a BHC and is expected to have a positive relationship with deposit efficiency.

To determine if technology impacts the efficiency and profitability of financial institutions the study will examine the top twenty-three BHCs. See Table 2.

Table 2—23 Bank Holding Companies Studied

BHC
AmSouth Bancorporation
Bank of America Corporation
Bank of New York Company, Inc.
Bank One Corporation
BB&T Corporation
Charter One Financial, Inc.
Comerica Incorporated
Fifth Third Bancorp
FleetBoston Financial Corporation
J.P. Morgan Chase & Co.
KeyCorp
M&T Bank Corporation
Mellon Financial Corporation
National City Corporation
Northern Trust Corporation
PNC Financial Services Group, Inc.
Regions Financial Corporation
SouthTrust Corporation

State Street Corporation
SunTrust Banks, Inc.
U.S. Bancorp
Wachovia Corporation
Wells Fargo and Company

This includes all of the subsidiary companies as ranked by the FDIC over the second and third quarters of the year 2002. There were two primary sources for the collection of data for this study. The FDIC provided all the data except for one variable and Gomez Inc. provided the IT variable's data set solely for the use of this study.

The two models that will test for gains in deposits as a direct result of increasing levels of IT are the Market Penetration Model also referred to as the DMS model and the second is the Efficiency Model also know as the EDE model.

(1) $DMS = \beta_0 + \beta_1 IT + \beta_2 NIM + \beta_3 OFFICES + \beta_4 SEC + \beta_5 TIME$

(2) $EDE = \beta_0 + \beta_1 IT - \beta_2 NIM - \beta_3 EFF + \beta_4 DENSITY + \beta_5 TIME + \beta_6$ STATE_ST

Deposit Share Model

Equation (1) is the Deposit Market Share Model in which market share is defined in percentage terms of total dollars deposited within the eight FDIC regions. The first of the independent variables, IT, is a proxy for technology for a specific firm.[41] For the purpose of this study, the IT proxy is a scoring of web-

[41] Limitations such as availability and cost of this data did not allow for the use of actual IT budgets that would serve as a better measure of the firm's commitment to IT and

functionality based upon third party consulting performed by Gomez Inc. The scoring is reported from a range of zero to ten, zero being the worst possible score. The web-functionality is assumed to have a positive relationship with the IT spending and therefore it is expected to have a positive relationship with DMS.

The second independent variable in equation (1) is NIM. Net interest margin is defined as the difference between the average loan rate and the average deposit rate for a firm. The variable has a positive coefficient because when the NIM of a firm shrinks (i.e. the loan rate decreases and/or the deposit rate increases), this reflects a time of high levels of securities, loans, and increasing levels of deposits.

The third explanatory variable is referred to as OFFICES. An OFFICE, is the ratio of a firm's total number of offices as compared to the total number of offices in the marketplace:

(3) $$\text{OFFICES} = \frac{\text{Total Firm's Offices}}{\text{Total Offices in the Market}}$$

The "market" is again defined as the eight FDIC regions. This ratio expresses a level of market penetration that a firm has on a national level. The national level is determined by calculating the total branches in the eight individual regions then taking their weighted total to form a national tally of offices. The national tally of offices is referred to as the total offices in the market. The function between deposits and the number of offices is positive. This translates that the greater offices or opportunities for a consumer to make deposits the greater the total

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willingness to pay. Website functionality data was donated by Gomez Inc. as a proxy for IT budget.

dollar level of deposits will be achieved resulting in a higher DMS; thus the coefficient of the OFFICES variable is expected to be positive.

The independent variable SEC is a proxy for the total dollar amount of money invested in securities. Referring to equation 4 this proxy is simply calculated as one minus the ratio of total loans to total assets when measured in dollars.

$$\text{(4)} \qquad SEC = \left[1 - \frac{\$\text{Total Loans}}{\$\text{Total Assets}}\right]$$

Since our proxy represents the percentage of total assets that are securities we would assume that an increase in SEC implies that the bank is taking a lower overall risk. Since the overall risk level is lower the bank can substitute deposits for equity. Therefore we expect a positive relationship between SEC and deposit market share.

The final variable is TIME. This is a dummy variable to identify which quarter the data is associated with. If the data is reflecting the second quarter of 2002 then the value for TIME is 0. When the data corresponds to the third quarter of 2002 then the value or time is 1.

Efficiency Model

The other model used to measure the effects of IT on total dollars deposited is referred to as the Efficiency Model. This model allows for the statistical measurement of gained efficiency due to increased use of IT.

