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# An Investigation of Bank Lending Practices To Test Portfolio Theory and Theories of Credit Rationing and Customer Relationships

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# An Investigation of Bank Lending Practices To Test Portfolio Theory and Theories of Credit Rationing and Customer Relationships

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## ABSTRACT

## AN INVESTIGATION OF BANK LENDING PRACTICES TO TEST PORTFOLIO THEORY AND THEORIES OF CREDIT RATIONING AND CUSTOMER RELATIONSHIPS

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The purpose of this study is to consider the theoretical basis of commercial loan pricing. Is commercial loan pricing most representative of pricing to reflect risk in the Markowitz sense or do banks ration their loanable funds based on credit risk or expected long-term customer value? Alternatively, does each theory contribute to the explanation of loan pricing?

Some of the pricing theories noted in this study have been tested at the aggregate banking level, however, few studies have been performed at the loan level. Moreover, the author is not aware of any study that tests which theory noted here best describes actual pricing practices for bank loans. In fact, DeVany (1984) and Goldfeld (1984) have noted that models of bank behavior have undergone little direct testing. Goldfeld acknowledges that the sparse empirical work in banking exists because much of the theoretical analysis is at the level of the individual bank where appropriate data are not available. This study overcomes that problem by

using the loan portfolio of one of the top 50 bank holding companies in the nation as a case study.

Portfolio theory, credit rationing, and customer relationships provide the basis for this investigation of how banks price commercial loans. Portfolio theory indicates that the risk of a particular loan as well as its contribution toward the riskiness of the entire loan portfolio provides the most information about loan pricing. Credit rationing, however, indicates that the contract interest rate an applicant is willing to accept acts as a signal of loan quality and predicts the bank's expected return on the loan. Finally, theories about customer relationships indicate that customer traits such as variability of deposits and length of the relationship play a role in the way banks price loans.

The data used in this study are at the loan level and were obtained from one of the top 50 bank holding companies in the nation. Loan pricing procedures are examined by performing a series of cross sectional generalized least square regressions where the expected return on the loan is the dependent variable in each regression. The non-nested J-test and Cox-test help determine whether any of the model specifications tested in this study provide significantly greater explanatory power in commercial loan pricing than the competing model specifications.

The empirical findings of this study should be considered exploratory in nature because of its reliance on data from one bank. Moreover, these results assume that each of the models have been properly specified. With these caveats in mind, the results are consistent with credit rationing and customer relationship theories (Hodgman and Kane and Malkiel). Moreover, the nonested Cox-test indicates that the credit rationing specification used in this study provides more explanatory power with regard to loan pricing than the customer relationship specification.

The regression of the portfolio theory specification provided statistically significant results, but with coefficients of the wrong sign. Contrary to theory, the results suggest that the expected return on loans increases as the variance decreases. In addition, the regression results do not provide strong support that loans are priced relative to the risk they contribute to the total portfolio.

In a matter related to loan pricing, this study also found that collateralized loans are associated with a smaller expected return than noncollateralized loans. This finding is consistent with Boot, Thakor, and Udell (1991) who suggest that firms use collateral to obtain more favorable loan terms.

The conclusions and implications of this study revolve around the illiquid nature of commercial loans which creates an inefficient market characterized by asymmetric information.

In light of the scarcity of information related to potential commercial loans, it is not surprising that customer relationship theories provide some explanation of current pricing practices. Certain aspects of a customer relationship, such as deposits and length of the relationship can provide banks with valuable information about the riskiness of loans. Moreover, relationships that cover several bank services may enable a bank to supplement thin loan margins.

Finally, the support, albeit weak, of credit rationing can also be explained with asymmetric information. Because of adverse selection and moral hazard, there is a point at which further increases in the contract interest rate on a loan will lead to declines in the expected return to the bank. Beyond this point, the profit maximizing bank should ration rather than loan its funds.

# CHAPTER I
# INTRODUCTION

Over the years, banks have been criticized for pricing the loans of their best customers too high and their worst customers too low. Indeed, Loan Pricing Corporation found that when 90 commercial loan officers across banks rated the risk of four loan cases, their ratings of risk were fairly consistent; but they varied from 50 to 200 basis points over the cost of funds on the suggested loan contract rate.[1] Moreover, a survey of credit practices at 100 of the largest banks in the nation revealed that loan approval and monitoring processes are not consistent with the nature and type of risk in a loan.[2]

Loan pricing has important implications for the economy on both a micro and macro level. For the individual bank, proper loan pricing leads to a better allocation of funds and thus to higher profits. This is particularly important at the extreme ends of the spectrum. On the one side, low-risk borrowers are likely to seek out more efficient sources of funds if banks price their loans too high. In contrast, if the riskiest borrowers are underpriced, they will capture a larger proportion of the loan portfolio's

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[1] "Portfolio Valuation Handbook," Loan Pricing Report, March 1989, p. 20.

[2] Sanford Rose, *American Banker*, January 28, 1992.

funds and will likely increase the volatility of the portfolio's returns. On the macro level, the proper valuation of loans contributes to a more efficient allocation of funds in the entire economy (Jaffee and Stiglitz, 1990).

The purpose of this study is to consider the theoretical basis of commercial loan pricing. Is commercial loan pricing most representative of pricing to reflect risk in the Markowitz sense or do banks ration their loanable funds based on credit risk or expected long-term customer value?[3] Alternatively, does each theory contribute to the explanation of loan pricing?

Some of the pricing theories noted in this study have been tested at the aggregate banking level, however, few studies have been performed at the loan level.[4] Moreover, the author is not aware of any study that tests which theory noted here best describes actual pricing practices for bank loans. In fact, DeVany (1984) and Goldfeld (1984) have noted that models of bank behavior have undergone little direct testing. Goldfeld acknowledges that the sparse empirical work in banking exists because much of the theoretical analysis is at the level of the individual bank where appropriate data are not available. This study overcomes that problem by using the loan portfolio of one of the top 50 bank holding companies in the

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[3]Appendix B reviews the methods banks currently use to price loans. It finds that the least developed area of loan pricing involves pricing relative to the bank's total loan portfolio.

[4]Some empirical tests performed at the loan level are: Berger and Udell (1989) which considers credit rationing, Berger and Udell (1990) which considers collateral and loan quality, and Hester (1962) which looks at a bank's loan offer function in terms of the loan rate of interest, the loan maturity, the amount of the loan, and the likelihood of collateral.

nation as a case study.

An understanding of the theories of commercial loan pricing is enhanced by a familiarity with the environment in which commercial banking exists. Therefore, Chapter II provides some background by explaining that credit markets are characterized by asymmetric information which presents borrowers with an opportunity to exploit lenders.[5] In the loan proposal stage, lenders face the adverse selection problem of assessing the quality of potential borrowers. After a bank grants a loan, asymmetric information gives rise to the moral hazard problem of monitoring and controlling the behavior of borrowers. Yet, as Leland and Pyle (1977) have pointed out, financial intermediaries have arisen in response to asymmetric information. Banks have become information gathering and monitoring experts, which has enabled them to find investment opportunities among assets that otherwise would not be marketable (Murton, 1989).

Chapter III reviews three theories that provide insight into commercial loan pricing: mean-variance analysis and portfolio theory, credit rationing, and customer relationships. Mean-variance analysis and portfolio theory indicate that loans should be priced relative to the risk of the individual loan as well as the loan's contribution of risk to the bank's loan portfolio. In contrast, credit rationing theories propose that banks price loans up to a maximum interest rate. Beyond that rate, banks do not loan funds because

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[5]Readers familiar with the literature that seeks to explain the reason for the existence of the banking industry can skip Chapter II without loss of continuity.

the adverse selection and moral hazard associated with relatively high rates offset the banks' increase in return. This theory, which has been developed along several different lines, indicates that rationing credit based on default risk is rational behavior for profit-maximizing banks (Jaffee, 1971; Jaffee and Modigiliani, 1969) and occurs because of moral hazard (Guttentag and Herring, 1984; Keeton, 1979; Stiglitz and Weiss, 1981).

The final theory considered in this study, the customer-relationship theory (Hodgman, 1961 and 1963; Kane and Malkiel, 1965), suggests that because some customers contribute more to banks' long-term profitability, their loans are priced lower. Moreover, during times of expanding credit demand, customers who are not preferred might be denied loans so that funds will be available for preferred customers. Sharpe (1990), however, argues that information asymmetries cause high-quality long-term borrowers to become "informationally captured," and these customers are charged higher interest rates because of the costs of communicating the quality of their loans to other banks.

Portfolio theory, credit rationing, and customer relationships provide the basis for this investigation of how banks price commercial loans. Portfolio theory indicates that the risk of a particular loan as well as its contribution toward the riskiness of the entire loan portfolio provides the most information about loan pricing. Credit rationing, however, indicates that the contract interest rate an applicant is willing to accept acts as a signal of loan quality and predicts the bank's expected return on the loan. Finally, theories about customer relationships indicate that customer traits such as variability of deposits and length of the relationship play a role in the way banks price loans.

Chapter IV describes the data and research methodology which are used to test the extent that these three theories affect commercial loan pricing. The data used in this study are at the loan level and were obtained from one of the top 50 bank holding companies in the nation. Loan pricing procedures are examined by performing a series of cross sectional generalized least square regressions where the expected return on the loan is the dependent variable in each regression. The non-nested J-test and Cox-tests help determine whether any of the models tested in this study provide significantly greater explanatory power in commercial loan pricing than the competing models.

Chapter V contains a presentation of the empirical findings which should be considered exploratory in nature because of its reliance on data from one bank. Moreover, these results assume that each of the models have been properly specified. With these caveats in mind, the results are consistent with credit rationing and customer relationship theories (Hodgman and Kane and Malkiel). Moreover, the nonested Cox-test indicates that the credit rationing specification used in this study provides greater explanatory power with regard to loan pricing than does the customer relationship view.

The test for portfolio theory provided statistically significant results but with coefficients of the wrong sign. Contrary to theory, the results suggest that the expected return on loans increases as the variance decreases. In addition, the regression results do not provide strong support that loans are priced relative to the risk they contribute to the total portfolio.

In a matter related to loan pricing, this study also found that collateralized loans are associated with a smaller expected return than noncollateralized loans. This finding is consistent with Boot, Thakor, and Udell (1991) who suggest that firms use collateral to obtain more favorable loan terms.

The conclusions and implications of Chapter VI revolve around the illiquid nature of commercial loans which creates an inefficient market characterized by asymmetric information. Within such an environment, the necessary information such as the default probability and recovery rates related to loans are difficult to collect and compile into a meaningful database. Methods to circumvent this problem have begun to appear in the literature and, in fact, the method used to measure the expected return and variance in this study can be used by banks as a starting point to more accurately access the risk of loans. Similarly, the pricing of individual loans relative to the bank's total loan portfolio is beginning to be considered by bankers, but development is in its infancy as well.

In light of the scarcity of information related to potential commercial loans, it is not surprising that customer relationship theories provide some explanation of current pricing practices. Certain aspects of a customer relationship, such as deposits and length of the relationship can provide banks with valuable information about the riskiness of loans. Moreover, relationships that cover several bank services may enable a bank to supplement thin loan margins.

Finally, the support, albeit weak, of credit rationing can also be explained with asymmetric information. Because of adverse selection and moral hazard, there is a point at which further increases in the contract interest rate on a loan will lead to declines in the expected return to the bank. Beyond this point, the profit maximizing bank should ration rather than loan its funds.

The case study nature of this study warrants that care should be exercised in applying these results to the banking industry as a whole. As noted in Chapters V and VI of this study, however, observers in the field of banking have provided anecdotal support for most of the findings presented in this study.

Further research should be undertaken to investigate the manner in which banks price commercial loans. This study relied on bond defaults and assumptions about loan recoveries to determine the return associated with defaults. With some banks now compiling databases of historical defaults on loans, this study can be repeated when more specific information becomes available. Further study should also be devoted to the question of whether banks properly assess the risk of loans. In particular, do bank-imposed risk ratings objectively assess risk, and does loan pricing account for the recovery value of loans in the case of default?

# CHAPTER II
# THE NATURE OF COMMERCIAL LOANS

Although commercial loans are a type of investment made by banks, they differ from investments made in the capital markets. Commercial loans, for example, are relatively illiquid and difficult to price while investments in capital markets are highly liquid and objectively priced in the market by the forces of supply and demand. These differences play a significant role in the way banks price and allocate their loanable funds.

Because this study is concerned with investigating theories that explain loan pricing, this chapter lays the foundation for such an understanding by examining the characteristics of the credit market. This chapter begins by comparing the efficient capital market environment to the credit market environment of information asymmetries. The role of banks in commercial lending grows out of this environment and is also addressed because it sheds light on how banks solve imperfect information problems. Moreover, the role of banks provides insight into the tools and information banks possess that enables them to price loans.

## Asymmetric Information in the Environment of Bank Loans

This section contrasts commercial loan markets characterized by asymmetric information with security markets that possess all relevant information. The problems of adverse selection and moral hazard that develop from asymmetric information are also discussed.

Asymmetric Information vs. Efficient Capital Markets

Security prices in efficient capital markets reflect those prices that would exist if all relevant information were available to investors (Fama, 1970). In general, this statement characterizes security markets where the large volume of buyers and sellers and their access to information ensures that securities are properly priced.

In contrast, bank loans exist in an environment of asymmetric information which makes them difficult to value. Moreover, because no objective market price exists for loans, bankers must use their information gathering skills to price loans relative to risk.[1] Borrowers, however, possess more information about the true expected return and risk of their projects than do lenders.

This condition of asymmetric information gives borrowers an opportunity to exploit lenders. In the loan proposal stage, lenders face the adverse selection problem of assessing the quality of potential borrowers. After a bank grants a loan, asymmetric information gives rise to the moral hazard problem of monitoring and controlling the behavior of borrowers.

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[1]As noted by Murton (1989), the externalities and information costs associated with banking are market failures that prevent the economy from achieving the "first-best" allocation of resources associated with perfect markets.

Adverse Selection

When a prospective borrower initially applies for a loan, the bank requests information about the firm's current and expected financial condition. Unsuccessful firms possess an incentive to be dishonest because if they withhold or falsify information about their past performance or the level of risk related to the project for which they wish to borrow funds, they might increase their probability of acquiring a loan at a more favorable rate. Given this incentive and credibility problem, banks run the risk of adverse selection: granting loans to borrowers who are poor risks.

Because of the adverse selection problem, in which banks are unable to properly identify an applicant's true risk, some lenders might price all applicants as if they possessed average risk (pooling equilibrium).[2] In this case, potential borrowers who are not fully rewarded for their low risk might withdraw from the market. This results in a social welfare loss if firms abandon projects that would have been profitable (Myers and Majluf, 1984). It is also possible that potential borrowers with relatively low risk projects would seek out informationally efficient intermediaries from which to borrow rather than deal with uninformed lenders offering the value of average risk (Leland and Pyle, 1977).[3]

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[2]For a further explanation of the problem of perceiving all as "average," see Akerlof (1970).

[3]It is often said that banks charge their best customers an interest loan rate that is too high and their worst customers a rate that is too low. In fact, adverse selection predicts that this condition will drive away the best customers--a situation that is perhaps reflected in the sharp growth of corporate use of commercial paper that began in the 1980s.

Moral Hazard

After a loan is granted, banks are faced with the moral hazard problem of monitoring and controlling excessive risk taking on the part of the borrower because the interests of the borrower may differ from that of the bank. This possible conflict of interests between lenders and borrowers is depicted in Figure 2.1--an illustration similar to that of Guttentag and Herring (1984). As shown in the figure, the bank's minimum rate of return is determined by the borrower's collateral (K) divided by the loan amount (L).[4] The bank's maximum return is equivalent to full payment of the loan contract (Z) at the end of the contract period. Thus, if the borrower's investment yields zero return, the bank collects only the collateral, and its yield on the loan is K/L (ignoring collection costs). The highest return the bank can earn is the promised return which occurs when the borrower's investment return is (Z-K)/L or higher. By contrast, the borrower's return is -K/L if the investment does not yield enough to pay the promised amount. However, as the gross return on the investment, $R_g$, increases beyond (Z-K)/L, the

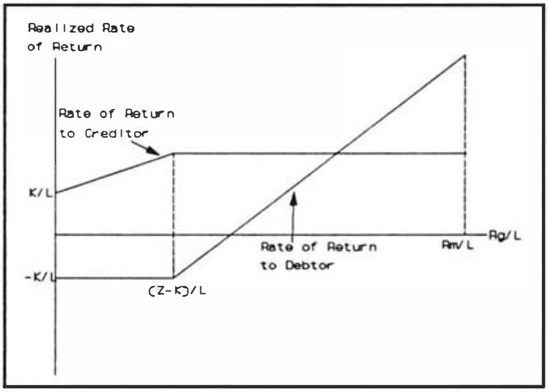

Figure 2.1: Moral Hazard and Bank Lending

[4]A glossary of symbols can be found in Appendix A.

rate of return to the borrower rises and is maximized at $R_m/L$.

The riskiness of the loan affects the borrower and lender differently. For example, the interests of the bank and the borrower may conflict if the borrower prefers investments that are associated with the possibility of relatively high returns and high risk. As shown in Figure 2.1, the borrower accrues all returns in excess of the loan repayment, but the borrower's loss is the same no matter how far below the default point the investment returns fall. The bank, on the other hand, is indifferent to the amount of profits the investor earns above the default point, but is interested in the extent of loss if the investment return is less than the default rate.

The possibility of moral hazard is likely to be higher in a firm whose business is failing. Such a firm has an incentive to take on higher risk projects because of the hope that the commensurately higher expected payoff will provide the added revenue needed for the firm to survive. If the firm's risk-taking is successful, the firm will survive and its loan will be paid in full; but if it is not successful, the firm will go bankrupt and the bank loan will go into default.

Because of moral hazard, loan contracts generally contain restrictions and protective covenants in an attempt to ensure full loan repayment. Moreover, banks monitor loans by occasionally requesting financial information from borrowers and by reconsidering a firm's financial status.[5]

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[5]These surveillance and monitoring activities of banks are called agency costs where banks are acting as an agent for their depositors' funds.

## The Role of Banks in Commercial Lending

A market characterized by information asymmetries complicates the loan pricing process because of the difficulties inherent in determining risk with limited information. The role banks fill in commercial lending, however, emerges from the need to overcome the problem of asymmetric information in the credit market.[6] Campbell and Kracaw (1980) suggest that "...in a perfect market environment, intermediaries could perform no unique financial service that investors would be unable to reproduce as easily."[7] However, under information asymmetries, some profitable investment opportunities are essentially nonmarketable but the information gathering and monitoring expertise of banks enables them to find productive investment opportunities among nonmarketable assets (Murton, 1989).

Most theories of commercial lending emphasize the abilities of banks to evaluate and monitor loans.[8] These theories can be further divided into

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[6]See, for example, Boyd and Prescott (1986), Campbell and Kracaw (1980), Chan (1983), Diamond (1984), Fama (1985), Kane and Malkiel (1965), Leland and Pyle (1977), and Seward (1990).

[7]As an alternative hypothesis to the proposal that financial intermediaries exist to resolve information asymmetries, Campbell and Kracaw (1980) suggest that financial intermediaries are portfolio managers who would earn a competitive management fee in an unregulated market. Under this alternative hypothesis, the U.S. banking system is a product of the regulatory environment. Therefore, problems surrounding information asymmetries are not critical in explaining financial intermediaries.

[8]In a review of banking models, Santomero (1984) found that explanations for the existence of financial institutions are approached from three points of view: 1) their role as asset transformers through diversification potential and asset evaluation, 2) the nature of the liabilities they issue and their central function in a monetary economy, and 3) their two-sided nature (assets and liabilities). Because this paper is concerned with the asset side of banking, only theories explaining commercial lending are reviewed.

two categories: theories that explain the role of commercial banks as either efficient or confidential evaluators and monitors of commercial loans. Both of these explanations involve resolving information asymmetries.

Efficiently Evaluating and Monitoring Commercial Loans

Banks can efficiently evaluate and monitor loans because they can diversify and access information that is not available to other capital market participants.[9] These two concepts are treated in turn.

Diamond (1984) developed a model in which diversification in the loan portfolio is key to a bank's net cost advantage relative to direct lending and borrowing. The model involves an ex-post information asymmetry between potential lenders and a risk-neutral entrepreneur who desires to raise capital for a risky project. Although the debt contract with which the entrepreneur raises funds involves costs, it is possible for lenders contracting directly with the entrepreneur to assume these costs by spending resources monitoring the results of the investment that the entrepreneur observes.

If many lenders exits, the cost of monitoring may be large or a free rider problem may exist where no security holder monitors because his or her share of the benefit is too small. The free-rider problem is solved when a bank monitors on behalf of those who provide the funds (depositors). When participants are risk neutral, Diamond shows that diversification increases the probability that the bank possesses sufficient loan proceeds to

[9]Chan (1983) has shown that financial intermediaries' role as informed agents leads investors to a higher welfare state.

repay a fixed debt claim to depositors. When a bank's number of loans approaches infinity, the probability that the bank possesses sufficient loan proceeds goes to one and the possibility of incurring necessary bankruptcy costs goes to zero. Thus, banks efficiently monitor loans because of their ability to diversify.

The second way banks efficiently evaluate and monitor loans when asymmetric information exists is through their access to information not available to others. According to Lummer and McConnell (1989), banks gain access to this information by one of two methods: investment in information-gathering technology or access to private information through customer relationships.