(2) $EDE = \beta_0 + \beta_1 IT - \beta_2 NIM - \beta_3 EFF - \beta_4 DENSITY + \beta_5 TIME + \beta_6 STATE\_ST$ The Efficiency Model is composed of five explanatory variables where Employee Deposit Efficiency (EDE) is a proxy deposit efficiency. The EDE is a ratio expressing the total deposits in dollars per the total number of full-time equivalent employees at the given time period.

(5) $$EDE = \frac{\text{Total deposits (\$)}}{\text{Total number of Full-time equivalent employees}}$$

The IT variable is the same as in the DMS model where web-functionality is a proxy for IT budgets. We would expect the same positive relationship as in the DMS model where increased levels of IT lead to efficiency gains in the BHC.

In this model, NIM is calculated in the same manner but the relationship with the dependent variable has changed. In the EDE model we expect the coefficient to be negative because as the NIM shrinks, consumers are more attracted to high deposit and would thereby deposit more dollars. Holding everything else constant we would expect this to increase the EDE. So, as NIM decreases the EDE increases, hence the negative coefficient.

The third explanatory variable, EFF, refers to a measurement of efficiency as defined by the FDIC. This efficiency proxy calculates the cost of operations for generating income where income is defined as fee income plus tax equivalent net interest income.

(6) $$EFF = \frac{\text{Operating cost}}{\text{Fee income + tax equivalent net interest income}}$$

Referring to equation 6, we can see that the lower value of EFF suggests a more efficient operation because a smaller operating cost would be generating more income; whereas a high value of EFF would indicate a substantial cost to earn revenue. Thus a lower value of EFF would indicate a more efficient firm with a lower level of X-Inefficiencies. A more efficient firm would require fewer total employees to produce the same level of output. Fewer employees would translate into a higher level of EDE for a firm. Refer back to equation 6 and we can see that a lower total number of employees would produce a higher value of EDE. An increasing value of EFF leads to a diminishing EDE, hence the negative with EDE.

DENSITY represents a ratio of total employees and total offices for a given firm.

$$(7) \qquad DENSITY = \frac{\text{Total Full-time equivalent employees}}{\text{Total Offices}}$$

This variable also has a positive effect on EDE because the greater value of density would indicate that there are a greater number of employees for each office all working to gain deposits for their firm. If the predicted positive relationship is false and it is actually negative then this indicates a diminishing return to labor whereby adding one more worker to the office is likely to lead to

less production in a branch. A high DENSITY value would represent a high level of employees and result in a low level of EDE.

The final variable STATE_ST is a dummy variable introduced to account for the statistical outlier generated by the State Street Bank. This is a significant outlier because State Street only has 2 offices where as other firms have office values in the hundreds and because of this the model is likely skewed when not adjusted for the uniqueness of State Street. In response to this skewed model a dummy variable was created. The BHC State Street is designated a value of 1 and all other firms are reported as 0.

Section IX – Analysis

DMS MODEL:

Using a least-squares regression model, the first linear regression model examined was the DMS model. Table 3 provides a summary of significant statistics for the DMS model.

Table 3—Efficiency Model

Efficiency Model

	DMS	EDE
IT	0.29414	45.0299
	1.53	0.41
NIM	0.28877	-261.371
	1.23	-2.45***
OFFICES	2.054377	
	8.61***	
EFF		-48.5078
		-4.42***
SEC	0.03293	
	2.97***	
DENSITY		5.346
		2.03**
TIME	-0.02553	260.997
	-0.12	1.99*
STATE_ST		-49743
		-2.04**
Adj R-SQ	0.7773	0.3258
PR>ChiSQ	0.1526	0.5784

***=99% confident

**=95% confident

*=90% confident

(1) $DMS = \beta_0 + \beta_1 IT - \beta_2 NIM + \beta_3 OFFICES - \beta_4 SEC + \beta_5 TIME$

The analysis of variance in the model provided an adjusted R-square value of 0.7773 indicating the model explains approximately 78% of the variation in DMS. This value is statistically significant.

Since the model is cross sectional, heteroscedastisty could be a potential problem. The next logical step in the analysis was to test for heteroscedastisty. To test we examined the first and second moment specification and its reported probability value of having a greater Chi-Square. The Chi-Square indicated that heteroscedastisty was not a problem in the model and no corrections were necessary.

Although the IT is positive as expected the results indicate that IT is not statistically significant. However 1.53 is an encouraging result because it suggests that there is some positive relationship that exists between IT and deposit market share in the DMS model as originally thought.