Information-gathering technology in which banks invest include such items as computers and software packages, data bases, and human capital. Two widely used data sources that aid banks in their identification of risk and price are Robert Morris Associates (financial ratio summaries for more than 95,000 financial statements) and Loan Pricing Corporation (pricing matrix created from over 6,000 commercial loans). Some banks also maintain extensive databases of their own customer's loan characteristics which loan officers can access to aid in their analysis. In addition, Altman (1985) notes that many large banks run extensive simulations of repayment and other measures of firm performance under alternative interest rates, general economic, inflation, and key variable assumptions in their financial analysis of potential borrowers.

Although current theory does not incorporate much about the information technology banks use, the literature has focused on the ability of banks to access private information through customer relationships. Theories generally suggest that banks gather information through a customer's deposit or loan patterns, and the private information they possess about their customers increases over time. In each of these theories, it is apparent that the marginal costs of monitoring are lower for banks than for other financial intermediaries because of the structure of the customer relationship.

In their seminal article on the information advantages gained through customer relationships, Kane and Malkiel (1965) argue that when a bank and customer develop a relationship through loans or deposits, the bank is able to discern the quality of the customer.[10] Moreover, the customer quality becomes apparent to the bank because the bank's ability to forecast the firm's future behavior is largely a function of the length of the relationship.

Black (1975) and Fama (1985) emphasize only the deposit relationship between a bank and its customers to explain why banks monitor loans at a lower cost than that of other financial intermediaries. According to this scenario, the historical relationship of a borrower as a depositor provides the

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[10]Hodgman (1961b) is credited with first noting the importance of the bank-customer relationship. In particular, he asserted that "Anyone who troubles to inquire of commercial bankers will discover that the deposit relationship of a loan customer is a primary consideration in determining the cost and availability of bank credit to that customer."

bank with information that allows it to identify the risks of granting a loan to a particular firm and enables the bank to monitor the loan at lower costs than other lenders.[11] Fama provides two facts to support this contention: banks usually require borrowers to maintain deposits at its bank,[12] and banks are the dominant suppliers of short-term inside debt.

More recently, Sharpe (1990) developed a dynamic theory of "customer relationships" in bank loan markets in which long-term bank-borrower relationships arise endogenously because of the asymmetric evolution of information. According to this model, all banks begin with the same amount of information when a new firm seeks a loan because no one has information about the expected quality of the firm. The bank that loans money to the firm, however, learns more about that firm's characteristics than do other banks through the monitoring process. Consequently, as time goes by, the bank that loans money to a particular firm is in an increasingly better position than "outside" banks to evaluate the firm's future performance.

Confidentially Evaluating and Monitoring Loans

In addition to efficiently evaluating and monitoring loans, banks

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[11]Sanford Rose, an observer of the banking industry, wrote in the June 22, 1992 issue of the *American Banker* that small commercial borrowers transact between 50 and 300 credits and debits monthly, which enables a lending officer to easily understand the patterns of their commercial activity. He notes that checking account surveillance is much more difficult for large borrowers, particularly if they operate in several different regions or employ more than one bank.

[12]This requirement has been relaxed over the years, particularly for a bank's largest customers.

provide an additional service through the confidential manner in which they treat the information they gather. Confidentiality is important for two reasons: some borrowers desire to withhold information from their competitors and some want banks to "signal" their firm's worth through the loan approval process.

When firms acquire funds through public debt, they are required to provide information that some firms prefer to keep confidential.[13] Campbell (1979) posits that managers can preserve the monopoly profits for the current owners of their firm by using a financing source that will monitor its activities and yet keep the information confidential--banks fill this role.

On the other hand, some firms may use banks as a funding source because banks signal to other capital market participants that the firm's project is of high value. This value, which is directly related to the asymmetric information problem, is explained in a theory developed by Leland and Pyle (1977). They reason that when firms try to sell information about their project directly to investors, concerns arise about the credibility of the information and adverse selection. Because it is difficult or impossible for some observers to determine whether the information is accurate, the price of the information will reflect its average quality and thus market

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[13]Some small firms, however, may be prohibited from obtaining debt in the capital markets because it is costly to provide the information required. Consequently, small firms might use banks to borrow funds because the bank pays the cost of information gathering. In fact, Blackwell and Kidwell (1988) found that minimizing overall costs is the motive behind some firms decision to use private markets rather than issue public securities.

inefficiency will result--investments will not be priced properly and resources might not be allocated properly.

The problems related to the transfer of information can be overcome by banks that gather information and buy and hold assets on the basis of their specialized information. Banks signal high value projects when they loan funds for a project because they back their opinions with investments of their own funds.[14]

Essentially, the intermediary causes a sorting of classes of risk. The entrepreneurs with projects that possess favorable risk characteristics wish to be identified so they deal with an "informationally-efficient" intermediary rather than with uninformed investors who would offer a price equivalent to the average level of risk. According to Leland and Pyle, the best risks are "peeled off," and thus the average risk becomes less valuable and induces the owners of the next best risks to deal with the intermediaries. This process continues until sellers of all types of risk sell to the intermediary except perhaps those firms with the worst projects.[15]

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[14]Campbell and Kracaw (1980) take this explanation a step further and demonstrate that initial wealth endowments resolve the moral hazard problem because they function as a guarantee of the reliability of the information when they possess a stake in the market large enough to override any incentive to misrepresent the information. This result leads to the conclusion that initial wealth endowments act as a barrier to entry in the market for information and as a general constraint on reliability.

[15]Leland and Pyle also propose that an entrepreneur's willingness to invest in his/her project serves as a signal of the project's quality. They posit that the value of the firm increases as the proportion of the firm owned by the entrepreneur increases. The logic behind this assertion is clear: if an entrepreneur believes a project is associated with a high probability of success, then the entrepreneur will desire to own as much of the project as possible in order to accrue
(continued...)

Fama (1985) reaches a similar conclusion when he considers what is special about bank loans that causes borrowers to pay higher interest rates than those on other securities of similar risk.[16] He suggests that the comparative advantage of banks as lenders (over other financial intermediaries) involves their ability to minimize information costs because of the positive signal they send when they renew a firm's short-term loans.[17] The loan renewal process triggers a periodic evaluation of the borrower's ability to repay its low-priority fixed payoff contract with the bank.[18] By renewing a firm's loan, banks send a positive signal to other agents with higher-priority fixed payoff claims who now do not have to duplicate the

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[15](...continued)
most of the profits. This explanation may be important to bankers as they seek to identify the quality of an entrepreneur's projects.

[16]In Fama's model of banking, he considers only loans on the asset side and demand deposits and certificates of deposit (CDs) on the liability side of the bank's balance sheet. Demand deposits are associated with a reserve requirement. According to the literature, the reserve tax is borne by depositors who accept a lower interest rate because of the special transaction services that they receive from the bank (such as redeemability for cash and checking accounts). Cds also carry a reserve requirement but provide no apparent transactions or liquidity services relative to commercial paper and bankers' acceptances--two securities whose yield and risk is similar to that of CDs. In addition, the yield on CDs and bankers' acceptances of the same maturity are almost identical and the difference between average yields on CDs and commercial paper are trivial. Thus, Fama argues, that since CDs must pay competitive interest rates, the reserve tax on the CDs is borne by bank borrowers. Hence, there must be something special about bank loans that makes some borrowers willing to pay higher interest rates than those on the other securities of equivalent risk.

[17]Fama also suggests that firms use banks to obtain funds instead of publicly traded debt because of contract costs--it is cheaper to give one agent (the bank) access to information within the firm than to produce the information associated with outside-debt financing.

[18]Banks generally are last or close to last in the line of priority among an organization's contracts that promise fixed payoffs.

cost of obtaining information about the firm.[19] Bank signals are credible, according to Fama, because the bank backs its opinions with resources (in terms of a loan) or by declining resources (if bad loans are made).

## Summary

Due to information asymmetries, banks have developed an expertise in efficiently gathering and monitoring information. This access to information enables banks to find profitable investment projects that would otherwise be unmarketable. Moreover, the confidential manner in which banks handle this information and the signal they transmit by granting a loan, provides an additional value to some borrowers who could obtain investment funds through alternative and perhaps less costly sources (see Figure 2.2).

The information that banks obtain about loan applicants enables them to resolve information asymmetries and price loans. The unanswered question, however, is how banks determine loan prices and whether those prices are related to risk or some other characteristic of the loan. The next chapter presents three theories that provide greater insight into how banks might price commercial loans.

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[19]James (1987) provides empirical support consistent with the uniqueness of banks and information-effect hypotheses. Specifically, James found that a statistically significant positive abnormal return accrues to stockholders of firms when they publicly announce bank credit agreements. Also, the announcement of publicly placed straight debt issues were associated with negative stock evaluations as suggested by the information-effect hypothesis (see, for example, Leland and Pyle, 1977). Lummer and McConnell (1989) and Best and Zhang (1992) have also found empirical support that the bank lending process transmits information to the securities market about the quality of the borrower.

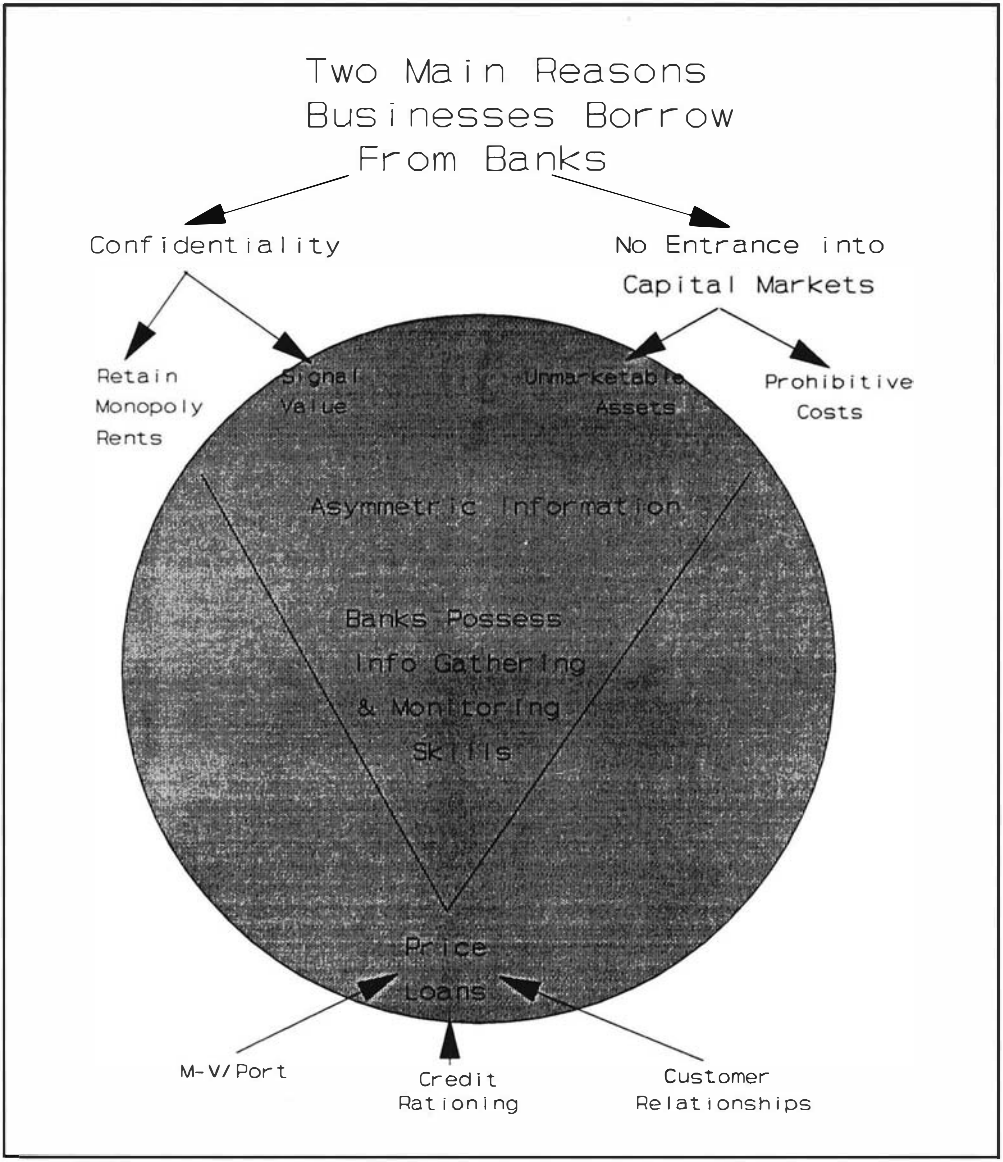


Figure 2.2: A Conceptual View of the Market for Commercial Loans

# CHAPTER III
# THEORIES ADDRESSING COMMERCIAL LOAN PRICING

The purpose of this chapter is to use the following three theories to explain the factors that might influence the way banks price commercial loans: 1) mean-variance analysis and portfolio theory, 2) credit rationing by default risk, and 3) customer relationships. Although these theories were not developed for the purpose of explaining loan pricing, each implies a theoretical basis with which to test loan pricing practices. These theories overlap in some respects, but each implies a unique view of loan pricing.

Mean-variance analysis and portfolio theory, which are reviewed first, indicate that loans should be priced relative to the risk of the individual loan as well as the loan's contribution to the variability of the bank's entire loan portfolio. Rather than increase the contract interest rate on a loan to control for risk, however, the theory of credit rationing indicates that some loans are denied because, beyond a particular interest rate, the additional risk of a loan outweighs the possible increase in revenues from the higher interest rate.

Finally, customer-relationship theories suggest two divergent views of pricing. The earliest customer relationships theories propose that loans should be priced by the long-term profits that the customer is expected to contribute to the bank. Consequently, loan pricing takes into account the return expected from such factors as the volume and variability of a customer's deposit. One view holds that longer customer relationships are equated with lower priced loans. An opposing theory argues that long-standing customers are priced relatively higher than others because these customers are "informationally captured"--unable to convince other lenders of their superior repayment record.

## Mean-Variance and Portfolio Theory in Loan Pricing

Financial theory indicates that assets are priced relative to risk, and portfolios are diversified such that the expected return is maximized for a particular variance or the variance is minimized for a particular expected return. In terms of loan pricing, this theory indicates that loans should be priced relative to their individual risk as well as their contribution toward the total variability of the loan portfolio.

### Mean-Variance Analysis

Mean-variance analysis indicates that the return and risk of an asset is represented by the mean and variance of its expected return (Markowitz, 1952).[1] The mean measures the most likely outcome of a set of events

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[1]The mean and variance alone can be used to represent an asset only when the expected returns of the asset are normally distributed or if the investor possesses a quadratic utility function which describes risk-averse behavior. Nevertheless, the distribution of expected returns to the bank on a loan contract is skewed rather than normal because returns are limited by the amount of the loan contract. Some empirical evidence exists, however, that banks possess quadratic utility functions with regard to the rate of return on assets. Also, other utility functions are locally approximated by quadratic utility. (For a further explanation of the relevance of quadratic utility in mean-variance analysis see Elton and Gruber, 1987.) In

(continued...)

and, in the case of loans, is defined as

$$(3.1)\qquad E(\tilde{R})=\sum_{i=1}^{N} d_i R_i$$

where $d_i$ is the probability of a random event, $R_i$, and N is the number of possible events.[2] Risk is defined as the variance of possible outcomes. Mathematically, the variance (VAR) is defined as the expectation of the squared difference from the mean:

$$(3.2)\qquad VAR=E[(R_i-E(\tilde{R}))^2].$$

Banks do not use equation (3.2) to measure a loan's risk because of the difficulties in measuring expected return. Instead, banks use their information gathering skills to determine the loan's risk rating (a measure that reflects default risk or the probability that a lender will not repay the loan) which is used to determine the contract interest rate.

The literature that considers loan pricing in terms of default risk suggests that the relationship between default risk and price is similar to that between the loan's expected return and the variance of the expected return. Flannery (1985) and Sinkey (1989) represent the relationship between default and the loan contract interest rate by first abstracting from

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[1](...continued)
addition, Hester and Pierce (1975) note that banks are likely to be risk averse, either because their objective functions are convex in discounted future net income or because influential depositors and/or regulators encourage them to act as risk averters.

[2]A glossary of symbols can be found in Appendix A.

resource costs such as overhead. The loan contract rate, $i^*$, required compensate the lender for the time value of money as reflected in the nominal rate of interest, i, and the probability of default, d. This relationship can be expressed as:[3]

$$(3.3) \qquad i^* = \frac{(1+i)}{(1-d)} - 1$$

As shown in Figure 3.1, this relationship is consistent with mean-variance analysis: loans that are perceived to carry higher risk are priced relatively higher than low risk loans. Moreover, the relationship is linear in the relevant range.[4]

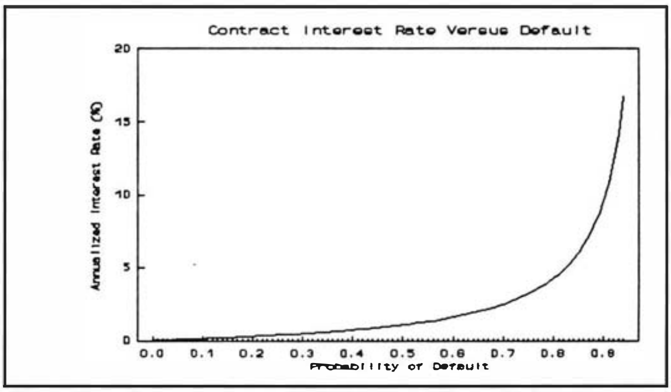

Figure 3.1: Contract Interest Rate vs. Default Risk

Portfolio Theory

In addition to pricing individual loans, portfolio theory (Markowitz, 1952; Tobin, 1958) suggests that investors choose their total loan portfolio to maximize expected return for a given variance or to

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[3]Jaffee and Modigliani (1969) show that this relationship is the first-order optimization of a bank's loan offer curve.

[4]Historical data indicate that the spread between the loan rate and opportunity rate at which banks can obtain funds or invest funds is typically small. The implication is that banks will generally assume modest default risk because their interest rate spread restricts them to a small margin of error. If the cost of funds equals 5 percent, for example, and a bank prices a loan 50 basis points above cost, the price is implicitly assuming that risk is 0.0048 percent probability of default.

minimize the variance for a given expected return--an efficient portfolio.[5]

The expected return for a portfolio of assets is simply the weighted average of the expected returns for the individual loans in the portfolio. Calculating the variance of the portfolio's returns is not as straightforward. It is the squared weighted average of the individual variances plus two times the weighted covariances between all the loans in the portfolio:

$$(3.4) \qquad VAR_p = \sum_{i=1}^{N} x_i^2 VAR_i + 2\sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j COV_{ij}.$$

where $VAR_p$ is the variance of the loan portfolio, $VAR_i^2$ is the variance of loan i, $COV_{ij}$ is the covariance between the returns on loans i and j, and x is the fraction of the portfolio represented by the loan. The formula for the portfolio variance shows that, in addition to the variance of individual loans, the covariances between pairs of individual loans is incorporated in the variance of the total loan portfolio. The variance of a portfolio with a large number of loans can be stated as the summation of its weighted covariances:

$$(3.5) \qquad VAR_p = 2\sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j COV_{ij}$$

Thus, the contribution of a loan's riskiness to the total portfolio is determined by its average covariance with all the other assets in the portfolio rather than simply the individual loan's variance.

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[5]Hart and Jaffee (1974) have shown that the separation theorem holds for depository financial intermediaries. They also found that the efficient frontier space is linear.

In general, portfolio theory indicates that if a bank holds many different types of loans in its portfolio, it can achieve a lower variability of actual loan losses for the same rate of return. In other words, maximization of return at a certain risk level implies a diversified portfolio.[6] The lower the correlation of return between loans, the lower will be the risk of the entire portfolio. Thus, portfolio theory implies that banks are not only concerned with the risk of a single loan, but with the loan's contribution to the variation of the total loan portfolio. Consequently, loans should also be priced relative to the bank's loan portfolio.[7]

Summary

Mean-variance analysis and portfolio theory imply that commercial loans should be priced relative to their individual risk as well as their contribution to the variation in the bank's total loan portfolio. According to this theory, price serves as the rationing mechanism. That is, when the demand for loans exceeds supply, banks ration some potential customers out of the market by raising the contract interest rate.

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[6]McManus (1992) provides empirical evidence that diversification can be a powerful force in reducing the riskiness of bank loan portfolios.

[7]Applications of portfolio theory to bank loan portfolios have been limited because of the difficulty in computing the expected return and variance on loans. Appendix B considers in more detail the unique methods that several authors have proposed to apply portfolio theory in banking. In general, these articles propose that banks measure risk concentrations within their portfolio so that the pricing of new loans can account for the impact of the new loan on the variability of the portfolio's total return.

## Credit Rationing by Default Risk

Instead of pricing loans strictly based on risk, credit rationing theories posit that banks control risk by denying credit to the riskiest borrowers. In other words, banks price loans up to a maximum interest rate, which is associated with a particular level of default risk, and beyond that rate banks do not loan funds regardless of the interest rate offered by the potential borrower.[8] Credit is rationed with asymmetric information because adverse selection and moral hazard increase the possibility that higher contract interest rates will be associated with losses that outweigh the expected return from the increase in interest rates. Therefore, credit rationing theories imply a nonmonotonic relationship between the expected return on the loan and the contract interest rate.

### Early Theories of Credit Rationing

The earliest theories of credit rationing grew out of the availability doctrine[9] which sought to explain the efficacy of monetary policy by

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[8]More precisely, credit rationing has been defined as an excess demand for commercial loans at the loan rate quoted by the banks (Jaffee and Modigliani, 1969) because quoted loan rates are below the Walrasian market-clearing level (Jaffee and Stiglitz, 1990).