The NIM variable reported a surprising lower T-value than was believed would be evident. It was expected that the NIM would be able to explain the variance in market share, but the data suggests that no such definitive relationship holds between the two. It was believed that the deposit and loan rates offered by the firm would have the greatest impact on the market share of total deposits or DMS. However the T-value reported after the linear regression was a surprising 1.23 and after comparison of the IT and NIM parameter estimates it seems apparent that IT is more statistically significant then NIM.[42]

The OFFICE variable proved to be extremely significant with a T-value of 8.61 at a 99% level of confidence. The coefficient value of 2.05427 indicates

that for every 1% gain in offices relative to other BHCs the Bank should expect to see a 2.05% gain in market share. Having a high value for OFFICES translates into a greater level of market penetration that leads to a positive impact on DMS. This provides statistical evidence supporting that market penetration is the most significant variable in the model.

The SEC variable is an estimate for the amount of securities for a given firm. The variable proved to be statistically significant with a T-value of 2.97 at a 99% level of confidence. This means that if a BHC were to increase its Securities relative to its total assets by 1% than there would be a corresponding .0329% gain in market share of deposits.

The final independent variable in this equation is TIME and was incorporated in the model to account for the time period in which the observations were made. The TIME dummy variable has no statistical significance in terms of deposit market share.

EDE MODEL:

(2) $EDE = \beta_0 + \beta_1 IT - \beta_2 NIM - \beta_3 EFF - \beta_4 DENSITY + \beta_5 TIME + \beta_6 STATE\_ST$

The EDE model, referring to equation 2 and 5, analyzes how the ratio of dollars deposited per employee is affected by six independent variables, five of which found to be statistically significant. The model is analyzed to have an adjusted R-square value of .3258. This indicates that the EDE model explains 32.58% of the variation in EDE.

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[42] Even though IT and NIM are insignificant there is no multicolinearity present.

Again due to cross sectional data, there was a potential problem of heteroscedastisty. In the same manner as in the DMS model we tested for heteroscedastisty by evaluating the first and second moment. This test reported a Chi-Square value that indicates there was no problem present.

The IT variable in this linear regression analysis is calculated to have a T-value of 0.41 with a standard error of 110.7239. The T-value suggests that this variable is not statistically significant in explaining any of the variation in EDE over the time period analyzed. Therefore it appears that web-functionality does not lead to more deposits per employee.

The first significant variable is NIM, which reports a T- value of –2.45 and a level of confidence of 99%. Unlike the DMS model, this value suggests that the NIM has a significant effect on the EDE of a firm. The coefficient indicates that when the NIM shrinks by 1% there will be a $261.37 gain in deposits gained per employee, which was expected.

The EFF variable relates operating cost to income as a measurement of efficiency, see equation 6, and has the greatest significance among the explanatory variables with a T-value of –4.42 at a confidence of 99%. This does imply that the overall efficiency of a corporation, when measured in these terms, has a significant impact on the level of EDE achieved by a firm. The coefficient –48.5078 suggests that if a BHC decreases its operational efficiency by 1% there would be a decrease in EDE by $48.51. This provides statistical support that the more efficient a firm is the greater the EDE. This can be attributed to X-efficiencies where as management's roles can have an indirect effect on the

deposit gains of the firm. Efficiency measurements like this one provide critical data when making managerial decisions regarding staffing, budgets, and expansion all three of which affect the performance of the firm.

The next explanatory variable, DENSITY, was created for the purpose of this study and reflects the overall relationship between employees and offices. Density was statistically significant with a T-Value of 2.03 and at a confidence level of 90%. This can be interpreted that the size of the firm's staff relative to its offices can have a positive affect on the efficiency of gaining deposits when measured in terms of individual employees. The DENSITY coefficient of 5.346 implies that an increase of 1% in employees relative to offices would bring forth a $5.34 gain in EDE. This being the case there is then implied a managerial practice which much be set forth in order to ensure optimal DENSITY for a given firm. DENSITY along with EFF provides statistical representation of X-Efficiency's affect on gaining deposits.

The TIME variable in the EDE model has a T-value of 1.99, which is on the borderline of being statistically significant especially with a 90% confidence interval. Assuming this variable is significant by examining the coefficient valued at 260.997 it can be interpreted that over the time period studied there was an increase of $260 dollars deposited per employee.

The dummy variable, STATE_ST, that was incorporated into the model to remove the statistical outlier that the BHC, State Street, had on the overall model showed statistical significance with a T-value of 2.04 at a confidence level of 95%. This implies that the individual BHC, State Street, was in fact skewing the

model causing unrepresentative data to be analyzed and that the problem created was easily corrected through the creation of the dummy variable. State Street is unique in that it is the only firm in the data set that had such an outlier that needed correcting.

Section X – Conclusion

The ultimate goal of this study was to provide statistical support that increasing levels of IT would result in gains in deposits and thus provide a firm with a competitive advantage. There were two different methods for measuring gains in deposits. The first of these measurements is in terms of total dollars deposited in a given BHC relative to all the dollars deposited in the marketplace or what we have labeled the DMS. The second of these measurements is focused more on the efficiency of gaining deposits. Do increasing levels of IT result in a more efficient manner in obtaining deposits? The dependent variable EDE was created as a proxy for this efficiency. Through this study we hoped to show that increasing levels of IT would result in increases in EDE.