[9]The availability doctrine became prominent at the end of World War II when empirical evidence suggested that the accepted theory of monetary policy would not enable the Federal Reserve Board to effectively carry out its policies. At the time, it was believed that for monetary policy to be effective, real expenditure decisions needed to be interest elastic, and the central bank needed the ability to force changes in relevant interest rates. Empirical studies, however, found little interest elasticity, and the Treasury restrained the Federal Reserve's ability to influence interest rates on government debt. Consequently, the availability doctrine developed as an alternative for the efficacy of monetary policy. Proponents of the doctrine argue that monetary policy is effective because financial institutions reduce the availability of funds rather than through changes in the cost of funds, which was thought to be the mechanism of change in the then prevalent view of monetary policy (Scott, 1957).

reductions banks made in the availability of their loanable funds. The first models of credit rationing use various credit market imperfections to show that it is rational for profit-maximizing banks to deny some requests for credit rather than to raise interest rates when the demand for loans exceeds supply (Freimer and Gordon, 1965; Hodgman, 1960; Jaffee, 1971; and Jaffee and Modigliani, 1969; Miller, 1962). Hodgman and Jaffee and Modigliani are summarized here because they were the two most influential of the early credit rationing models.

Hodgman's (1960) model suggests that rational profit-maximizing banks use the riskiness of customer loans as the criterion to ration credit.[10] He defines loan risk as the ratio of the expected value of the payoff from a loan to the expected value of loss (payments below the agreed upon contract). Furthermore, Hodgman assumes that banks require a loan risk ratio above the equilibrium ratio that exists in a perfectly competitive market; and he demonstrates that as the size of the loan increases, the risk ratio can be kept above the equilibrium figure by increasing the interest rate. Beyond a certain loan size, however, increasing the interest rate will not prevent a decrease in the risk ratio (at this point the supply curve becomes backward bending). Thus, the bank will not grant a loan, but will ration credit to a prospective borrower who wishes to borrow an amount larger than this

[10]One year later, however, in response to a critique of his 1960 article, Hodgman (1961a) said he now thought bank credit rationing was not caused by risk considerations but by the effort of bankers to maximize long-term profits through favored loan treatment of profitable depositors-borrowers.

maximum, regardless of the interest rate the borrower offers.

Jaffee and Modigliani (1969) show that the principle of increasing default risk with increasing loan size and the narrow spread of loan rates over cost (caused by ceiling interest rates) creates a situation where it is rational for profit-maximizing banks to ration credit. They base the reason for credit rationing on the fact that banks classify borrowers into a small number of groups.[11] Within each class, the bank charges a uniform rate even though the firms within a group may be diverse with respect to risk and the amount of their loan demand. The group loan rate is selected to maximize bank profits over the entire group. Some firms, however, are rationed because they possess above-average demand or above-average risk. Consequently, rationing may occur in every risk class.

Early models of credit rationing show that it is rational for profit-maximizing banks to ration credit rather than to increase contract interest rates when demand exceeds supply.[12] In terms of loan pricing, these

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[11]These groups are based on objective factors such as type of industry, asset size, and standard financial measures. Jaffee and Modigliani conclude that bankers can best exploit their market power by classifying customers into a small number of classes because of the ceiling price caused by considerations of good will, social mores, and legal restrictions. The incentive to adopt a segmented classification exists because banks desire to maintain rates as close as possible to the collusive optimum, but cannot openly collude. The use of a small number of risk classes, based on readily verifiable objective criteria, appears to be an efficient way to optimally price loans without competitively underbidding other banks. This classification structure is also facilitated by tying rates to a prime rate that is set through price leadership.

[12]Empirical tests which support the view of credit rationing on an aggregate banking level include Fair and Jaffee (1970), Jaffee (1968), Jaffee and Modigliani (1969), and Silber and Polakoff (1970). This research generally focuses on the speed with which commercial loan rates adjust to changes in open market rates. A finding of "sticky" rates supports credit rationing because it implies that the credit markets do not respond to demand by changing
(continued...)

models predict that banks will price loans relative to risk but will choose a cut-off contract interest rate that is associated with maximizing their profits. However, the early models did not explain the underlying cause of credit rationing.

Credit Rationing Based on Imperfect Information

The most recent theories of credit rationing use imperfect information to explain why rational profit-maximizing banks ration credit.[13] This section reviews the credit rationing model developed by Stiglitz and Weiss (1981) and further explained by Jaffee and Stiglitz (1990) because it provides insight into loan pricing by explaining why the relationship between the loan's expected return and contract interest rate is parabolic. In particular, their model implies that beyond a certain point, interest rates do not compensate sufficiently for risk because the negative adverse selection and incentive effects that accompany relatively high rates may outweigh the increase in return from those higher rates as shown in Figure 3.2.[14] Thus,

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[12](...continued)
price. Slovin and Sushka (1983), however, find that commercial loan rates are not sticky during the period 1953 to 1980. Also, Berger and Udell (1989) provide empirical evidence that credit rationing is not an important macroeconomic phenomenon in a test based on over 1,000,000 commercial loans.

[13]Akerlof (1970) and Rothschild and Stiglitz (1971) first suggested that imperfect information played a role in loan markets while Jaffee and Russell (1976) were first to apply the concept in a model of credit rationing.

[14]Similarly, Guttentag and Herring (1984) propose an asymmetric information model, but they include the borrower's capital position, default risk, and a probability that nature will draw from a disastrous distribution. Their model indicates that lenders maximize expected return when the expected value of the increase in the contract rate when the borrower does not default equals the expected loss caused by the induced increase in the probability of default.

equilibrium in the credit market may be characterized by credit rationing or excess demand.

To show that credit rationing can exist and that the relationship between the bank's expected return and contract interest rate is parabolic, it must be shown that the expected return a bank receives does not increase monotonically with the interest rate charged. Nonmonotonicity can be shown by either adverse selection effects or adverse incentive effects. These two concepts are explained in turn.

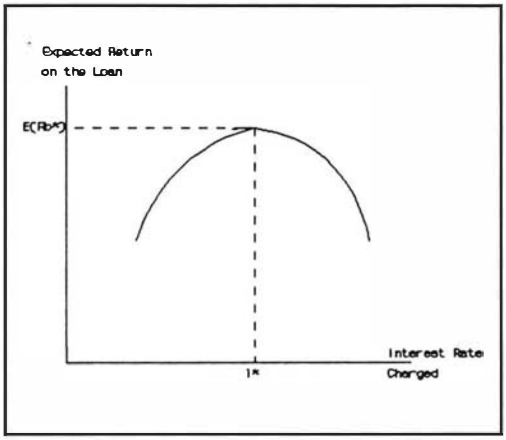


Figure 3.2: Relationship Between Expected Return and Risk.

As noted in the previous chapter, adverse selection occurs because low-risk borrowers may drop out of the market as rates rise and because banks are unable to identify with certainty those borrowers who will repay their loan in full. Stiglitz and Weiss argue that interest rates may act as a screening device[15] in this environment because individuals willing to pay relatively high interest rates may, on average, be worse risks: they are willing to pay high rates because they do not anticipate repaying the loan.

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[15]Guttentag and Herring (1984), Milde and Riley (1988), and Schreft and Villamil (1992) also argue that contract interest rates on loans act as a signalling device of the borrower's characteristics when lenders possess imperfect information.

An example illustrates how the mix of loan applicants changes adversely when interest rates increase. In this example, the bank identifies a group of projects and for each project, $\theta$, there exists a distribution of gross returns, $R_g$.[16] (Appendix A contains a glossary of symbols.) Moreover, assuming that the bank can distinguish projects with different mean returns but cannot identify the riskiness of a project, the $F(R_g,\theta)$ is the bank's subjective perception of the project's distribution of returns and $f(R_g,\theta)$ is the associated density function. This example also assumes that increases in $\theta$ correspond to greater risk. Finally, L is the amount a firm borrows at contract interest rate $i^*$, and the firm defaults if the return plus collateral, K, is insufficient to repay its loan: $K + R_g \leq L(1 + i^*)$.

The net return to the borrower is $\pi(R_g,i^*) = \max(R_g-(1+i^*)L; -K)$, and it indicates that at worst the project fails and the firm must pay the bank the agreed upon collateral.

Moreover, borrowers with riskier returns possess a higher expected profit. Thus, firm profits are a convex function of the return on the project (See Figure 3.3).

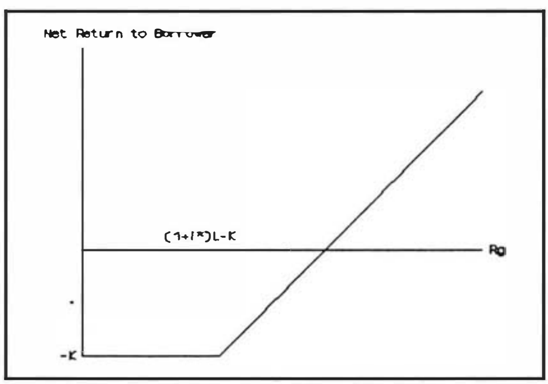

Figure 3.3: Net Return to Borrower

[16]Stiglitz and Weiss assume that both borrowers and lenders seek to maximize profits. Also, banks exist within a competitive environment, but a "price-taking" equilibrium does not exist such that supply equals demand.

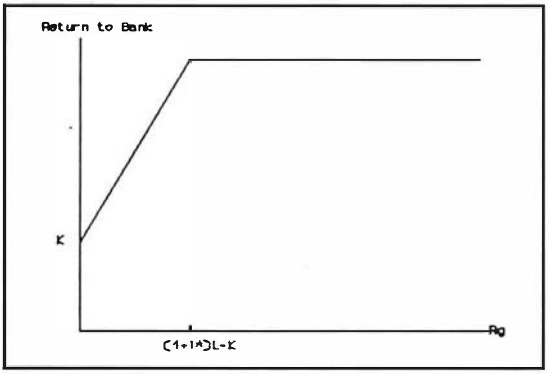

Figure 3.4: Return on Loans to Banks

The return to the bank is written as $\rho(R_g,i^*) = \min(R_g+K; L(1+i^*))$ which indicates that the bank will collect either the maximum that the borrower can repay if the project fails or the agreed upon interest and principal if the project is successful. As shown in Figure 3.4, the return to the bank is a concave function of the return on the project. Thus, expected return decreases as risk increases because the probability of default increases.

Given the convex nature of the return of the project to firm profits, a critical value (risk) $\hat{\theta}$ exists for a given interest rate $i^*$ such that a firm will borrow if and only if $\theta > \hat{\theta}$. As interest rates rise, the critical value of $\hat{\theta}$ increases, which means that investors with less risky projects are unable to make a profit. Thus, they drop out of the market and the mix of applicants worsens. At the same time, the concavity of the bank's return indicates that the expected returns to the bank are smaller with higher loans. Therefore, although an increase in the interest rate increases the bank's return, an adverse-selection effect may be acting in the opposite direction.

Another example clarifies the possibility that the adverse effect outweighs the direct effect of an increase in interest rates. Assume only two groups of borrowers exist: a safe group that borrows only when the interest rate is below i-1 and a risky group that borrows only when the interest rate is below i-2 where i-1 < i-2. When interest rates are slightly above i-1, the mix of applicants changes dramatically as shown in Figure 3.5 because all of the low-risk applicants withdraw.

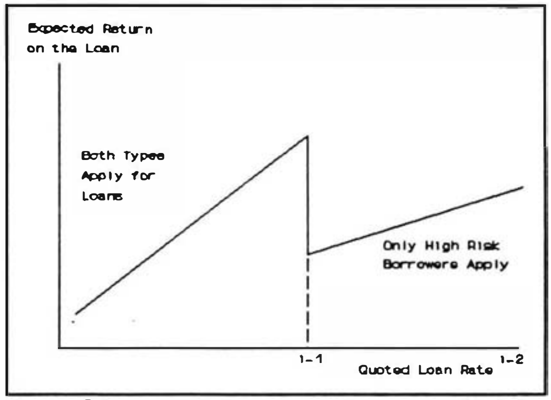

Figure 3.5: Mix of Applicants Worsens with High Rates

The second way changes in interest rates might adversely affect bank profits is through their impact on the borrower's behavior or moral hazard. Raising the interest rate associated with a project obviously decreases the returns on that project to the investor. However, higher interest rates may also induce firms to take on projects with lower probabilities of success but higher payoffs when successful.

To show that interest rates act as an incentive mechanism, it is assumed that firms may choose alternative projects. The two projects considered here are denoted by superscripts "j" and "k." First, Stiglitz and Weiss establish that if, at a given contract interest rate $i^{**}$, a risk-neutral firm is indifferent between two projects, an increase in the interest rate causes the firm to prefer the project with the higher probability of bankruptcy. The increase in $i^*$ lowers the expected return to the borrower from the relatively safe project more than it lowers the expected return from the project that carries a higher risk. This is shown in Figure 3.6 where the borrower chooses risky project j when $i^*$ increases beyond $i^{**}$. As a result, raising the interest rate above $i^{**}$ might increase the riskiness of loans enough to lower the expected return to the bank.

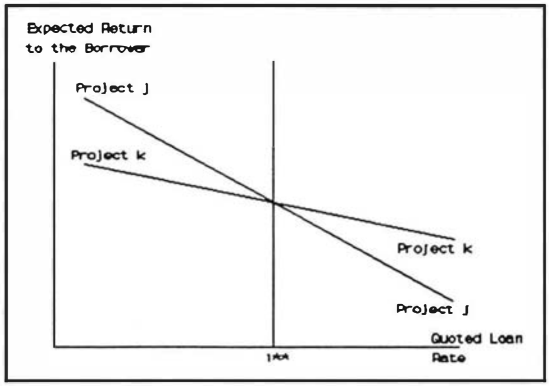

Figure 3.6: Rates as an Incentive Mechanism

In summary, credit rationing predicts that loans will be priced such that the expected return on the loan reaches a maximum at a particular rate and beyond that rate declines relative to the contract interest rate. Consequently, $i^*$ serves as a signal of loan quality.

Collateral and Credit Rationing

Collateral requirements provide another mechanism for banks to price loans. Stiglitz and Weiss (1981) propose that increasing collateral requirements or the fraction of the project financed by equity is not a good means of allocating credit when an excess demand for funds exists and when the contract interest rate is fixed. Under these circumstances, increasing collateral requirements beyond some point may also decrease the bank's returns by either decreasing the average degree of risk aversion of the pool of borrowers or encouraging borrowers to undertake riskier projects.[17]

In contrast, some argue that credit rationing is avoided when a bank can set collateral requirements and interest rates simultaneously.[18] Barro (1976), for example, argues that collateral functions as an incentive for borrowers to repay their loans; and in the case of default, provides some return to the bank. As such, he argues that the unwillingness of banks to lend in the Jaffee and Modigliani-type theories do not reflect credit rationing but reflects (p. 448) "...the upward slope of the loan supply curve graphed versus the appropriate price that includes a consideration of collateral." Jaffee and Stiglitz (1990), however, argue that the collection of collateral may reduce but generally does not eliminate the risk of default because collateral may be uncertain and transactions costs may be associated with its liquidation.

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[17]This conclusion is contrary to that of Leland and Pyle (1977) who argue that an investor's proportion of equity in a project provides a positive signal of its expected success. However, in a study written after the one noted above, Stiglitz and Weiss (1986) show that collateral decreases risk when collateral and interest rates are set simultaneously.

[18]Similarly, Guttentag and Herring (1984) show that an increase in a borrower's capital (asset value) position limits the possibility of moral hazard. This occurs because the optimal riskiness of an investment project to a borrower increases as the contract rate rises; but the optimal degree of riskiness declines as a borrower's capital position increases. In fact, they show that moral hazard disappears when the capital position of the borrower equals the total payment from the borrower at the end of the contract period because the borrower cannot increase his or her expected return by taking on riskier projects. With no capital position, however, the borrower can obtain the maximum benefit from increasing the riskiness of the investment. Consequently, the lender is most vulnerable to moral hazard when capital is minimal.

Summary

Theories of credit rationing indicate that rational profit-maximizing banks may decline some loans rather than let price act as the rationing device. In addition, recent theories conflict on whether increasing collateral exacerbates or mitigates moral hazard. The implication of these theories for loan pricing is that contract loan rates act as a signal of loan quality; and because of adverse selection and incentive effects, the relationship between a loan's expected return and contract interest rate is curvilinear.

**Loan Pricing and Customer Relationships**

Customer relationship theories propose that customers who contribute more to the bank's long-term profitability are given loans with lower rates. These theories, however, disagree on the effect that the length of the relationship plays in pricing.

Importance of Customers in Providing Deposits

The earliest theories of customer relationships developed in response to credit rationing by default risk and centered on the importance of customers in providing deposits. These theories argue that during times of expanding credit demand, customers who are not preferred might be denied loans so that funds will be available for the preferred customers who desire more credit.[19]

Hodgman (1961) was first to emphasize the importance of the customer relationship. He argued that deposits are important to banks because they are a principal and profitable source of the bank's ability to lend and invest. The size of a bank's portfolio of earning assets relative to equity capital is a function of the amount of its deposits, and the deposits are a function of the services provided to deposit customers, including loan accommodations.[20] Consequently, when deposit customers provide the bank with net income in excess of the activity costs of their account, they are granted loans with lower rates than other customers, particularly nondepositors. In addition, deposits are particularly dear to banks during times of strong loan demand.

Kane and Malkiel (1965) also argue that deposits play a role in the importance of a customer relationship. They show that increases in the volatility of individual or aggregate deposit balances unambiguously worsens a bank's portfolio because it, *ceteris paribus,* increases aggregate risk

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[19]After completing a survey of bankers, Hodgman (1963) concluded that in contrast to credit rationing by default risk (p. 149): "In the bank-customer relationship, however, we have another explanation for credit rationing which does not depend upon risk or uncertainty and which can be related directly to observed bank practice. At the heart of the customer relationship is the mutual dependence on loans and deposits."

[20]Hence, bankers will maximize their lending capacity by giving priority to the loan requests of their largest depositors.

exposure and thus reduces both short- and long-run profits.[21] In addition, deposit variability decreases expected profits if the costs of asset acquisition and sale are considered or if it is assumed that deposit flows and asset yields are inversely related. As a result, a class of customers, $C^*$, exist whose past behavior contributes an important and favorable role in determining the bank's expected profits and aggregate risk exposure. Thus, loan denials to $C^*$ requests may cause customer alienation and loss of important deposit relationships.

These deposit-relationship theories were developed within a regulatory environment that was more restrictive than that which exists today and a less developed market for corporate bond issues. Despite the substantial changes in the banking environment over the last decade, deposits remain an important low-cost source of funds for banks. Hence, loan pricing practices could still be expected to reflect the importance of deposits.

Other Important Borrower Characteristics

Kane and Malkiel (1965) argue that, in addition to deposits, the $C^*$ customers are described by a vector whose elements are indices of the account's current size, future growth prospects, length of its attachment to the bank, the apparent cohesion of that attachment, and the cyclical pattern

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[21]Harrison and Meyer (1975) found that increases in deposit variability reduces bank profits because it forces banks to increase their holdings of liquid assets tat the cost of being more fully loaned.

of the customer's loan needs.[22] Obviously, large accounts are preferred to small ones, growing accounts are more valuable than declining ones, stable deposits are preferred to volatile deposits, old accounts are preferred to new accounts,[23] and cohesive accounts are preferred to footloose ones.[24] The characteristics noted here affect both the short-run and long-run bank profits. Consequently, one would expect banks to charge lower contract loan rates to customers with favorable characteristics. In the short run, $C^*$ customers would be associated with a smaller return on loans than non-$C^*$ borrowers. In addition to the above advantages, the marginal cost to investigate the new loan requests of $C^*$ borrowers are much lower than that for new customers.

Given the importance of $C^*$ customers, the relevant marginal calculation of granting a loan is not whether the additional profit from making the loan outweighs the increased risk. Rather, a utility maximizing bank may agree to grant a $C^*$ request even though, compared with its prerequisite optimum, it is associated with a decrease in utility because not granting the loan also decreases utility. This implies that bankers must

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[22]Some $C^*$ borrowers are important to lenders because their borrowing needs are greatest at times other than peak credit demands. Kane and Malkiel suggest two ways to measure this characteristic: the customer's expected mean indebtedness over typical cycles of loan demand and the coefficient of correlation between the customer's outstanding loans and aggregate excess demand for loans at the bank.

[23]As a banker's experience with an account increases, he or she should be better able to predict its behavior.

[24]The durability of the past customer-bank relationship should reduce the bank's estimate of outcomes around the mean. In other words, its variance.

consider the benefit and costs of an entire customer relationship in order to price loans.[25]

Customer Relationships with Asymmetric Information

Both the theory of Hodgman and Kane and Malkiel assume that bankers possess full and certain information needed about borrowers. In contrast, Sharpe (1990), assumes an asymmetric environment.[26] His dynamic theory of customer-relationships suggests that long-term bank-borrower relationships arise endogenously because of the asymmetric evolution of information, and these relationships create the potential for *ex post* or temporary monopoly power even though banks are *ex ante* competitive.[27]

According to Sharpe's theory, high quality firms continue to transact business with a particular bank, not because they are treated particularly well, but because they are "informationally captured." This situation occurs because in the process of lending, a bank learns more than others about its customers. Thus, the bank that loans to the high quality firm offers it a

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[25]From the bank's view, the discounted income stream associated with the services to depositors equals a lump-sum benefit that is tied to customer loans. This benefit may outweigh the benefits of the higher contract interest rates obtained from nondepositor loans.

[26]In this theory, the key informational asymmetry that affects pricing is that which occurs between banks rather than between banks and borrowers. According to Sharpe (1990, p. 43): "Rather than moral hazard, it is the potential for taking advantage of captive customers, by altering the terms of trade, that gives rise to a reputation equilibrium where competitors earn rents over time."

[27]Jaffee and Stiglitz (1990) also argue that the information costs of determining default create a tendency toward natural monopoly in the supply of credit to a particular person, firm, or industry.

lower rate, when compared with other banks (although the lower rate still allows the bank to accrue rents). Competing banks do not offer lower rates than the bank which currently serves the customer because it is difficult for the borrowing firm to convey information to other banks about its superior performance.[28] Moreover, adverse selection makes it difficult for a bank to attract another bank's good customers without drawing the bad customers as well.

Although banks are expected to earn no profit over the life of an average customer relationship, an inefficient allocation of capital occurs because the market does not force banks to offer better rates to their higher quality customers than to their lower quality customers. Consequently, banks can expect to earn economic profits on their better customers. These rents are competed away, however, because competition forces banks to grant lower interest rates on loans offered to new customers (when banks possess the least information about the firms). As a result, lower quality firms acquire a larger proportion of the bank's capital than in the standard asymmetric information case.[29]

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[28]Sharpe's theory presents important information about the far-reaching economic impact of bank failures which is consistent with Bernanke's (1983) explanation that the rise in the cost of credit from the collapse of financial institutions may have contributed to the depth of the Great Depression. Specifically, Sharpe implies that when a bank fails, its best customers are unlikely to find another bank that will lend to it as cheaply. In this case, it is possible that the additional interest burden placed on the firm will cause it to lower working capital investment which ultimately may lead to less production, employment, and even bankruptcy.

[29]Sharpe's theory suggests that the inefficiencies just noted can be reduced if banks develop reputations based on nonbinding promises. As future market participants learn that

(continued...)

Empirical Test of Customer Relationships

The few empirical tests of customer relationships that were identified provide support that these relationships play a role in pricing. Using a sample of 3 large banks, Hester (1979) found that deposit balances and the number of years the depositor had been with the bank favorably affected the terms of the customer's loan. Also, Murphy (1969) found indirect support that depositors receive some reduction in the price of loans vis-a-vis nondeposits. In a more extensive study of 674 loans collected in 1972 from 62 banks, Hester (1979) found, *ceteris paribus*, borrowers with larger demand deposit balances are charged lower contract interest rates on loans. Also, previous borrowers from the bank received lower interest rates than first-time borrowers. In general, he concludes that (p. 355)

> ...a bank determines loan amount in large part by evaluating the nature of its relationship with a borrower. Once the decision to lend and the loan amount are settled, a bank apparently looks to collateral for protection and to a differential in the interest rate to compensate itself for risk exposure.

Hester's results also provide some support for Sharpe's theory. In particular, he found that borrowers who are considered "highly profitable customers to the bank in the past" are charged new loan rates that are relatively high when compared with all other customers.

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[29](...continued)
the bank keeps its promises, "implicit contracts" arise. These commitments are characterized by prices that more closely approximate the optimal prices, and therefore lead to a more efficient allocation of capital.

Summary

The customer-relationship approach to pricing suggests that, in view of a bank's total portfolio and long-term profits, some customer relationships provide a greater net contribution to profits than others. Therefore, these preferred customers are charged lower contract interest rates on loans than other customers. Moreover, a bank might ration credit to other applicants during times of rising credit demand in order to ensure available credit for its preferred customers.

In an environment of asymmetric information, however, Sharpe suggests that a bank's long-term customers become informationally captured such that they cannot obtain a lower contract interest rate at another bank. In this model, the asymmetric evolution of information creates *ex post* monopoly powers for the bank; but the market for new customers remains competitive. Thus, long-standing customers are charged relatively higher contract interest rates compared with new customers. Moreover, to the degree that banks lend to new customers at interest rates that are initially low, these accounts are likely to generate losses.

## Summary Comments and General Hypotheses

As reviewed in this chapter, portfolio theory as well as the theories of customer relationships and credit rationing provide information about loan pricing. Although these theories overlap to some degree, each suggests unique predictors of the expected return on commercial loans which are determined by pricing procedures (See Table 3.1). Mean-variance analysis and portfolio theory indicate that risk is the most important predictor of expected return. In contrast, credit rationing theories suggest that the loan contract rate is the most important determinant of expected return, and the relationship between these two variables is curvilinear. Although recent theories agree that the relationship is caused by adverse selection and incentive effects, they conflict on whether increased collateral requirements reduces the negative adverse affects.

Finally, customer relationship theories suggest that a number of customer characteristics affect loan pricing, but these theories propose conflicting explanations of the length of customer attachment to the bank. Some customer relationship theories indicate that better customers, including those who have borrowed from the bank for a long period of time, are more highly valued customers and thus are charged lower rates. In contrast, Sharpe's theory of customer relationships posits that banks charge relatively high rates to customers who have dealt with the bank for a longer period and charge relatively low rates to new customers.

The general research question to be tested in this study is how banks price commercial loans. The theories reviewed in this chapter imply several hypotheses that provide information about the research question.

**Portfolio Theory:**

Hypothesis 1a: Banks price commercial loans such that the expected return is positively related to the loan's individual risk and the loan's contribution of risk to the bank's entire loan portfolio.

**Credit Rationing**

Hypothesis 2a: Banks price commercial loans such that the expected return reaches a maximum at a particular rate and beyond that point declines relative to the contract interest rate.

Hypothesis 2b: The expected return on collateralized loans is greater than the expected return on noncollateralized loans.

**Customer Relationship:**

Hypothesis 3a: Banks price commercial loans such that the expected return they earn from commercial loan customers who contribute most to the long-term profitability is lower in the short run than that which they receive from nonpreferred customers.

Hypothesis 3b: The expected return banks earn from commercial loan customers who have been with the bank for a long period of time is greater than that for new customers.

## Table 3.1: Summary of Theories Applied to Loan Pricing

| Theory | Implied Relationship | Rationing Device | Implied Determination of Price |
|---|---|---|---|
| **Mean-Variance** | Figure 3.7 | Price | ●Individual Risk |
| **Portfolio** | Figure 3.7 | Price | ●Contribution to Portfolio Risk |
| **Credit Rationing** | | | |
| Stiglitz and Weiss (1981) | Figure 3.8 | Risk | ●Interest Rates as Signal<br>●Collateral as Signal |
| Guttentag and Herring (1984) | Figure 3.8 | Risk | ●Collateral Solves Moral Hazard |
| **Customer Relationship** | | | |
| Hodgman (1961) Kane and Malkiel (1965) | Figure 3.9 | Long-Run Customer Profit | ●Importance of Customer Relationships |
| Sharpe (1990) | Figure 3.10 | Not Applicable | ●Better Customers are Informationally Captured |

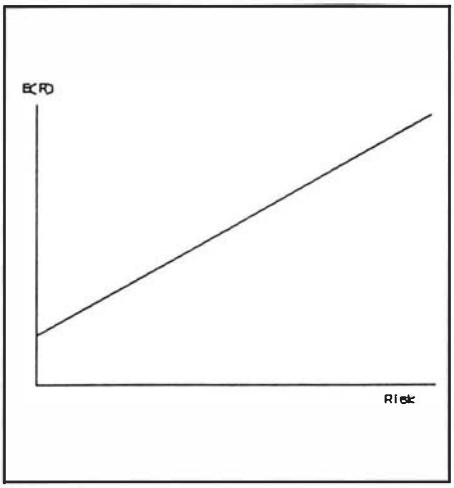


Figure 3.7: Mean-Variance Analysis

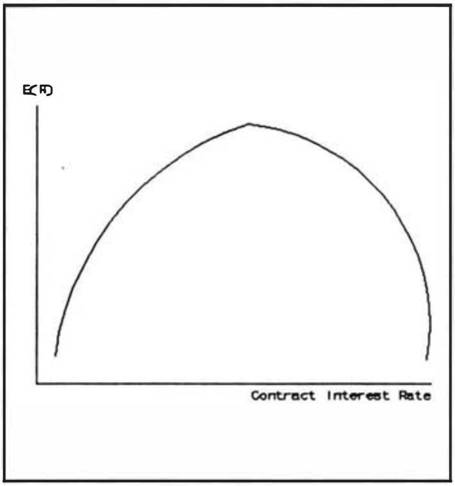


Figure 3.8: Credit Rationing

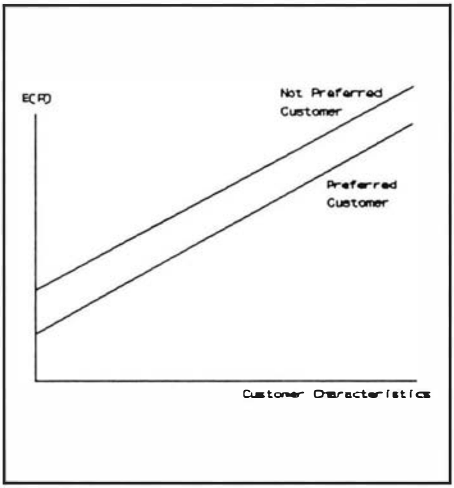


Figure 3.9: Customer Relationships with Perfect Information

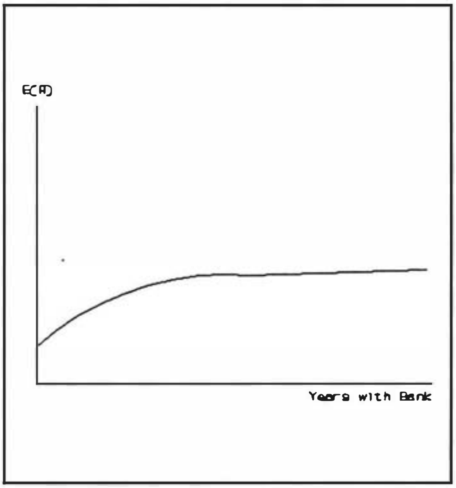


Figure 3.10: Customer Relationships with Asymmetric Information

# CHAPTER IV
# RESEARCH METHODOLOGY

This chapter explains the methodology that will be used to test the general research question of whether mean-variance portfolio theory, credit rationing, and/or customer relationship theories explain the way banks price commercial loans. First, limitations of the analysis are considered. Second, the data, which consist of the commercial loan portfolio of a medium-sized bank, are described. Third, the variables used in this study are defined, and the ordinary least square equations that specify each of the theories is presented. Finally, the non-nested tests are described. These tests are used to determine if any of the three models provides an explanation for the way loans are priced.

## Limitations of Analysis

Three main limitations should be kept in mind when reviewing this analysis. First, because this analysis is based on the loan portfolio of one bank, the implications of the regressions performed here will provide evidence with regard to commercial loan pricing practices. However, the results should be cautiously applied to other banks because a bank's degree of risk aversion affects its pricing practices.

A second limitation concerns the calculation of the expected return, which is the dependent variable. The expected return was derived by making assumptions about default rates and the recovery associated with defaulted loans. At first, this appears to be a significant hindrance to the tests. However, whenever an investor considers purchasing an asset, he or she must derive the expected return based on the best information available. This is a particularly formidable task with bank loans because information is less available when compared with the bond or stock markets. A more detailed explanation of the derivation of expected return follows in this chapter.

Finally, it is assumed that the proper model specification is used to test each theory. The relationship between risk and return has been well developed and accepted in portfolio theory, but the theories of credit rationing and customer relationships are not as standardized. Consequently, some may argue that the specifications used in this paper do not fully capture the theories they are said to represent.

## Data

The loan-related data used in this study were obtained from databases maintained by one of the top 50 bank holding companies in the nation. Consequently, the detail of the data surpasses that of databases previously used that rely on the Federal Reserve Bank's Survey of Terms of Bank

Lending. The database used in this study contains commercial loan information at the customer and the loan (note) level. In addition, it contains information about other services used by the customer such as certificates of deposit.

Description of the Data

The cross-sectional database created for this study consists of 1,670 loans granted by the case study bank from July 1992 through December 1992.[1] Because this study attempts to determine how loans are priced, the database identifies the relevant variables at the loan origination date. In other words, if the loan is granted in July 1992, the relevant variables are those that existed in July 1992 which the loan officers could have used to determine the proper price of the loan. The loan-specific information includes items such as the risk rating, expected maturity, contract interest rate, and deposits. Table 4.1 describes the variables used in this study and provides descriptive statistics. All variables were obtained from the case study bank except for CORR and GROWTH which were created by using data from ZETA® Services and the U.S. Department of Labor. The

[1]The time frame during which loan information was obtained from the case study bank is limited because customer-related information was not available in the database prior to July 1992. In addition, some of the loans in the database were excluded from the study because of the bias they would introduce into the tests. Specifically, a large number of loans were excluded because they were floor plans for automobile dealers. Floor plan loans consist of a separate loan for each automobile the dealer possesses. Consequently, these multiple loans were associated with identical customer-specific data, which could bias the regression results. Also, some loans were excluded because they were associated with organizations that are granted lower rates because of their tax-exempt status. The loans of these firms are faced with a different pricing scheme than other firms and would also bias the results of the empirical tests performed for this study. Finally, the database includes fixed and variable rate loans.

**Table 4.1: Description of the Database**

| Variable | Description | Observations | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| $E(R_i)$ | Bank's expected return on loan i (equation 4.1) | 1,670 | 1.38 | 2.39 | -13.85 | 14.43 |
| $i_i^*$ | Contract interest rate on loan i | 1,670 | 7.05 | 1.57 | 3.12 | 18.00 |
| $i_i$ | Average monthly cost of funds by maturity* | 1,670 | 4.01 | 0.82 | 2.92 | 7.28 |
| $d_i$ | Probability of default associated with loan i | 1,670 | 0.05 | 0.05 | 0.00 | 0.40 |
| $IRR_i$ | Internal rate of return if loan i defaults | 1,670 | -38.51 | 29.26 | -94.50 | 7.00 |
| $VAR_i$ | Variance on loan i (equation 3.2) | 1,670 | 69.74 | 90.05 | 0.00 | 936.72 |
| $RISK_i$ | Bank determined customer risk code for loan i | 1,670 | 3.70 | 0.80 | 1.00 | 6.00 |
| $PREMIUM_i$ | Contract rate less cost of funds ($i^*$-i) for loan i | 1,670 | 3.03 | 1.40 | -1.99 | 14.55 |
| $MATURITY_i$ | Estimated days to maturity for loan i | 1,670 | 734.00 | 603.00 | 1.00 | 2,730.00 |
| $A_i$ | Original amount of loan i (in thousands) | 1,670 | 1,036.00 | 3,434.00 | 1.00 | 45,000.00 |
| $GROWTH_i$ | 10-year projected growth rate for 3-digit SIC to which loan i belongs | 1,670 | 21.07 | 23.03 | -45.95 | 107.10 |
| $CORR_i$ | Correlation between loan industry and bank loan portfolio | 1,670 | 0.02 | 0.15 | -0.49 | 0.59 |
| $DEPOSITS_i$ | Amount of deposits associated with loan applicant i | 1,670 | 11,045.00 | 40,939.00 | 0.00 | 551,576.00 |
| $DEPSTE_i$ | Standard error of deposits associated with loan i** | 899 | 20,518.00 | 54,040.00 | 6.84 | 551,576.00 |
| $TIME_i$ | Length of the customer i's relationship with the bank | 1,670 | 2,451.00 | 2,701.00 | 3.00 | 16,621.00 |

*Using an average rather than daily cost of funds introduces a small measuring error into the $E(R_i)$. However, the monthly change in the cost of funds was relatively small. The average one-month change in the cost of funds over the three-year period used was 15 basis points for the overnight rate and successively smaller average changes for the long-term rates.

**DEPSTE covers a period of six months: July 1992 through January 1992. The standard error statistic is used rather than the standard deviation to reduce volatility caused by an upward trend in deposits (See Murphy, 1968 and 1969 for problems related to measuring variation in deposits).

derivation of GROWTH and CORR will be explained in greater detail later.

Measuring Expected Return

The expected return of an asset is measured at the time the loan is originated and is the sum of the return of its probable outcomes multiplied by the probability of their occurrences (Markowitz, 1958).[2] Measuring the expected return on bank loans is difficult because the market for bank loans is limited. Therefore, no quoted market prices exist like those of stocks and bonds. Interpreting Financial Accounting Standard Number 107's recommendations for fair valuation of securities that have no quoted market prices, Kao (1992) suggests adjusting cash flow by a loan's future default probability and the salvage value in the event of default. Expanding on Kao's suggestion, the expected return in this study is calculated with the following four variables: 1) the probability of default, 2) the cost of funds, 3) the return on the loan if it is paid-in-full, and 4) the return on the loan if it defaults. In equation form,

(4.1) $E(R_i) = [(1-d_i)(i_i^*-i_i) + d(IRR_i-i_i)]$

where $E(R_i)$ is the bank's expected return on loan i, $d_i$ is the default probability on loan i, $i_i^*$ is the contract interest rate on loan i, $i_i$ is the cost of funds given loan i's maturity and origination date, and $IRR_i$ is the internal rate of return on loan i if it defaults. An explanation of the measurement of the variables follows.

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[2]See pages 23-25 for a more in-depth explanation of expected return.

**Default Rate.** The first consideration in determining the expected return of the loan is the default rate. Although default rates for commercial loans are not available, they exist for corporate bonds which are found in an environment similar to that of commercial loans. In fact, Altman (1992 and 1993) and Kao (1992) suggest that bond mortality rates can be used to determine lenders' expected loss rates and this method is used by Miller (1991a) at an aggregate level.[3] The bond default rates,[4] shown in Table 4.2, were determined by Standard & Poor's (January 1993 CreditReview) based on a pool of new corporate bonds issued in the 1980s and are used in this study as estimated defaults for commercial loans. A bond rated BBB or a loan rated 2,[5] for example, is associated with 1.24 percent probability of defaulting within the first four years and 8.64 percent within ten years. Both the bank's risk rating and the estimated maturity of the loan were used to determine the probability of default for each loan in the database.[6]

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[3]The author knows of no study that tests the appropriateness of using bond default rates as a substitute of default for commercial loans. Until commercial loan default data are collected, however, bond default rates remain one of the few alternatives to approximate commercial loan default.

[4]In the Standard & Poor's study, a bond is said to default if the firm fails to make an interest or principal payment by the due date or if the firm files for bankruptcy.

[5]The bank risk ratings used by the case study bank are integers one through eight where one is associated with the least probability of default. Banks generally do not grant loans if the risk rating is higher than "four." Particularly during recessionary periods, however, a bank may grant a loan to a current customer whose credit rating has fallen to six or seven in order to help maintain the viability of the firm.

[6]Risk ratings were matched with the Standard & Poor's corporate bond ratings through discussion with individuals at the case study bank involved in loan pricing.

Table 4.2: **1981-1990: Standard & Poor's Cumulative Default Rates on New Issues, In Percentages**

| Risk Rating | | Years-to-Maturity | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bond | Loan | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A | 1 | 0.00 | 0.00 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 1.80 | 1.80 | 3.98 |
| BBB | 2 | 0.00 | 0.38 | 0.79 | 1.24 | 1.37 | 2.37 | 3.28 | 4.80 | 4.80 | 8.64 |
| BB | 3 | 0.54 | 2.86 | 4.99 | 9.75 | 14.79 | 17.36 | 21.68 | 22.87 | 24.62 | 28.07 |
| B/BB[7] | 4 | 0.68 | 2.99 | 6.50 | 11.36 | 18.07 | 21.31 | 23.46 | 25.68 | 27.93 | 30.35 |
| B | 5 | 0.81 | 3.12 | 8.01 | 12.98 | 18.77 | 25.23 | 28.49 | 31.24 | 32.63 | 32.63 |
| CCC | 6,7,8 | 3.13 | 12.22 | 24.98 | 34.51 | 39.91 | 39.91 | 39.91 | 39.91 | 39.91 | 39.91 |

**Cost of Funds.** The second variable needed to measure expected return is the cost of funds. This variable was obtained from the case study bank and is the average monthly cost of funds.[8] The cost of funds is based on the yield of government securities of a like maturity with the loan plus an additional amount that covers insurance and broker costs.

**Return on the Loan if Paid-In-Full.** The third variable, the return on a paid-in-full loan, is easily measured. It is the contract interest rate less the cost of funds. Thus, if the contract interest rate on the loan is 5 percent and the cost of funds is 2 percent, then the return on the loan is 3 percent.

**Internal Rate of Return (IRR).** The final variable to consider is the IRR that results if the loan defaults. Measuring the default on loans is difficult because banks have not built statistically credible databases pertaining to

[7]The default rates associated with this risk rating is an average of the B and BB ratings.

[8]The case study bank uses daily data in assessing the cost of funds, but only monthly historical data were available. Using an average rather than a daily cost of funds introduces a small measuring error into the expected return. However, the monthly change in the cost of funds was relatively small. The average one-month change in the cost of funds over the study period used was 15 basis points for the overnight rate and successively smaller average changes for the long-term rates.

the defaults and recoveries of loans.[9] Therefore, the default measurements used in this study are based on the limited analysis that has been performed by trade groups, consultants, and employees of the case study bank.

An example calculation of IRR is shown at the end of this section. First, however, the following four variables used to derive IRR are explained: 1) the amount of the loan that is paid off before default, 2) the percentage of the original loan amount that is recovered from the collateral, 3) the contract interest rate, and 4) the expected maturity of the loan.