The DMS again reports a high adjusted R-square value most probably due to the limited data set; however, it does have statistical significance that needs to be further analyzed over a larger data set to better test the model.

DMS, the measurement of market penetration, is measured in percentage terms of total offices for a given firm relative to total offices in the eight FDIC regions. This reflects the availability of the firm to the consumer. Increased levels of IT should increase website functionality making it more user friendly

and more interactive. However this was not the case. This website then serves as an available channel for the bank and consumer to undertake transactions. Instead of using website functionality as a means of measuring IT other possible proxies of E-banking exist that could be used to study the effect of IT on deposit market share. It is uncertain as to the future of E-Banking (Electronic Banking). One thing that is certain is that the Internet is becoming an increasingly more adopted market arena and if market penetration is as prominent on the Internet as it is in the traditional market arena then web-site functionality could become a defining characteristic of a firm.

More appealing is the fact that the IT variable had a greater T-value then did the NIM, which before the regression analysis was predicted to have the greater value of the two when compared. This is promising and provokes further investigation into IT and its effect on market share in regard to total dollars deposited. Perhaps since the DMS model was completely focused on the total dollars deposited that instead of using the NIM variable it would be better suited for the model to substitute one that only reflected the deposit rate of a firm would be better suited for the model. It is possible that incorporating the loan rate into the model would create bias and not reflect an accurate portrayal of the significance of the rate offered on total dollars deposited.

The DMS model provided statistical evidence that IT was having an effect on the amount of total dollars deposited. However the limitations placed on this study due to the scarcity of published IT data did not permit sufficient enough statistical evidence to merit the variable IT of being significant. The analysis of

IT when compared to NIM was thought provoking and is encouraging. Perhaps IT does have a significant effect on the total dollars deposited. Yet in the time frame in which these observations were made there is not strong enough evidence to support this theory. The DMS model has provided insight as to the importance of market penetration and availability of services to consumers. The deregulation of interstate banking laws and the trend of consolidation have provided BHCs with the opportunity to increase their number of offices and target markets. Both factors are direct influences regarding the gains of deposits and market share overall. At this time there is no concrete statistical evidence that higher levels of IT create a competitive advantage for a given firm. The DMS model is a foundation for further studies and if analyzed over a longer time period it is believed that IT would show a stronger statistical significance. Using a larger time series data set we would hope that levels of IT would change more dramatically over a longer time and thus have more significance in explaining the variation of deposit market share.

TIME has a greater impact on the Efficiency Model than it does on the Market Penetration Model because the variance in the number of employees over the two quarters studied is far greater then the variance in the total dollars deposited in a BHC over the same time period. Changes in staffing and employee assets are far more volatile then changes in the DMS. If this study were analyzed over a longer time period there are two possible theories regarding the effects of TIME on the EDE model. Scenario A, if the firm maintained its size, in terms of employees, then over the 12 quarter period we would expect to see a small T-

value for TIME suggesting that TIME plays little or no role in the EDE. Scenario B, if the firm were to grow or shrink dramatically, again in terms of employees, then over those 12 quarters we would expect to see a T-value of great significance, reflecting the impact that TIME would show have on EDE.

The EDE and the DMS model both are centered on total dollars deposited. In the DMS the total dollars deposited are expressed as a fraction of all dollars deposited in the eight FDIC regions and in the EDE model as a ratio of dollars deposited relative to employees. Why is the NIM only significant in one model? It is not significant in the DMS model because as discussed earlier it is skewed by the incorporation of loan rates into a deposit driven function. The NIM is significant in the EDE model because there exists a relationship based upon the correlation between the NIM for an individual office and its attractiveness to consumers. The more attractive or smaller the NIM, the more we would expect a greater level of deposits in that particular office relative to those offices in the immediate area thus affecting the EDE for a given firm.

The model did provide statistical support that there was significance in the level of staffing for a given firm relative to the number of offices it occupied. This DENSITY relationship demonstrates that administrative decisions regarding staffing of an office impact the efficiency in which an individual employee contributes to the total gained deposits of a firm.

The EDE model provided a mathematical expression relating to the X-efficiency of a given firm. A higher EDE would reflect a superior administrative team and superior management of inputs and outputs. The goal was to

demonstrate that the administrative decision to increase levels of IT would generate a higher EDE due to gained increases in efficiencies. After an analysis of the EDE model using a least-squares linear regression model it was apparent that there was no statistical significance in IT. Thus there was no gained efficiency through a managerial decision to increase IT.

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