The first consideration in measuring the IRR is the amount of the loan that is repaid before the loan defaulted. The measure used in this study is based on an examination of highly leveraged loans by Loan Pricing Corporation. In that study, Miller (1991a) found that, on average, default occurred after 34 percent of the initial commitment was paid.[10] Similarly, this study assumes that if the loan defaults, the default occurs after 34 percent of the initial commitment is paid. Thus, a $10,000 loan defaults the month that total interest plus principal payments equals $3,400.

The second factor used in measuring IRR is based on the type of collateral associated with the loan. The case study database identifies the type of collateral, such as undeveloped land, inventories, and equipment associated with each loan. Estimates for the expected percentage of loan

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[9]For a description of this problem, see Loomis (1993).

[10]The time period over which this study was performed was not cited.

loss in the case of default were obtained by collateral types through discussions with executives at the case study bank and consultants in the field of banking. These discussions produced loss estimates on more than 50 collateral categories that varied widely from 0 percent if the loan was secured by certificates of deposit to more than 50 percent for some types of unsecured real estate.[11] The loss amount is based on principal only and does not consider losses due to lost interest payments or other costs associated with recovery.

The last two factors used to measure IRR, the contract interest rate and the expected maturity of the loan, are found in the case study bank's database.

The calculation of IRR can now be shown in an example. Assume a $10,000 loan is granted with a contract interest rate of 8 percent and a maturity of 4 years.[12] In addition, the loan is collateralized with a type of collateral that is associated with a 50 percent total recovery rate. Further, it is assumed that 34 percent of the original loan amount was paid before the date of default. Such a loan requires monthly payments of $244.13 and would default at its 14th loan payment--the time at which approximately 34 percent or $3,400 of the original loan amount was paid. Because of the type of collateral associated with this loan, an additional $1,582 is

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[11]The exact loss amounts are not shown here for confidentiality reasons.

[12]In calculating the IRR, the loan maturity and interest rate was rounded to the nearest whole number.

recovered for a total recovery of $5,000 or 50 percent. The IRR, which is -54.30 percent, is calculated by solving the following equation:

$$0 = \sum_{t=1}^{T} \frac{\$244.13}{(1+IRR)^{t/12}} + \frac{\$1{,}600}{(1+IRR)^{T/12}} - 10{,}000$$

where t represents the number of months from the origination date of the loan and increases to T which is the month of default. In the example shown above, T equals 14.

**An Example of Expected Return.** By way of example, Table 4.3 shows the computation of expected return for four loans found in the database.

**Table 4.3: Measuring Expected Return with Information Available at the Time of the Loan Origination**

| Loan | Risk Rating | Maturity Years | Default Probability | Contract Rate | Cost of Funds | Payoff Before Default | Loss Based on Collateral | $IRR_i$ |
|---|---|---|---|---|---|---|---|---|
| A | 1 | 1.0 | 0.0000 | 6.00 | 3.89 | 0.34 | -0.38 | -0.784 |
| B | 2 | 4.0 | 0.0124 | 6.25 | 3.89 | 0.34 | 0.00 | -0.001 |
| C | 3 | 3.0 | 0.0499 | 6.50 | 3.61 | 0.34 | 0.00 | -0.005 |
| D | 4 | 3.0 | 0.0650 | 7.00 | 3.61 | 0.34 | -0.25 | -0.305 |

| Loan | $E(R_i)$ |
|---|---|
| A | 0.021100 = [(1-0.0000)(0.0600) + (0.0000)(-0.7840)] - 0.0389 |
| B | 0.022825 = [(1-0.0124)(0.0625) + (0.0124)(-0.0010)] - 0.0389 |
| C | 0.025654 = [(1-0.0499)(0.0650) + (0.0499)(-0.0050)] - 0.0361 |
| D | 0.009525 = [(1-0.0065)(0.0700) + (0.0065)(-0.3050)] - 0.0361 |

## Statistical Tests

Loan pricing procedures are examined by performing a series of cross sectional ordinary and generalized least square regressions where the expected return on the loan is the dependent variable in each of the regressions (see Table 4.4).[13] Since one cannot nest these specifications, non-nested hypothesis testing criteria are used to discriminate among the specifications shown in Table 4.4

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**Table 4.4: Statistical Tests**

Portfolio Theory

(4.2) $E(R_i) = \beta_1 + \beta_2(VAR_i) + \beta_3(VAR_i)^2 + \beta_4 CORR_i + \beta_5 M_i + \beta_6 A_i + \epsilon_i$

Credit Rationing

(4.3) $E(R_i) = \beta_1 + \beta_2 i_i^* + \beta_3 i_i^{*2} + \beta_4 M_i + \beta_5 A_i + \epsilon_i$

Customer Relationships

(4.4) $E(R_i) = \beta_1 + \beta_2 GROWTH_i + \beta_3 DEPOSITS_i + \beta_4 TIME_i + \beta_5 M_i + \beta_6 A_i + \epsilon_i.$

(4.5) $E(R_i) = \beta_1 + \beta_2 \log TIME_i + \beta_3 M_i + \beta 4A_i + \epsilon_i.$

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## Controlling for Maturity and Size

A consideration before moving on to the measurement of each hypothesis is how to control for maturity and size.[14] The maturity of a loan

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[13]Some might argue that the contract interest rate (price) should be used as the dependent variable, but credit rationing theories preclude this use because they suggest that the contract interest rate signals loan quality which determines price. In other words, the contract loan rate is an independent rather than dependent variable. Using expected return as the dependent variable affords a test of the hypothesized credit rationing relationship between the expected return and the contract interest rate. The tradeoff is that the tests now measure the expected return, which is determined by price (contract interest rate), rather than testing price directly.

[14]The results of the hypothesis may also vary by loan purpose because the type or purpose of the loan also affects its riskiness. Inventory loans, for example, may be less risky than loans for the expansion of plant and equipment because the payoff from plant and equipment is based on a larger and more sustained increase in demand than that typically needed to exhaust inventories. Such information, however, was not available from the case study bank.

affects its riskiness because the longer the maturity, the greater the possibility that default might occur. Although maturity is incorporated by differences in the cost of funds and default probabilities, it is included as an independent variable in each equation specified to capture any residual effects of the length of the loan on the expected return.

Different pricing practices are expected by size because larger loans are generally associated with larger firms 1) that often possess publicly traded stocks which translates into more public information about the firms and 2) that experience a more competitive loan environment because of the national rather than regional scope of their market. Therefore, the original amount of the loan is added to each regression.

Testing Mean-Variance Portfolio Theory

Mean-variance portfolio theory is considered in hypothesis 1 below.

> Hypothesis 1: Banks price commercial loans such that the expected return is linearly[15] and positively related to the loan's individual risk and the loan's contribution of risk to the bank's entire loan portfolio.

The following equation considers whether mean-variance analysis and portfolio theory are used in pricing:

$$(4.2) \quad E(R_i) = \beta_1 + \beta_2(VAR_i) + \beta_3(VAR_i)^2 + \beta_4 CORR_i + \beta_5 M_i + \beta_6 A_i + \epsilon_i.$$

Equation (4.2) is a cross-sectional test in which $E(R_i)$ represents the bank's expected return from loan i, $\beta_1$ is the constant term, $VAR_i$ is the

[15]Linearity is assumed as a first approximation.

variance[16] for loan i, $VAR_i^2$ is the variance squared and is used to test whether the relationship is nonlinear, $CORR_i$ measures the correlation of an industry's credit quality with the return on the bank's total loan portfolio, $M_i$ is the number of days over which the loan is to be paid, $A_i$ is the original amount of the loan, and $\epsilon_i$ is the error term.

The variable which represents the correlation between the return on the case study bank's loan portfolio and the loan industry's credit quality (CORR) warrants further explanation. The return on the bank's loan portfolio is simply the interest income produced from the loan portfolio less charge-offs net of recoveries all divided by the total loan balance.[17] Credit quality is the percentage change in the credit quality of the 4-digit standard industrial classification (SIC) to which the loan belongs.[18] The credit quality measure was obtained from ZETA® Services which specializes in measuring credit quality. Both the return on the bank portfolio and credit quality measures are quarterly and were correlated for the 39 quarters from the second quarter of 1983 through the fourth quarter of 1991.

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[16]Even though the variance is measured from the expected return, which is the dependent variable, the relationship predicted by mean-variance analysis is not a certainty because the bank can misprice the loan by applying the wrong premium (contract interest rate less cost of funds), risk rating, or collateral requirements. In fact, loan D in Table 4.3 is mispriced relative to its variance. The variance of each loan in the table is: $VAR_A = 0.00000$, $VAR_B = 0.479$, $VAR_C = 2.006$, and $VAR_D = 85.465$. [Variances in the regressions are multiples by 100 to avoid the negative bias that would occur when numbers less than one are squared.]

[17]These data were obtained from the case study bank's quarterly earnings reports.

[18]In some cases, a 4-digit SIC credit quality measure was not available. Therefore, CORR was measured at the 3-digit SIC level for 102 observations and at the 2-digit SIC level for 118 observations.

The correlation between the bank's return on its loan portfolio and credit quality provides a useful measure of portfolio pricing because the lower correlations of returns between loans leads to lower variations in the entire portfolio.[19] Thus, if a loan's credit quality moves opposite that of the case study bank's loan portfolio over time, the addition of this loan to the portfolio could reduce the variability of the entire loan portfolio. Said differently, the variation of an existing loan portfolio can be reduced by adding loans of firms whose business cycle runs counter to that of the bank's portfolio. The underlying concept is that a firm's credit quality is most likely to deteriorate during business downturns. If the firm's business cycle trough occurs counter to that of the bank's loan portfolio, then adding the counter-cyclical firm's loan to the bank's portfolio can potentially reduce the variation in the portfolio.

Because bankers are generally risk-averse (Flannery, 1985 and Hester and Pierce, 1972), they are expected to place greater value on industries that reduce the total variability of the return on their loan portfolio. Moreover, "Because bank shareholders are willing to trade off some expected profits in order to avoid uncertainty (and vice versa), the diversification principle has an important implication for loan pricing" (Flannery, 1985, p. 462). Consequently, it is hypothesized that bankers discount the contract interest rate of loans whose industry is associated

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[19]For a more detailed explanation of the role correlations play in portfolios, see pages 25 through 27.

with a relatively small or negative correlation (higher credit quality numbers are associated with better credit quality). Hence, $\beta_4$ is expected to be positive.

Support for mean-variance analysis would be evident from a positive and statistically significant $\beta_2$ coefficient because the expected return should increase as the variance increases. In addition, assuming a linear relationship between risk and return, $\beta_3$ is expected to be statistically insignificantly different from zero. A joint hypothesis test (Yancey, Judge, and Bock, 1981) would indicate that $\beta_2 > 0$ and $\beta_3 = 0$. However, the relationship between expected return and risk may not be linear. Therefore, portfolio theory would be supported by $\beta_3 > 0$. As noted above, portfolio theory suggests a positive coefficient $\beta_4$ since loans that decrease the variance of the bank's loan portfolio are expected to be priced relatively lower than other loans and hence should be associated with a lower expected return. Finally, in this test as well as the others noted below, $\beta_5$, the coefficient which measures maturity, is expected to be positive because longer maturities are generally associated with higher default rates.

Testing the Theory of Credit Rationing

The pricing implications of credit rationing theories are considered in the following hypotheses:

> Hypothesis 2a: Banks price commercial loans such that the expected return reaches a maximum at a particular rate and beyond that point declines relative to the contract interest rate.

Hypothesis 2b: The expected return on collateralized loans is greater than the expected return on noncollateralized loans.

The following equation considers the implications from the theory of credit rationing in pricing commercial loans:

(4.3) $E(R_i) = \beta_1 + \beta_2 i_i^* + \beta_3 i_i^{*2} + \beta_4 M_i + \beta_5 A_i + \epsilon_i$

where $i_i^*$ represents the contract interest rate. In this case, the contract interest rate on the loan acts as a signal that, after a particular point, causes the expected return on the loan to fall (Stiglitz and Weiss, 1981). Therefore, a statistically significant positive $\beta_2$ and negative $\beta_3$ would support credit rationing because the relationship between the expected return and interest rates form a parabola. In this case, a joint hypothesis would indicate that $\beta_2 > 0$ and $\beta_3 < 0$. If only $\beta_3$ is statistically significantly different from zero and positive, this result would not provide evidence against credit rationing because a bank that properly rations credit based on default risk would decline loans at the point where adverse selection and moral hazard outweighs the possible increased returns from risk.

A secondary question raised in credit rationing literature is whether collateral intensifies moral hazard (Stiglitz and Weiss, 1981) or reduces it (Guttentag and Herring, 1984).[20] This question is investigated with an analysis of the means of the expected return on loans when loans are

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[20]Moral hazard, which means that borrowers take on more risk than agreed upon in the contract, may still occur if the loan is paid in full. In such a case, the borrower who took on a riskier project was successful. It is unlikely that this happened enough times to significantly bias the results, particularly since the sample data include a business cycle downturn.

grouped based on whether the loan terms include collateral.

## Testing Customer-Relationship Theories

The pricing implications of customer relationships are considered in the following hypotheses:

> Hypothesis 3a: Banks price commercial loans such that the expected return they earn from commercial loan customers who contribute most to their long-term profitability is lower in the short run than that which they receive from nonpreferred customers.

> Hypothesis 3b: The expected return a bank earns from commercial loan customers who have been with the bank for a long period of time is greater than that for new customers.

The following equation is used to test the degree to which customer relationships are important in pricing loans as defined by Hodgman (1961 and 1963) and Kane and Malkiel (1965):

(4.4) $E(R_i) = \beta_1 + \beta_2 GROWTH_i + \beta_3 DEPOSITS_i + \beta_4 TIME_i + \beta_5 M_i + \beta_6 A_i + \epsilon_i$.

Sharpe (1990), however, suggests an opposing model with regard to time:

(4.5) $E(R_i) = \beta_1 + \beta_2 \log TIME_i + \beta_3 M_i + \beta 4 A_i + \epsilon_i$.

In the above equations, $SIZE_i$ is the current size of account i, $GROWTH_i$ is the future growth prospects for account i, $DEPOSITS_i$ is the total deposits for account i, and $TIME_i$ is the total days customer i has dealt with the bank.

The measurement of the variables in equations (4.4) and (4.5) is fairly straightforward. GROWTH is the projected growth rate of industry employment from 1990 through 2005 (U.S. Department of Labor, 1992).[21] Projections were generally applied at the three-digit standard industrial classification level.[22] DEPOSITS is the dollar value of deposits. TIME is the number of days since the customer opened his or her first loan or deposit account with the bank.

Support for the importance of customer relationships in pricing would be indicated by a negative coefficient for DEPOSITS and GROWTH. Also, a negative coefficient for TIME would provide evidence for the importance of customer relationships as suggested by Hodgman and Kane and Malkiel; but a positive coefficient would support Sharpe's "informationally captured" notion. A further test of Sharpe's concept is provided in equation (4.5) where TIME is transformed by using a log function because the relationship between the expected return on the loan relative to the length of the relationship is expected to be convex: the interest rate on loans for new customers are discounted while longer customers are charged a higher rate.

Non-Nested Tests

The explanatory power of the models that represent the theories above are compared by using the non-nested J-test (Davidson and MacKinnon,

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[21]These projections are used because they were available in 1992 when the loans in the database were made. Output is a better measure of industry growth, but it is not available from a public source at the level of detail used in this study.

[22]If a growth projection is not available at the 3-digit SIC level, then the projection for the relevant 2-digit level is used. One hundred twenty observations required projections at the 2-digit level.

1981) and Cox test (Cox, 1961 and 1962 and Pesaran, 1974).[23] These tests are explained through the following two hypothesis:

$$H_0: y = X\beta_x + u_x$$
$$H_1: y = X\beta_z + u_z$$

The J-test is performed by first separately performing the regressions specified by theories "X" and "Z" and saving the fitted values ($\hat{y}_X$ and $\hat{y}_Z$) from the regressions. The second step involves re-estimating the regression concerning theory X and including $\hat{y}_Z$ from the second equation as an independent variable. If the coefficient on $\hat{y}_z$ is significantly different from zero, then the null hypothesis that model X provides the greatest explanatory power is rejected in favor of $H_1$. This process is repeated to test whether theory X provides additional information to theory Z by reversing the roles of $H_0$ and $H_1$. It is possible that both models will be rejected as the most informative set of regressors.

The Cox-test is a stronger nonnested test because it takes into account the residuals as well as the predicted values of the competing theories. The explanation of this test is based on the following two regression models (Greene, 1993, pp. 222-225):

$$M_X: y = X\beta_X + u_X, \qquad u_X \sim N(0,\sigma^2 I_n),$$
$$M_Z: y = Z\beta_Z + u_Z, \qquad u_Z \sim N(0,w^2 I_n),$$

where y is the (n X 1) vector of observations on the dependent variable, X and Z are (n X $k_X$) and (n X $k_Z$) observation matrices for the regressors of

[23]Models are non-nested if the regressors of one model cannot be expressed as a linear combination of the regressors of the second model (Pesaran, 1987).

models $M_X$ and $M_Z$, $\beta_X$ and $\beta_Z$ are the ($k_X$ X 1) and ($k_Z$ X 1) regression coefficient vectors, and $u_X$ and $u_Z$ are the (n X 1) error vectors, and $I_n$ is the identity matrix of order n.

The information needed to calculate the Cox statistic for testing the hypothesis that X provides greater explanatory power than Z is obtained as by-products of computing the following four least square regressions. (See Table 4.5 for a summary of this procedure.) First, the regression model $M_x$ is run to obtain the fitted value (Xb) and the mean-squared residual ($s_X^2$). The value for $s_X^2$ is set aside to be used in the Cox statistic. Second, Xb is used as the dependent variable with the independent variables of the competing model. This regression is performed in order to obtain the residuals ($M_zXb$) and the sum of squared residuals ($b'X'M_ZXb$) which are set aside to be used in the Cox statistic. Third, the residuals $M_zXb$ are used as the dependent variable with the independent variables of the regressors for theory X. The value for the sum of squared residuals $(b'X'M_Z)M_X(M_ZXb)$ from this regression is set aside to be used in the Cox statistic. Finally the regression model $M_z$ is run to obtain its mean-squared residual ($s_Z^2$).

The above information is used to compute two more statistics that allow the measurement of the Cox statistic (q). First $s_{ZX}^2$ is computed as $s_X^2$ + $(1/n)b'X'M_ZXb$. Second $c_{12}$ is computed as

$$c_{12} = \frac{n}{2}\ln\left[\frac{s_z^2}{s_x^2+(1/n)b'X'M_zXb}\right] = \frac{n}{2}\ln\left[\frac{s_z^2}{s_{zx}^2}\right]$$

Now, the hypothesis that X is the correct set of regressors and Z is not is tested by the following statistic:

$$q=\frac{c_{12}}{(Est.Var[c_{12}])^{1/2}}=\frac{c_{12}}{[(s_x^2/s_{zx}^4)b'X'M_zM_xM_zXb]^{1/2}}$$

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**Table 4.5: Definition of Variables Needed to Compute the Cox-Statistic**

Regression Models:

$M_X$: $y = X\beta_X + u_X$, $\quad u_X \sim N(0,\sigma^2 I_n)$,

$M_Z$: $y = Z\beta_Z + u_Z$, $\quad u_Z \sim N(0,w^2 I_n)$,

$$Cox\ Statistic = q=\frac{c_{12}}{(Est.Var[c_{12}])^{1/2}}=\frac{c_{12}}{[(s_x^2/s_{zx}^4)b'X'M_zM_xM_zXb]^{1/2}}$$

where

$$c_{12} = \frac{n}{2}\ln[\frac{s_z^2}{s_x^2+(1/n)b'X'M_zXb}] = \frac{n}{2}\ln[\frac{s_z^2}{s_{zx}^2}]$$

$s_Z^2 = e_Z'e_Z/n$ = mean-squared residual in the regression of y on Z

$s_X^2 = e_X'e_X/n$ = mean-squared residual in the regression of y on X

Xb = fitted values in the regression of y on X

$M_ZXb$ = residuals in a regression of Xb on Z

$b'X'M_ZXb$ = sum of squared residuals in the regression of Xb on Z

$s_{ZX}^2 = s_X^2 + (1/n)b'X'M_ZXb$

$(b'X'M_Z)M_X(M_ZXb)$ = sum of squared residuals in the regression $M_ZXb$ on X

$M_Z = I - Z(Z'Z)^{-1}Z'$

$M_X = I - X(X'X)^{-1}X'$

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where a large value of q in a standard normal table is evidence against the null hypothesis that X is the correct set of regressors.

As noted earlier, the nonnested tests consider the explanatory power of one hypothesis against another. Since three hypotheses are considered in this study, the tests must be computed for three pairs: 1) portfolio versus credit rationing, 2) portfolio versus customer relationships, and 3) credit rationing versus customer relationships. Failing to reject one hypothesis does not rule out the possibility that the other hypotheses contribute information about pricing.

# CHAPTER V
# PRESENTATION OF EMPIRICAL FINDINGS

This chapter contains the empirical results of the tests presented in the previous chapter. The results provide evidence consistent with credit rationing and customer relationship theories. Both the nonnested J-test and the Cox test indicate that the specification used for the credit rationing model provides more information about the expected return on loans than the specification used for the customer relationship model.

The specification used to test portfolio theory provides statistically significant results, but of the wrong sign: the expected return on loans decreases as risk (variance) increases. Further tests were performed because of this surprising result, and the additional tests suggest that loan pricing at the case study bank might not adequately account for losses associated with the possibility of default. In other words, default is more likely with high variability of return which suggests that the case study bank might be mispricing its loans.

Finally, the impact of collateral on loan pricing is considered. The results indicate that the expected return associated with collateralized loans is lower than that for loans without collateral. These results are consistent with Boot, Thakor, and Udell (1991) who argue that firms use collateral to obtain more favorable loan terms.

## Testing for Heteroscedasticity

Most of the theories tested in this chapter were positively evaluated for heteroscedasticity. *A priori* evidence and examination of the residual patterns of the dependent variables suggest the original amount of the loan (A) is causing the heteroscedasticity problem.[1] As shown in Table 5.1, the Park-Glejser test statistically verifies that the original amount of the loan is contributing to the heteroscedasticity.[2]

Even though the data are heteroskedastic, they are not adjusted to reduce the heteroskedasticity because the nonnested tests used in this chapter require ordinary least squares regression results. Moreover, even in the presence of heteroskedasticity, the parameter estimates remain unbiased and consistent.[3] As a result, the coefficients can be interpreted

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[1]*A priori,* the variance of the loan amount is expected to increase around the expected return as loans became smaller because smaller loans are associated with less information and thus are probably priced with greater variation. In contrast, larger loans typically originate from larger firms, which often are traded publicly. The larger loans are probably priced more accurately because of the additional information.

[2]The Park-Glejser statistics shown in Table 5.1 are obtained by first regressing the model specification with ordinary least squares in order to obtain the residuals which are used as a proxy for the variances. The log of the squared residuals from the regression is used as the dependent variable in an ordinary least squares regression where the log of the loan amount (A) is the independent variable. The hypothesis that A is contributing to the heteroskedasticity in the data is accepted if its coefficient is statistically significantly different from zero.

[3]When data are heteroskedastic, their variances are not constant over observations. As a result, ordinary least squares places more weight on the observations with large variances

(continued...)

straightforwardly; but the t-statistics should be interpreted conservatively because they overestimate the significance of the results. For the interested reader, Appendix C contains the generalized least squares results (which reduce the heteroskedasticity) for the tests shown in this chapter.

**Table 5.1: Park-Glejser Results where Log(A) is the Dependent Variable, T-Statistics in Parenthesis (Observations = 1,670)**

| | Full Sample | > $1 Million | < $1 Million |
|---|---|---|---|
| Portfolio Theory | 0.176203<br>(6.81)* | -0.353437<br>(-2.44)** | 0.135835<br>(3.17)* |
| Credit Rationing | 0.034245<br>(1.35) | -0.365671<br>(-1.77)** | 0.210792<br>(5.01)* |
| H,K&M Customer Relationship | 0.127444<br>(4.79)* | -0.104367<br>(-0.610) | 0.176327<br>(4.34)* |
| Sharpe Customer Relationship | 0.135594<br>(5.25)* | -0.324195<br>(-1.99)** | 0.209164<br>(4.84)* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

## Regression Results for Portfolio Theory, Credit Rationing, and Customer Relationship Theories

This section considers whether the signs of the coefficients in each model are consistent with those hypothesized by the theory and then tests whether any of the models provides the greatest amount of explanatory

[3](...continued)
relative to those with small variances. This weighting system causes the parameter estimates to be inefficient--they are not associated with a minimum variance.

power. The results shown in this section are not consistent with the notion that banks price loans relative to portfolio theory. However, the results are consistent with credit rationing and customer relationship theories. The three theories are considered in turn.

Portfolio Theory

The test of the portfolio specification used in this study provides no evidence that loan prices are positively related to risk. As shown in column one of Table 5.2, the coefficient associated with VAR is statistically significantly different from zero and inversely related to the expected return on the loan while the hypothesis calls for a positive coefficient. The coefficient for $VAR^2$ is also negative, but it is not statistically significant. Although these results are contrary to basic financial theory, they are suggested by banking industry observers who say that banks price their best customers' paper too low and their worst customers' paper too high.[4]

The definition of expected return and variance used in this study is set forth by portfolio theory. However, the variables used to calculate the loan's expected return and variance are broader than those used by banks. Specifically, the expected return is based on the risk rating the bank applies to the loan, the type of collateral associated with the loan, and the recovery amount of the loan if it defaults--an approach that explicitly incorporates

[4]For example, see Foss (1992), Portfolio Valuation Handbook (1989) and Rose (1992).

**Table 5.2: Ordinary Least Squares Results where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis (Observations = 1,670)**

| | Portfolio Theory | Credit Rationing | Customer Relationships H,K&M | Customer Relationships Sharpe |
|---|---|---|---|---|
| Intercept | 3.547293 (61.14)* | -2.067980 (-4.71)* | 3.399496 (37.38)* | 4.038350 (18.00)* |
| VAR | -0.015015 (-33.09)* | | | |
| $VAR^2$ | -0.000000 (-0.01) | | | |
| CORR | 0.537148 (2.27)** | | | |
| A | -0.000000 (-16.29)* | -0.000000 (-3.04)* | -0.000000 (-12.23)* | -0.000000 (-13.23)* |
| M | -0.001293 (-18.77)* | -0.002956 (-43.10)* | -0.002458 (-32.25)* | -0.002362 (-31.34)* |
| RATE | | 0.849947 (7.45)* | | |
| $RATE^2$ | | -0.006419 (-0.89) | | |
| GROWTH | | | 0.003428 (1.72)*** | |
| DEPOSITS | | | -0.000000 (-6.04)* | |
| TIME | | | -0.000015 (-0.87) | |
| Log(TIME) | | | | -0.105007 (-3.42)* |
| Adjusted $R^2$ | 0.64 | 0.58 | 0.42 | 0.40 |
| F-Statistic | 600.13* | 569.67* | 235.76* | 372.91* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

more information than most banks probably use to price loans.[5] Consequently, the calculation of the expected return and variance may be biasing the results. Theoretically, however, the contract interest rate and the cost of funds used by banks to price loans should implicitly incorporate default probability and recovery rates. The difference between the definition used in this study and that which banks use allows further tests that shed light on the surprising results from portfolio theory. These tests are presented later in this chapter.

The second measure of portfolio pricing, CORR, is positive and statistically significantly different from zero at the 5 percent level. This result should be discounted, however, because t-statistics are overestimated in the presence of heteroscedasticity. CORR measures the correlation between the return on the bank's loan portfolio and the change in the credit worthiness of firms in the same industry group. The positive relationship suggests that the pricing practices of the case study bank might have taken into consideration the correlation between the industry in which the borrower is a member and the bank's total loan portfolio. However, the heteroscedastic-consistent results shown in Appendix C indicate that the coefficient is not statistically significantly different from zero. The insignificance of this variable is consistent with the banking literature which indicates that banks have only recently begun to consider the impact on

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[5]The loan pricing examples shown in Table B.1 of Appendix B, for example, do not consider the impact of collateral recovery in loan pricing.

individual loans of the return to their total loan portfolio.[6]

The variables, A and M were included in each of the regressions to control for the size and maturity of the loans. Both variables were statistically significantly different from zero and inversely related to the expected return on the loans in each regression specified in Table 5.2. In fact, this relationship held true for every regression that was run for this study irrespective of how the sample was subdivided. These findings provide strong support that the expected return increases as the loan size and maturity decreases.

The relationship between the expected return and the amount of the loan can be explained from several different points of view. First, smaller loans may be associated with smaller firms that are considered riskier than larger firms. Second, as suggested by customer relationship theories, larger loans contribute more to the bank's long-run profits. Thus, they are charged less in the short run in an attempt by the bank to retain the preferred customer. Third, increased competition for larger loans might have driven down the expected return for these preferred loans. The increased competition includes banks as well as other financial markets, such as commercial paper. Finally, this finding is also consistent with the theory that large loans are associated with relatively lower interest rates because of economies of scale.

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[6]For example, see Gollinger and Morgan (1993), Larr and Stampleman (1993), and Morsman (1991).

The regressions performed for this study also provide strong support that the expected return on loans is inversely related to the maturity of the loan. This result is opposite the expected result: longer loans are associated with higher returns because they possess a greater probability of default. The bond defaults shown in Table 4.2 clearly show this relationship between default and time. According to officials at the case study bank, however, short-term loans are preferred over long-term loans. Consequently, only the bank's best customers are granted loans with relatively long maturities. As suggested by customer relationship theories, preferred customers are granted lower interest rates. The lower interest rates translate into lower expected returns for the bank.

Credit Rationing

The regression results for credit rationing specification shown in Table 5.2 are consistent with the notion that banks control risk by denying credit to the riskiest borrowers and use the contract interest rate as a signal of a borrower's riskiness. The theory of credit rationing, which assumes asymmetric information, suggests that beyond a maximum interest rate, banks do not lend because higher rates do not compensate for adverse selection and moral hazard.

Results consistent with credit rationing can be found in three different relationships. First, weak support for credit rationing would be indicated by an upward sloping contract interest rate. Second, if the bank does not ration credit properly, a parabolic relationship would exist between the expected return on the loan and the contract interest rate. Third, a negative sign on the coefficient of the squared interest rate would also support credit rationing by indicating the relationship is nonmonotonic and loans are not extended beyond a certain interest rate.

The results shown in column two of Table 5.2 provide weak support for credit rationing. The contract interest rate (RATE) is positive and statistically significantly different from zero. However, a statistically insignificant relationship exists between $RATE^2$ and the expected return. (A joint test for RATE and $RATE^2$ was rejected.)

Customer Relationship Theories

Two model specifications of customer relationships are considered in Table 5.2. The first model is denoted H,K&M because it relies on theories presented by Hodgman (1961) and Kane and Malkiel (1965). The second model specification is based on Sharpe (1990).

According to the H,K&M theories of customer relationships, certain customer characteristics contribute more to a bank's long-term profitability than others. Thus, the relevant marginal calculation of granting a loan is not whether the additional expected profit from making the loan outweighs the increased risk, but the importance of the characteristics of the customer to the bank's long-run profits. Specifically, large accounts are preferred to small ones, growing accounts are more valuable than declining ones, larger deposits are preferred to smaller deposits, and old accounts are preferred to new accounts. Consequently, one would expect banks to charge lower contract loan rates to customers with these favorable characteristics; and in the short-run, these preferred customers would be associated with a smaller expected return than the less preferred customers.

The regression results shown in column three of Table 5.2 provide mixed support for customer relationship theories. As mentioned earlier, the relationship between the expected return on the loan and its size is negative and statistically significantly different from zero in all of the model specifications used in this study. According to customer relationship theories, customers with large loan amounts are charged a relatively lower interest rate because they are preferred. Thus, the expected return on these loans is inversely related to the amount of the loan.

Projected industry growth (GROWTH) is the wrong sign and is not statistically significantly different from zero. Thus, the results do not provide support that the more preferred faster growing firms may be associated with a smaller return because they are expected to grow over the years and contribute more to the long-term profits of banks than slowly growing firms.

The sign of the coefficient for the account's deposits (DEPOSITS) is consistent with the customer relationship theory. DEPOSITS is statistically significantly different from zero and inversely related to the expected return.

Similar to the loan size argument, these customers are granted a lower contract rate because of their long-term contribution to the bank's profits.[7]

The length of the customer relationship is not statistically significantly different from zero but negatively related to the loan's expected return.[8] According to customer relationship theories, longer-term relationships provide greater opportunity for profits. Thus, these customers are charged less in the short run.

The second model specification of the customer relationship theory (Sharpe, 1990) simply states that bank customers become informationally captured by the bank that provides it with loans. Because of asymmetric information, the bank that loans to a customer learns more about that customer over time than do other banks. Thus, the bank that loans to the high quality firm offers it a lower rate, when compared with other banks; but the contract rate would be even lower if competing banks knew the true high quality of the customer. As a result, banks charge their better customers--those that become informationally captured--a relatively high rate

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[7]Customer relationship theories also suggest that customers with less deposit variability are preferred. Deposit variability (DEPSTE) is not included in the customer relationship specification because only 899 loans were associated with the data required to calculate deposit variability. A separate customer relationship regression was run with the 899 observations and it indicates that DEPSTE is statistically significantly different from zero at the 1 percent level. (DEPOSITS were not included in this regression because of multicollinearity.) Moreover, DEPSTE is negatively related to the expected return. The result is opposite that suggested by customer relationship theory: customers with lower deposit volatility are preferred customers who receive a lower contract interest rate than nonpreferred customers.

[8]The form of this variable may be misspecified because the Sharpe customer relationship results indicate TIME is inversely and statistically significantly related to the expected return when TIME is in log form.

compared with new customers.

The results shown in the fourth column of Table 5.2 do not support Sharpe's theory. The length of the customer relationship (log(TIME)) is statistically significant but inversely related to the loan's expected return.

J-Test and Cox-Test

The J-test and Cox-test consider whether any of the theories tested in this study provide significantly more explanatory power in commercial loan pricing. (See pages 69 through 73 for a further explanation of non-nested tests.) As mentioned earlier, the model specification for portfolio theory and Sharpe's (1990) customer relationship theories provide coefficients that are statistically significantly different from zero, but signs opposite those hypothesized by their respective theories (see Chapter IV). Because these model specifications fail to explain loan pricing as proposed by theory, they are not included in the non-nested tests.

**Table 5.3: Results of J-Test: Predicted Values for Re-estimated Equations, T-Statistics in Parenthesis Dependent Variable: Expected Return on Loans**

| | Predicted Values for: Credit Rationing | Customer Relationships H,K&M |
|---|---|---|
| $H_0$: Credit Rationing<br>$H_1$: H,K&M Customer Relationship | | 0.209541<br>(1.64) |
| $H_0$: H,K&M Customer Relationship<br>$H_1$: Credit Rationing | 0.992941<br>(25.57)* | |

*Significant at the 1 percent level.
**Significant at the 5 percent level.

**Table 5.4: Results of Cox Test (q Statistic)**
**Dependent Variable: Expected Return on Loans**

| | q Statistic |
|---|---|
| $H_0$: Credit Rationing<br>$H_1$: H,K&M Customer Relationship | -2.003 |
| $H_0$: H,K&M Customer Relationship<br>$H_1$: Credit Rationing | -149.98* |

*Significant at the 1 percent level.

The results of the J-test presented in Table 5.3 indicate that the credit rationing specification provides more explanatory power than the M,K&M customer relationship specification. The null hypothesis that the credit rationing specification contains greater explanatory power is accepted over the H,K&M customer relationship specification because the predicted value of H,K&M is not statistically significantly different from zero when added to the credit rationing specification. In contrast, the null hypothesis that the customer relationship specification contains more explanatory power is rejected in favor of credit rationing because the predicted value of credit rationing is statistically significant at the 1 percent level when added to the H,K&M customer relationship specification.

The results of the Cox-test shown in Table 5.4 also indicate that the credit rationing specification provides the greatest amount of explanatory power. The q-value of -2.003 indicates that the null hypothesis that the credit rationing models contains the greatest amount of explanatory power should be accepted over the alternative hypothesis that the H,K&M customer relationship theory provides the greatest amount of explanatory power. When the hypotheses are switched, the q-statistic of -149.98 indicates that the null hypothesis of the H,K&M customer relationship theory should be rejected in favor of credit rationing.

## Further Tests of Loan Pricing

The remainder of this chapter considers three additional questions related to loan pricing. First, did the calculation of expected return account for the lack of evidence in this study that banks price loans relative to risk? Second, are collateralized loans priced differently than noncollateralized loans? Finally, are loans from larger firms, which are usually associated with more information, priced differently than loans from smaller firms, which are usually associated with less information?

### Calculation of Expected Return

The definition of the expected return on the loan used in this study is broader than that used in previous studies of loan pricing and is also broader than that used by most banks. In earlier studies, the premium had been used to measure a bank's return on its loans, mainly because further information was not available (for example, Berger and Udell, 1989). However, the premium does not explicitly take into account such factors as the default probability or the recovery on the loan in the case of default because of the subjective nature of risk evaluations (see Table 5.5).[9] If, as suggested by industry observers, banks do not currently incorporate the default probability related to loans (Altman, 1993), then a regression which

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**Table 5.5: Two Ways to Determine the Return on a Loan**

Expected Return

Calculation: $(1\text{-}d)(i\text{-}i^{*}) + (d)(IRR\text{-}i^{*})$

- Default Probability (d) - determined by applying the loan risk rating and the maturity of the loan to corporate default tables (see pages 57 and 58 for a more detailed explanation of this process).

- Risk Rating - an integer from one to eight where one is assigned to the least risky loans. Ratings are assigned by the bank's account managers. The ratings are based on financial measures and other firm-specific information.

- Premium $(i\text{-}i^{*})$ - defined below as the contract interest rate less the cost of funds.

- Internal Rate of Return (IRR) - the return on the loan if default occurs. It assumes default occurs after 34 percent of the loan has been paid. The total recovery rate of the loan is dependent on the type of collateral associated with the loan.

Premium

Calculation: $(i\text{-}i^{*})$

- Cost of Funds $(i^{*})$ - based on the yield of a government bond with a maturity equal to that of the proposed commercial loan plus a factor which covers the cost of insurance and brokerage fees.

- Rate (i) - the contract interest rate on the loan, which is based on the risk rating but does not estimate recovery in the case of default.

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uses the premium instead of the expected return as the dependent variable will be associated with an increased error variance.

[9] Banks can calculate default probabilities and the expected recovery on loans in the case of default. However, the historical data needed to make such calculations have not been gathered and stored by banks.

The first column of Table 5.6 presents the results of the portfolio theory regression as specified for this study where the expected return is the dependent variable. The second column contains the results when the premium is used as the dependent variable. The statistical significance and

**Table 5.6: Reconsidering the Portfolio Theory Specification**
**Ordinary Least Squares Results, T-Statistics in Parenthesis (Observations = 1,670)**

| | Dependent Variables | | | |
|---|---|---|---|---|
| | Expected Return | Premium | Expected Return | Premium |
| Intercept | 3.547293<br>(61.14)* | 3.192322<br>(63.13)* | 4.031320<br>(17.50)* | 1.418214<br>(9.20)* |
| VAR | -0.015015<br>(-33.09)* | 0.000337<br>(0.85) | | |
| $VAR^2$ | -0.000000<br>(-0.01) | 0.000014<br>(9.70)* | | |
| RISK | | | -0.190320<br>(-3.30)* | 0.455177<br>(11.86)* |
| CORR | 0.537148<br>(2.27)** | 0.332567<br>(1.61) | 0.294687<br>(0.96) | 0.559346<br>(2.73)* |
| A | -0.000000<br>(-16.28)* | -0.000000<br>(-17.45)* | -0.000000<br>(-13.58)* | -0.000000<br>(-14.90)* |
| MATURITY | -0.001293<br>(-18.77)* | -0.000157<br>(-2.62)* | -0.002394<br>(-31.74)* | 0.000108<br>(2.14)** |
| Adjusted $R^2$ | 0.64 | 0.20 | 0.40 | 0.22 |
| F-Statistic | 600.13* | 84.56* | 279.74* | 116.17* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

signs of the coefficients differ. When PREMIUM is used as the dependent variable, VAR is positive and insignificant while $VAR^2$ is positive and statistically significantly different from zero. These results suggest that as the risk (defined as the variance) related to the loan increases, the premium also increases as indicated by portfolio theory. Thus, the way expected return is measured may be affecting the results. However, the error estimate associated with the regression when the premium is used as the dependent variable supports the view that the premium is a less accurate measure than the expected return. The increased error associated with the premium is evident in the estimated residual variance of the regression which is represented by a smaller adjusted $R^2$ and F-statistic when compared with the regression that uses the expected return as the dependent variable.

The measure of risk (VAR) used in this study also may be broader than that used by banks because it explicitly takes into account the default probability of the loan as well as the recovery amount related to the loan. As noted in Table 5.5, the case study bank denotes risk by assigning each loan an integer from one to eight where one is the least risky category. Ratings are assigned by account managers and are based on financial measures and other firm-specific information.

The third and fourth columns in Table 5.6 replace VAR and $VAR^2$ with RISK, the bank's measure of risk that ranges from one to eight. When the premium is used as the dependent variable, a positive and statistically significant relationship exists between the premium and RISK. This relationship suggests that the loans of the case study bank are priced relative to risk if the bank's risk rating properly accounts for all of the risk involved with the loan. The fourth column of Table 5.6 indicates that the case study bank's risk rating is statistically significant and inversely related to expected return, which incorporates default probabilities and expected recovery rates.

The difference between the regression results presented in the last two columns of Table 5.6 suggest that default probability and recovery amounts may not be adequately incorporated into loan pricing. This result is not surprising, given the difficulty of obtaining historical information on loan defaults. According to Jaffee and Stiglitz (1990, p. 843):

> Even in insurance markets, where actuarial data are available to measure risk, significant variation are sometimes observed in the premia charged for the same risk. All the more so, competition in loan markets will not always eliminate errors in borrower classifications.

Collateral and Loan Pricing

Two theories propose opposing views of the impact of collateral on loan pricing. Stiglitz and Weiss (1981) posit that increasing collateral requirements beyond some point may cause a bank's expected return to decline because higher collateral requirements decrease the average degree of risk aversion of the pool of borrowers or encourages borrowers to undertake riskier projects. In contrast, Barro (1976) argues that collateral acts as an incentive for borrowers to repay their loans; and Boot, Thakor, and Udell (1991) suggest that firms use collateral to obtain more favorable loan terms. In the latter two studies, the expected return on collateralized loans is expected to be lower than that of non-collateralized loans.

A t-statistic is used to test the equality of the means of the expected return of these two independent samples: loans with collateral requirements and loans without collateral. Table 5.7 compares the means of the expected return for all loans and subdivides the data by risk ratings one through four. The results suggest that collateralized loans are associated with smaller

**Table 5.7: Comparing the Means of the Expected Return on Loans by Bank Risk Rating**

| Risk-Rating | No Collateral | Collateralized | T-Statistic |
|---|---|---|---|
| All Loans | 2.98 | 1.00 | 16.80* |
| Rated 1 | 3.12 | 0.06 | 4.28* |
| Rated 2 | 3.04 | 0.77 | 8.89* |
| Rated 3 | 2.60 | 0.86 | 11.37* |
| Rated 4 | 3.31 | 1.23 | 10.12* |

*Significant at the 1 percent level.
***Significant at the 10 percent level.

**Table 5.8: Comparing the Means of the Premium on Loans by Bank Risk Rating**

| Risk-Rating | No Collateral | Collateralized | T-Statistic |
|---|---|---|---|
| All Loans | 3.23 | 2.99 | 2.24** |
| Rated 1 | 3.12 | 0.07 | 4.37* |
| Rated 2 | 3.06 | 0.89 | 8.57* |
| Rated 3 | 2.82 | 2.64 | 1.38 |
| Rated 4 | 3.56 | 3.35 | 1.23 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.

expected returns than noncollateralized loans. In other words, collateral is associated with a higher expected payback and thus lower perceived risk. These results support Barro, and Boot, Thakor, and Udell. This relationship held true for the total sample as well as each individual risk rating.

A comparison of the means of the premium on loans provided similar results. As shown in Table 5.8, loans with collateral were associated with statistically significantly smaller premiums than those without collateral. This relationship, however, was not significant for loans with risk ratings three and four.

Firm Size and Loan Pricing

Large firms are expected to be associated with relatively more information than small firms because the larger firms are more often publicly traded. Unfortunately, the size of the firm associated with each loan in the database is not available. However, the study makes the same assumption used by previous studies that larger loans are associated with larger firms. Consequently, the regressions are recalculated for portfolio theory, credit rationing, and customer relationships where the sample is divided between loans greater than or equal to $1 million and those that are less than $1 million (see Tables 5.9 through 5.12).

The regressions that are subdivided by size provide results similar to those already reported in the case of customer relationships as defined by Sharpe (Table 5.2). The regression results of the subdivided data do not support customer relationship theory as suggested by Sharpe. The differences in the results when the data are subdivided by size of the model specifications for portfolio theory, credit rationing, and customer relationship (Hodgman, Kane and Malkiel) are explained in turn.

Table 5.9 indicates that the portfolio specification results differ when loans are split by size. In the case of loans larger than $1 million, CORR is

**Table 5.9: Portfolio Theory: Results of Ordinary Least Squares by Loan Size where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis**

| | Loan Size | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| Intercept | 1.576070 | 4.285988 |
| | (12.39)* | (69.70)* |
| VAR | -0.010704 | -0.014650 |
| | (-9.00)* | (-34.49)* |
| $VAR^2$ | -0.000002 | 0.000002 |
| | (-0.44) | (1.61) |
| CORR | -1.499283 | 0.679206 |
| | (-2.91)* | (2.99)* |
| A | -0.000000 | -0.000003 |
| | (-3.22)* | (-14.68)* |
| M | -0.001030 | -0.001738 |
| | (-6.25)* | (-25.78)* |
| Adjusted $R^2$ | 0.60 | 0.73 |
| F-Statistic | 72.89* | 768.11* |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

statistically significant and inversely related to the expected return which suggests that the largest loans are not priced relative to the risk contribution they provide to the overall portfolio. This result might have occurred because the largest loans comprise the largest proportion of the portfolio.

In terms of credit rationing, Table 5.10 indicates that a parabolic relationship exists between the expected return and the contract interest rate of the largest loans. For small loans, however, the relationship between expected return and the contract rate is convex. This finding implies that the marginal return on the small loans increases as the variance increases.

**Table 5.10: Credit Rationing: Results of Ordinary Least Squares by Loan Size where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis**

| | Loan Size | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| Intercept | -7.381894<br>(-6.06)* | 1.317769<br>(2.04)** |
| RATE | 2.821347<br>(6.26)* | 0.192749<br>(1.27) |
| $RATE^2$ | -0.203454<br>(-5.13)* | 0.025252<br>(2.86)* |
| A | -0.000000<br>(0.72) | -0.000002<br>(-7.64)* |
| M | -0.002553<br>(-16.97)* | -0.002986<br>(-40.52)* |
| Adjusted $R^2$ | 0.57 | 0.59 |
| F-Statistic | 84.73* | 510.54* |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

On the larger loans, however, the marginal return decreases as the variance increases. This finding suggests that the case study bank may extend loans to large customers beyond the point of its maximum expected return--a practice which does not occur for smaller customers as suggested by the positive and statistically significant coefficient for $RATE^2$ in the regression of loans that are less than $1 million. In other words, large loans may not be rationed as often as small loans.

**Table 5.11: Customer Relationship (H,K&M): Results of Ordinary Least Squares where the Dependent Variable is the Expected Return on Loan, T-Statistics in Parenthesis**

| | Loan Amount | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| Intercept | 1.494124<br>(8.50)* | 4.189849<br>(42.64)* |
| GROWTH | 0.003182<br>(0.70) | -0.000934<br>(-0.47) |
| DEPOSITS | -0.000000<br>(-1.64) | -0.000000<br>(-2.04)** |
| TIME | -0.000055<br>(-1.61) | 0.000015<br>(0.83) |
| A | -0.000000<br>(-2.00)** | -0.000003<br>(-13.24)* |
| M | -0.002112<br>(-13.57)* | -0.002781<br>(-35.29)* |
| Adjusted $R^2$ | 0.45 | 0.50 |
| F-Statistic | 41.19* | 282.76* |
| Observations | 257 | 1410 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

Table 5.11 provides similar results regarding the customer relationship theory (Hodgman, Kane, and Malkiel). The results indicate that the largest loans are priced differently than those that are less than $1 million. In the regression of the largest loans, DEPOSITS is not statistically significantly different from zero when regressed against the expected return and it is significant in the regression where loans are less than $1 million. This suggests that pricing based on customer relationships is more important for smaller firms. This may be true for several reasons. First banks may encourage customer relationships with smaller firms in order to gain more information about them because information is scarce relative to larger firms. Second, larger firms are able to "shop around" and use several different banks for their service needs. Third, the size of large customers allows them access to public markets for loan needs.

**Table 5.12: Customer Relationship (Sharpe): Results of Ordinary Least Squares where the Dependent Variable is the Expected Return on Loan, T-Statistics in Parenthesis**

| | Loan Amount | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| Intercept | 2.477525<br>(5.35)* | 4.468982<br>(19.87)* |
| Log(TIME) | -0.169990<br>(-2.77)* | -0.044208<br>(-1.43) |
| A | -0.000000<br>(-2.04)** | -0.000003<br>(-13.76)* |
| M | -0.002040<br>(-13.41)* | -0.002756<br>(-35.39)* |
| Adjusted $R^2$ | 0.44 | 0.50 |
| F-Statistic | 67.40* | 470.14 |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.

# CHAPTER VI
# CONCLUSIONS AND IMPLICATIONS

The empirical results of this study provide some rationale for the way the case study bank prices commercial loans. Specifically, the results are consistent with the credit rationing and customer relationship specifications used in this study. Little support is found that commercial loans are priced as described by the portfolio theory specification used in this study.

More generally, the empirical results of this study provide little support that banks price commercial loans relative to risk in the strict sense described by portfolio theory. This result is anticipated by Jaffee and Stiglitz (1990) who argue that loan markets do not function like other markets. In fact, the data used in this study suggest that as the riskiness of a loan increases, the expected return to the bank decreases. This inverse relationship provides some support for those who contend that banks price the paper of their best customers too high and their worst customers too low (Foss, 1992).

Some support is found for the customer relationship view that banks offer relatively low interest rate loans to those customers whose characteristics are expected to offer most to the long-run profits of the bank. Consequently, when considered aside from risk, banks do grant their best customers lower interest rates. The empirical results also provide weak support for credit rationing which suggests that the contract interest rate on the loan acts as a signal of credit quality, and banks ration borrowers that exceed a certain risk level. Finally, the results of the non-nested Cox-test suggest that the credit rationing specification used in this study provides more explanatory power regarding the expected return on commercial loan prices than does the customer relationship specification.

The fact that bank loans exist in illiquid markets with scarce information provides one explanation for why this study found little support for portfolio theory but statistically significant explanatory power in customer relationships and credit rationing. The remainder of this chapter uses the concept of asymmetric information to draw conclusions and implications from the empirical results.

## Illiquid Markets and Asymmetric Information

The findings described in this study are best understood when considered within the commercial loan environment which is characterized by illiquid assets with asymmetric information. According to Murton (1989, p. 2 and 3),

> ...banks specialize in lending to a unique class of borrowers. For these borrowers, 'public information on the economic conditions and prospects of such borrowers is so limited and expensive that the alternative of issuing marketable securities is either nonexistent or unattractive' [Goodhart, 1987, p. 86]. Because these borrowers cannot easily convey information about their own creditworthiness to lenders (or conversely, because lenders cannot easily ascertain the creditworthiness),

> there are agency costs associated with the borrowing and lending arrangements available to them. Banks alleviate these costs by specializing in evaluating and monitoring this class of borrowers.

Bernanke (1983) also notes that banks are a mechanism to overcome the information problems associated with some assets that would otherwise be nonmarketable. Consequently, the very nature of commercial loans makes their pricing and risk assessment very difficult.

Credit evaluation is an essential part of the process of pricing an illiquid security, particularly because a borrower's risk classification determines the interest rate charged which, in turn, determines the efficiency of credit allocation in the economy.[1] Banks, however, have not developed databases of reliable historical information about the default and recovery rates associated with past lending.[2] Even if banks had kept good records, Rosenberg and Kravitt (1993) note that it is difficult to estimate the risk of loss on commercial loans because they are heterogeneous. Moreover, a certain amount of subjectivity is incorporated into the loan assessment process as various loan officers interpret the data surrounding a prospective loan applicant.

In addition to the lack of information, the pricing of commercial loans has intensified because of increased competition. Not only do banks face

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[1]See, Jaffee and Modigliani (1969), Jaffee and Stiglitz (1990), Kao (1992), and Stiglitz and Weiss (1981).

[2]See, for example, Morsman (1991), Larr and Stampleman (1993a and 1993b), and Rosenberg and Kravitt (1993).

competition with more than 11,000 other commercial banks that exist in the United States, but competition from nonbanking sources has risen. Commercial paper, for example, made up 3 percent of short-term borrowings by nonfinancial firms prior to 1966 and that figure rose to 15 percent by 1991. In fact, Beckett and Morris (1992) provide support for the view that good substitutes for bank loans have increasingly become available over the past decade.

Lack of Evidence for Portfolio Theory

The illiquid nature of commercial bank loans, the associated lack of historical data, and increasing competition provide possible explanations for why this study found little support for the basic financial relationship between risk and return. In essence, portfolio theory may not be very effective in explaining commercial loan pricing because the market for loans does not possess the level of efficiency that is found in the capital markets for which this theory most directly applies (see Table 6.1).

**Table 6.1: Comparing the Characteristics of Commercial Bank Loans and Efficient Capital Markets**

| | Commercial Loans | Efficient Capital Markets |
|---|---|---|
| Method of Setting Price | Credit Analysis | Auction Market |
| Method of Setting Risk | Credit Analysis | Auction Market (Price) |
| Buyer's Relationship to Price | Administered/Negotiated | Price Taker |
| Information | Asymmetric | Fully Available |
| Number of Buyers/Sellers | Few | Many |
| Type of Commodity | Heterogeneous | Homogeneous |

Flannery (1985) notes that practical considerations complicate the application of portfolio theory to bank loan selection and pricing decisions. For example, portfolio theory assumes investors are "price takers" because the market sets the price relative to risk and investors purchase assets at the going price. Commercial bank loans, however, do not trade in public markets.[3] Instead, the bank examines each applicant's financial characteristics in order to determine its creditworthiness and then determines the contract interest rate. Moreover, Flannery notes that portfolio models do not account for the fact that a bank's skill at analyzing credit and its ability to bargain affects the risk-return characteristics of the loans in its portfolio.

Credit markets also deviate from the standard models of supply and demand because interest rates indicate what the borrower promises to repay rather than what he will actually repay (Jaffee and Stiglitz, 1990, p. 838):

> If credit markets were like standard markets, then interest rates would be the "prices" that equate the demand and supply for credit. However, an excess demand for credit is common--applications for credit are frequently not satisfied. As a result, the demand for credit may exceed the supply at the market interest rate.

Theories of portfolio selection also assume that all relevant and necessary information about potential investments is available. Indeed, the availability of information is a basic assumption that leads to proper pricing. By contrast, though, bankers work with asymmetric information. Table 5.6

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[3]In the last few years, banks have started to securitize some commercial loans which enables the loans to be sold more easily in public markets.

suggests that loans might not be priced relative to risk if the case study bank did not adequately account for the recovery amount associated with the loan in the case of default. Intensifying the difficulties in pricing loans under conditions of asymmetric information is the apparent existence of an oversupply of loanable funds which has, most likely, driven the price of commercial loans below its associated risk level.[4]

The results obtained in this study for the portfolio specification are consistent with those stated by observers in the banking industry and thus are probably representative of most banks. With regard to risk and pricing, observers have found great variation in pricing practices between banks.

Three implications result from the lack of evidence for portfolio theory. First, banks can reduce the variability of returns on their loan portfolio by using more objective methods of measuring the individual risk of the loan and by considering the risk of the loan relative to the entire loan portfolio. According to Chirinko and Guill (1991, p. 19), "Ignoring covariation [between a loan and the portfolio] would substantially understate risk premiums." The method used in Chapter IV of this study to determine the expected return on loans can be used by banks as a starting point to improve their measurement of risk on loans. Other studies which suggest similar methods include Altman (1993), Kao (1993), and Gollinger and

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[4]See, for example, Lipen and Mitchell (1993), *Wall Street Journal*.

Morgan (1993).[5]

Second, banks that possess more information will more accurately assess the risk and price of loans. In this regard, information about the loan applicant should be supplemented with economic information about the geographic market in which the applicant operates.[6] Indeed, Harrison Young, the Federal Deposit Insurance Corporations' director of resolutions, expects that fewer banks will be involved in commercial lending in the future, but "The new commercial lenders will specialize either regionally or by industry..." (*American Banker*, October 1, 1993). Moreover, Nakamura (1993, p. 3) argues that "... the profitable lender is the one who best understands the businesses that borrowers are engaged in and the value of collateral that borrowers put up to guarantee loans."

The third implication of the portfolio theory results described in this study is that increasing competition for commercial bank loans will continue to pressure banks to offer interest rates that are below the risk implied by the loan. Perhaps the force of competition, more than any other force, has driven banks to consider loans in the broader context of the entire customer relationship because pricing the loan in consideration of the entire

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[5]The basic concept of portfolio management as applied to bank portfolios is presented in Larr and Stamplemen (1993a and 1993b).

[6]Ross (*American Banker*, October 2, 1992) suggests that the loan portfolio should be analyzed in terms of its response to different economic events: "Industry and regional performance can be examined through simulation under a range of potential economic events, such as a significant shift in exchange rates, a Japanese financial collapse, a recession, or a pronounced regional downturn."

relationship enables a bank to supplement its compensation for the risk.[7]

Customer Relationships Reduce Information Problems

The results of this study also provide some support that customers whose characteristics imply greater long-run profits for the bank are granted lower interest rates than others. Thus, the long-run impact on profits is a more important determinant of granting a loan than is the risk of the loan. According to Kane and Malkiel (1965), a utility maximizing bank may agree to grant a loan to a preferred customer even though the customer's risk will cause the bank to experience an overall decrease in utility because not granting the loan will also decrease utility. The implication of the customer relationship approach is that banks can supplement low returns on loans by other services offered by the bank such as cash management.

Customer relationships are also important to banks because they improve the banks ability to monitor their customers. Kane and Malkiel (1965) argue that when a bank and customer develop a relationship through loans or deposits, the bank is able to discern the quality of the customer. Black (1975) and Fama (1985) also suggest that the historical relationship of a borrower as a depositor provides the bank with information that allows it to identify the risks of granting a loan to a particular firm and can lower the bank's monitoring costs of that firm. Within an environment of scarce

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[7]The desire to further compensate a bank for taking on a risky loan through the profits of additional services is likely to create tension between relationship managers and portfolio managers who may seek divergent goals.

information, the information gained about a firm through the relationship provides the bank with the ability to more accurately price future loans.

Credit Rationing

Credit rationing is also an outgrowth of an illiquid market with scarce information. Credit rationing proposes that the bank does not grant loans beyond a certain contract interest rate because, at a ceratin point, adverse selection and moral hazard increase the possibility that higher contract interest rates will be associated with losses that outweigh the expected return from the increase in interest rates. Thus, interest rates signal credit worthiness in the absence of more reliable information. Moreover, the relationship between the expected return and the contract rate suggests that banks can maximize their expected return by rationing.

Credit rationing suggests that banks control risk by denying credit to the riskiest borrowers. The internal risk rating system that most banks use to assess the risk of commercial loans supports the credit rationing view. In the case study bank, for example, loans are assigned a risk rating from one through eight where one is the least risky. The bank's funds are rationed such that firms ranked five or higher are not typically granted a loan.

The empirical tests in this study provide weak support for credit rationing. Specifically, the results indicate that the relationship between the contract interest rate and the expected return on the loan is positive.

Collateral and Pricing

Finally, this study found that the expected return associated with collateralized loans is higher than that for loans without collateral. These results are consistent with Boot, Thakor, and Udell (1991) who argue that firms use collateral to obtain more favorable loan terms. In an environment of scarce information, collateral may decrease moral hazard thereby giving the borrower a greater incentive to repay his loans (Barro, 1976).

Further Research Questions

The results of this study suggest that further research is needed to more fully understand commercial loan pricing. For example, even though commercial loans are illiquid assets and exist in an environment of asymmetric information, can they be priced relative to risk? Recently, studies have begun to suggest ways for banks to more rigorously and objectively access commercial loan risk. Can such measures increase the efficiency of loan pricing? Alternatively, must loan pricing be considered an "art" because commercial loans are too heterogenous and mathematical tools are too general.

A tangential topic to commercial loan pricing is competition. Has the increase in nonbank competition for loans that intensified in the 1970s and 1980s caused banks to inaccurately price loans relative to risk? Specifically, if the least risky firms have moved to the more efficient bond markets, are the remaining smaller and more risky firms too difficult to price because of asymmetric information?

Government regulation may also play a role in explaining the results found in this study. Did the regulation of banks prior to the 1980s encourage inaccurate pricing of commercial loans? Is the banking industry still undergoing a transitory period in which they are learning to more accurately price loans because they can no longer rely on the protection of the government from outside competition?

Finally, would actual commercial loan default probabilities improve the results of this study with regard to portfolio theory? As noted earlier, banks have only begun to collect default rates for commercial loans (this study used corporate bond default rates as a proxy). When commercial loan default rates become available, the empirical tests of this study should be replicated.

# APPENDIX A
# GLOSSARY OF SYMBOLS

Symbols in Text

$d_i$ = Probability that default will occur on loan i
$C^*$ = Loan customers whose relationship is valued highly by the bank
$E(R_b)$ = Bank's expected return on a loan
$F(R_g,\theta)$ = Bank's perception of the distribution of returns on a borrower's project
$f(R_g,\theta)$ = Density function associated with the above
$i^*$ = Contract interest rate on the loan which is set by the bank
i = Time value of money equal to the nominal rate of interest or cost of funds
K = Collateral
L = Initial loan amount
N = Number of possible events
$R_g$ = Borrower's gross return on the investment
$R_i$ = Random event i
$R_m$ = Borrower's maximum rate of return on the investment
$VAR_i$ = Variance related to the expected return on loan i
$VAR_p$ = Variance on the loan portfolio
$x_i$ = Fraction of the portfolio represented by loan i
Z = The sum equal to full repayment of the loan contract (principal and interest)
$\theta$ = Risk associated with borrower's investment project
$\hat{\theta}$ = Yield on investor's project which determines whether he/she will borrow

Symbols in Regressions

$A_i$ = Dollar amount of loan for loan i
CORR = Correlation between the return on the bank loan portfolio and the credit risk of the industry in which the firm belongs
$DEPOSITS_i$ = Total deposits associate with borrower i
$DEPSTE_i$ = Standard deviation of month-end deposits for loan i
$E(R_i)$ = Expected return on loan i
$GROWTH_i$ = Projected growth rate for the borrower's industry
$i_i^*$ = Contract interest rate on loan i
$M_i$ = Maturity of loan i in days
$R_{pt}$ = Return on the bank's loan portfolio at time t
$TIME_i$ = Number of days the customer has held a loan or deposits with the bank
$VAR_i$ = Variance of the expected return on loan i
$\beta$ = Regression coefficient

## APPENDIX B
## METHODS USED BY BANKS TO PRICE COMMERCIAL LOANS

Most financial assets are sold in markets where the forces of supply and demand drive their risk-adjusted price toward an equilibrium. In these markets, investors are enticed to hold risky assets by the relatively high expected returns they offer. Because such markets do not exist for most commercial loans, bankers must rely on their expertise and a variety of methods to price loans relative to risk.

Theory suggests that for a loan portfolio to be priced efficiently,[1] the interest and fee income on its individual loans should incorporate 1) the bank's cost of funds,[2] 2) other costs related to the loan (such as overhead), 3) compensation for specific risks that increase the volatility of the loan's expected returns, and 4) compensation for portfolio risk. The bank's cost of funds normally comprises the greatest portion of a loan's price and is easy to determine--it is equivalent to the yield on the U.S. government security with a maturity equal to that of the loan[3]

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[1]Efficiency here means that the loan is priced exactly as it would be priced if all information were known. It is important to note that an efficiently priced loan is equivalent to its fair market price. Consequently, if a borrower were to request and obtain a lower interest rate, it would reduce the bank's expected profit. In making the decision to grant the loan, the bank would have to determine whether it could obtain a higher return if its resources were invested in an asset other than the loan. Also, an efficient portfolio is defined as the portfolio associated with the highest expected return of all portfolios available in a certain risk class, or the lowest risk of all portfolios available in a certain expected return class.

[2]The bank's cost of funds is comprised of the risk-free rate (government bond rate) plus the additional cost of the bank to borrow funds which is based on its own risk rating. Naturally, the cost of funds varies by bank, giving some a competitive advantage over others in their pricing of loans.

[3]Loans that are associated with a maturity of less than one year are generally priced relative to a shorter-term note such as the London Interbank Offered Rate (LIBOR).

plus a markup to account for the fact that loans to banks are riskier than loans to the U.S. government. Because the four remaining components of price are more difficult to determine, they are sometimes estimated intuitively or are not considered at all in the commercial loan pricing process. As a result, banks often price the loans of their best (lowest risk) customers too high and their worse (highest risk) customers too low. In either case, though, mispriced loans lead to the misallocation of assets in a bank's portfolio. The result is that the loan portfolio is less than optimal in terms of expected return risk and return.

The purpose of this chapter is to review the banking literature on current and proposed methods for pricing commercial loans. No one loan pricing model exists that is suitable for all loans and all banks. This chapter does not attempt to categorize loan pricing methods by bank size or customer type. Rather, it categorizes loan pricing methods into three groups that each emphasize one aspect of loan pricing but that must be used collectively to properly price loans. The first method, pricing to reflect profit, provides the basis of any decision to sell a product or a service: income and cost must be identified so that expected return can be determined. The second method, pricing to reflect specific risks, indicates that borrowers should be charged a premium for identifiable factors such as maturity and industry-type that tend to increase the risk that repayment will not occur as scheduled. The final method, pricing to reflect portfolio risk, indicates that the loan interest rate should incorporate a premium or discount to account for the variability an individual loan adds to or takes away from a bank's entire loan portfolio. Of the three methods described in this chapter, pricing to reflect portfolio risk possesses the least practical application in banking trade journals.

**Pricing to Reflect Profitability**

The first step in properly pricing loans requires that income (interest charges and fees) and costs (direct and indirect costs associated with making, servicing, and collecting the loan as well as an approximation of possible default) be identified as precisely as possible so that a loan's profitability or yield can be determined. The loan can then be accepted or rejected based on some pre-determined target rate.

Although the identification of costs and income seems relatively straight forward, this process can be complex. To begin the process, the bank must have an information system with which it collects, analyzes, and makes available relevant credit cost information to those pricing loans. The amount of information that is needed for the pricing process depends on whether the bank's strategy involves using relationship pricing or transaction pricing (also known as stand-alone pricing).[4]

Relationship pricing is generally used by regional and community banks that tend to service the middle-to-lower customer loan market. These banks attempt to "cross sell" products to the customers they serve. A customer who uses the bank's cash management services, for example, would be encouraged to borrow. Accordingly, relationship pricing holds that customer services are interrelated and thus loans should be priced to account for this broad relationship.[5] Consequently,

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[4]For examples, see Brick (1984), Ferrari (1992), Johnson and Grace (1990, 1991), Knight (1975), Rasmussen (1991), Rudis and Owens (1989), and Yang (1991).

[5]As pointed out by Ferrari (1992), stand-alone pricing should be used in conjunction with relationship pricing. He argues that banks should not devote resources to unprofitable business lines. However, accepting a small loss from one aspect of a customer relationship is wise if another facet of the relationship with the same customer is extremely profitable.

this approach measures the effect of such items as the compensating balances[6] and cash management revenues (also called activity revenues)[7] of all of the relationships a customer possesses with the bank to determine the "loan-relationship" profitability.

In contrast, some banks prefer to service only transaction loans.[8] These transaction (merchant) banks adhere to the stand-alone pricing perspective which holds that customers evaluate each bank product separately and assumes that customers may use several institutions to meet their financial needs. Thus, each product is analyzed and priced independently of others to ensure its profitability.

Because profitability pricing provides an in-depth framework of the income and costs that must be considered in loan pricing, two loan pricing examples are provided. The first is based on the stand-alone view, and the second holds the customer-relationship view.

Stand-Alone Pricing Example

The following numerical illustration from Brick (1984) shows how an estimated yield can be determined on commercial loans by using the stand-alone perspective. This example assumes a bank is considering a loan request for a three-year, $1-million revolving credit (see Table B.1). The bank requires a commitment fee of 1/2 of 1% per year on the unused portion of the commitment

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[6]A compensating balance is a noninterest-bearing deposit that a commercial loan customer is required to place in the bank according to the loan agreement. Most loans do not require compensating balances, particularly upper market (large) loans.

[7]Cash management costs include such items as lock boxes, returned items, stop payments, and wire transfers.

[8]Relationship banks make transaction loans as well, but with the expectation that they will lead to a relationship.

and compensating balances of 7% of the commitment plus 5% of borrowings.

**Table B.1: Stand-Alone Loan Pricing Example**

| | |
|---|---|
| Type of loan: | Revolving credit |
| Commitment: | $1 Million |
| Term: | 3 Years |
| Contract Interest Rate: | 1.10 x Prime (Initial Prime is 7%) = 7.70% |
| Accrual Method: | Actual/360 Method |
| Adjusted Nominal Rate*: | 7.7% x (365/360) = 7.81% |
| Commitment Fee: | 0.5% on Unused Portion of Commitment |
| Compensating Balances: | 7% of Commitment + 5% of Borrowings |
| Estimated Usage: | 75% (First Year) |
| Reserve Requirement: | 12% |
| Options: | Convertible into 3-year, Fixed-Rate Term Loan at 1.2 x Prime |

| | | | |
|---|---|---|---|
| A. Income | | | |
| 1. Interest Income | | | |
| $1 Million (.75)(.0781) | = | | $ 58,575 |
| 2. Fee Income | | | |
| $1 Million (1-.75)(.005) | = | | 1,250 |
| Total Income | | | $ 59,825 |
| B. Outlay | | | |
| 1. Average Loan Amount | | | |
| $1 Million (.75) | = | | $750,000 |
| 2. Less: Net Demand Deposit Balances | | | |
| $1 Million (.07) | = | $ 70,000 | |
| $1 Million (.75)(.05) | = | 37,500 | |
| Gross Demand Deposit | | 107,500 | |
| Less: Reserve Req. @.12 | = | 12,900 | |
| Net Demand Deposits | = | 94,600 | |
| Net Outlay | = | | $655,400 |

C. Estimated Loan Yield (y)

y = $59,825/$655,400 = 0.0913 or 9.13%

* When the actual/365 accrual method is used, the adjusted nominal rate is the same as the contract rate.

Source: Brick (1984).

The interest rate on the loan floats with the prime rate which is 7%[9]; and because the borrower's default and term risk justifies a price of 1.10 times prime, the initial contract rate on the loan is 7.7%.[10] The bank uses the actual/360 accrual method so the adjusted nominal loan rate is (365/360) x 7.8% = 7.81%. Finally, about 75% of the commitment or $750,000 will be used during the first year of the loan.

To estimate a loan yield (y), the bank's income must be determined net of compensating balances and reserve requirements. Table B.1 shows that given an estimated first-year usage of 75% on a $1 million revolving loan, the interest and fee amounts contribute $59,825 in total income. The outlay needed for this loan is the average loan amount less the usable net demand deposit balances. Consequently, the net outlay for this example loan is $655,400, which produces an estimated yield of 9.13%. Of course, the effective yield would be higher because

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[9]Generally the contract price of a loan is set at a fixed or variable rate and then is not reconsidered until the loan is renewed. A relatively new concept called performance based pricing, however, attempts to give the borrower an incentive to improve his/her performance (and therefore decrease his/her risk rating) by promising to decrease the contract loan rate when certain performance measures are met. More frequently, though, a schedule is attached to the loan contract that spells out increases in the contract loan rate as the credit migrates from a high quality to a lower quality loan (risk increases). If the borrower is rated by a bond rating agency such as Moody's, then the bond rating is used as the performance base by which the loan price is adjusted. In the case of non-rated firms, relevant financial ratios are used as the measure of performance.

[10]In this example, the riskless time value of money is incorporated into the prime rate, which is then adjusted based on the borrower's default and term risk. Using the prime rate rather than the risk-free rate as a basis for pricing the loan leads to imprecise pricing of risk because the spread between the target rate and the risk-free rate varies over time. For example, if the spread between the prime rate and the risk-free rate starts at 1 percent, then if the risk-free rate falls and the prime remains steady, the loans priced at 1.1 times prime will be priced too high.

interest payments are generally made monthly or quarterly.[11]

The stand-alone method requires information limited to the loan itself. Therefore, the calculations shown in Table 3.1 can be expressed in the following simple formula[12]:

$$y = [ur + f(1-u)] / [u - (b_1 + b_2u)(1-R)]$$

where y is the estimated loan yield, u is the estimated first-year commitment usage, r is the adjusted nominal rate, f is the commitment fee, $b_1$ is the compensating balance requirement on the total commitment, $b_2$ is the compensating balance requirement on the borrowings, and R is the reserve requirement on the compensating balances. Thus, for the example used here:

$$y = [(.75)(.0781) + (.005)(1-.75)] / [.75 - (.07 + (.05)(.75))(1-.12)]$$

$$= .59825 / .65540 = .0913 \text{ or } 9.13\%.$$

An advantage of this pricing formula is that it allows bankers to determine the yield on different types of commercial loans with various combinations of costs and can be easily incorporated into a computer program. In essence, it ensures that a loan's spread covers its costs if payments are made as scheduled. Knight (1975), however, suggests that bank's perform more detailed analysis on their largest customers to insure that adequate profits are generated by the entire account relationship.

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[11]The effective rate (i) is determined by the following equation:

$$i = [1 + (y/n)]^n - 1$$

where y is the estimated loan yield and n is the number of times per year interest is compounded.

[12]If a revolving credit or an open line uses a fixed commitment fee based on the total commitment rather than the unused portion, then the formula is $y = [ur + f] / [u - (b_1 + b_2u)(1-R)]$.

## Relationship Pricing

Table B.2 shows the elements of a customer-relationship profitability analysis as suggested by Knight. This analysis, which is typical of most, contains a detailed listing of sources and uses of funds, income, expenses, net income, and profitability measures.

Although the mathematics of profitability analysis are simple, the items used to measure the relationships are difficult to determine. Moreover, one can debate how to measure the items in this analysis. Johnson and Grace (1990), for example, show that the treatment of deposit balances in a profitability analysis has a significant impact on the loan's expected yield. The "total funds" approach gives the customer credit for deposits and uses the total funds borrowed as the base on which to measure profitability. The "net borrowed funds" model, however, essentially credits customer deposits at the bank's cost of funds rate by assuming that the borrower only uses the difference between the loan balance and the deposit balance. As a result, the net borrowed funds approach overstates the profitability of a loan and understates the pricing.

## Summary

A disadvantage of loan profitability analysis is that it requires the collection and analysis of a detailed set of data about loans. The strength of this analysis, however, can far outweigh the cost. Loan profitability analysis, whether relationship or stand-alone, indicates whether the income from a loan will cover costs if all interest and principle payments are made as scheduled. Moreover, it draws attention to the most profitable or unprofitable accounts and products, and thus allows more efficient allocation of resources.

**Table B.2: Customer-Relationship Profitability Analysis**

| | | | |
|---|---|---|---|
| A. Sources and Uses of Funds | | | |
| 1. Average Loan Balances: | | | $_____ |
| 2. Average Collected Balances: | | $_____ | |
| a. Investable Balance (x% reserve): | $_____ | | |
| 3. Average Time Balance: | $_____ | | |
| a. Investable Balance (x% reserve): | $_____ | | |
| 4. Total Loanable Funds (2a + 3a): | | | $_____ |
| 5. Bank Funds Used by Customer (1 - 4): | $_____ | | |
| a. Allocated Capital (8% of 1): | | $_____ | |
| b. Funds Transferred from Pool (5 -5a): | $_____ | | |
| B. Income | | | |
| 6. Gross Interest Income on Loans: | $_____ | | |
| 7. Earnings on Deposit (x% of 4): | $_____ | | |
| 8. Fees Paid: | | | |
| a. Service Charge Fees | | $_____ | |
| b. Loan Commitments | | $_____ | |
| c. Data Processing | $_____ | | |
| d. Total (8a + 8b + 8c): | | $_____ | |
| 9. Total Income (6 + 7 + 8): | | | $_____ |
| C. Expenses | | | |
| 10. Activity Costs from Account Analysis: | $_____ | | |
| 11. Interest Accrued on Time Deposits: | $_____ | | |
| 12. Charge for Bank Funds Used: | | | |
| a. Allocated Capital (20% of 5a): | $_____ | | |
| b. Pool Funds (x% of 5b): | $_____ | | |
| c. Total (12a + 12b): | | | $_____ |
| 13. Loan Handling Expenses: | | | $_____ |
| 14. Cost of Fee Services: | | $_____ | |
| 15. Data Processing: | | | $_____ |
| 16. Total Expenses (10 + 11 + 12 + 13 + 14 + 15): | $_____ | | |
| D. Net Income | | | |
| 17. Net Income Before Taxes (9 - 16): | | | $_____ |
| E. Profitability Measures | | | |
| 18. Allocated Capital Index (17/5a): | | | _____% |
| 19. Net Profits/Net Funds Used (17/5): | | | _____% |
| 20. Net Profits/Gross Amount Borrowed (17/1): | | | _____% |
| 21. Gross Profits/Net Funds Used [17+12c)/5]: | | | _____% |

Note: Activity (cash management) costs include items such as lockbox services, coin shipments, wire transfers, stop payments, and returned items.
Source: Knight (1975).

Articles that explain methods of pricing to reflect costs, however, provide little information about how to price the risks of a loan. The next section presents loan pricing models that concentrate on pricing risk.

**Pricing to Reflect Specific Risks**

Financial theory indicates that the expected return on an investment increases as risk increases.[13] A larger expected return is necessary to entice risk-averse investors to hold an instrument whose returns have greater variability than instruments with lower risk. When investments are traded in efficient markets where information is accessible to all investors, the price of the investment reflects risk. Because most bank loans are not traded in an open market and exist in an environment of asymmetric information, market-driven measures of risk do not exist. Consequently, bankers must gather information such as current financial data about borrowers and relationships between industries in order to accurately assess and price the risk of each loan. As with determining costs related to a loan, the more accurate the information about risk, the closer to a "market" price the loan will be priced. Also, when risk is properly priced the bank's management can be more confident that they are holding a portfolio with the mix of risk that they desire.

This section describes four methods that have been suggested to price the risk of bank loans. The first, measuring the default risk of a loan, uses specific information about a particular loan applicant to assess one aspect of risk--the

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[13]Risk is defined by the variance of the expected return around its mean. In other words, risk can be interpreted as volatility.

probability that the loan will not be repaid as scheduled. The second and third methods go beyond default risk and suggest how other risk factors such as maturity and industry-type can be measured and incorporated into the price of the loan. A final method discussed in this section uses bond market prices to assess the price of risk.

Pricing Default (Credit) Risk

Default risk is the probability that a borrower will not repay his/her loan under the terms initially agreed upon. Default risk, which is dependent on the borrower's characteristics, is determined in isolation of other loans in the bank's portfolio. Because many methods have been developed to measure default risk and are thoroughly discussed in the literature, only a few methods are briefly reviewed.[14]

Financial ratio analysis provided one of the earliest measurements of bankruptcy (and default) and remains a useful method of detecting operating and financial stress in firms.[15] Beaver (1967), for example, found that certain financial ratios exhibited significantly different measures when comparing healthy firms with firms experiencing financial difficulties. Moreover, certain financial ratios discriminated between matched samples of failed and nonfailed firms for up to five years prior to failure. Generalizing from several studies, the most helpful ratios

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[14]For a survey of bankruptcy and loan classification models, see Altman (1983) and Scott (1981).

[15]See, for example, Altman (1968), Beaver (1967), Dietrich and Kaplan (1982), Libby (1975), and Smith and Winakor (1935).

were those that measured a firm's profitability, liquidity, and solvency.[16]

The analysis of financial ratios has been enhanced by applying statistical techniques such as regression and multivariate discriminant analysis which consider interactive effects and groupings of variables. Two better known models of this type are the Z-score model and ZETA analysis. The Z-score model incorporates working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, market value equity/book value of total liabilities, and sales/total assets in a multivariate discriminant analysis to predict firms that are likely to go bankrupt. A study by Altman (1983) indicates that the model predicted a sample of 33 firms with 95 percent accuracy when the financial ratios were tested one year before bankruptcy. The accuracy of the model fell to 36 percent, however, when the ratios were tested 5 years before bankruptcy.

ZETA analysis, produced by Altman, Haldeman, and Narayanan (1977), improved the longer-term accuracy of the Z-score by successfully classifying 90 percent of the sample firms one year prior to bankruptcy and 70 percent of the firms up to five years prior to bankruptcy. The ZETA model relies on the following seven variables: return on assets (earnings before interest and taxes/total assets), stability of earnings (normalized measure of the standard error of estimate around a 10-year trend in the return on assets), debt service (earnings before interest and taxes/total interest payments), cumulative profitability (retained earnings/total

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[16]In practice, the set of ratios used often varies by the industry being analyzed. Moreover, the information content of ratios varies over time. Currently, leverage is a critical ratio as is interest and fixed charge coverage. Robert Morris Associates publishes an ***Annual Statement Studies,*** which summarizes the financial ratios from more than 95,000 financial statements. The statements are collected from banks and are categorized by the company's asset size and 4-digit standard industrial code.

assets), liquidity (common equity/total capital),a nd size (total tangible assets).

Although the above methods classify firms only into the two categories bankrupt and nonbankrupt, they provide meaningful insight into those variables that provide information about default. Dietrich and Kaplan (1982) extended the bankrupt/nonbankrupt categories by developing a model that computes a score that classifies loans into one of four mutually exclusive risk categories by using a debt-equity ratio, a funds-flow-to-fixed-commitments ratio, and sales trends. In addition, Bierman and Hausman (1970) suggest a dynamic programming technique that indicates whether to offer credit to a customer based on a set of decision rules.

After determining the risk rating or default probability of a loan, it can be incorporated into the price of the loan.[17] A useful illustration is presented by Saunders (1987) in which he assumes a contract loan rate is determined by the risk-free and default rate. In this case, a profitable loan contract rate would be determined by the following formula:

$$i^* = [(1+r)/(1-d)] - 1$$

where $i^*$ is a profitable loan contract rate, r is the risk-free nominal rate of interest, and d is the probability of default.[18] Using the formula above and assuming a default probability of 1 percent and 2 percent, Table B.3 indicates that the pricing is consistent financial theory which associates higher default probabilities (risk) with higher loan contract rates. Specifically, default risk increases as credit quality

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[17]Miller (1991), Loan Pricing Corporation, used the cumulative seven-year default rate of Standard & Poor's bond default statistic as a proxy for the default rate for bank loans with comparable risk.

[18]To determine the dollars that would be received for every $1 lent, the formula is simply $1+i^* = (1+r)/(1-d)$.

**Table B.3: Incorporating Default Rates into Pricing**

| T-Bill Rate | Probability of Default | Loan Contract Rate (1-year) |
|---|---|---|
| 10% | 1% | 11.11% |
| 10% | 2% | 15.79% |

declines. Therefore, banks must be compensated for additional risk through higher loan contract rates. As discussed next, however, risks in addition to default should be considered in loan pricing.

Subjectively Determine Areas of Risk and Apply Factors

Buck (1979) suggests a framework for pricing loans that consists of identifying risks that effect loans and quantifying them in a manner that can be incorporated into pricing. Admittedly, the identification and quantification of risk under Buck's approach is subjective, but after the risks are identified and quantified, the risk factors can be mechanically applied to loans to create an overall risk premium. Some examples of the risks that might be identified are credit risk, maturity risk, collateral value risk, and commitment period rate risk.

Once the underlying cause for the risk is identified, an associated premium factor can be determined. With regard to maturity risk, for example, longer loan maturity is associated with increased risk because time increases the possibility of changes in the borrower's credit strength or other events that might adversely affect the probability of loan repayment. According to Buck, maturity risk factors can be determined by using the yield curve in the bond market, or a straight-line premium can be computed, such as the one shown in Table B.4.

With factor tables for each risk, the determination of a loan target price is straightforward. The factors are simply added as costs to the loan to determine the contract loan price. Consequently, this method prices loans relative to risk, although the risks and associated factors are subjectively determined.

**Table B.4: Maturity Risk**

| Maturity (Yrs.) | Factor (%) | Maturity (Yrs.) | Factor (%) | Maturity (Yrs.) | Factor (%) |
|---|---|---|---|---|---|
| 0-1 | 0 | 10 | .94 | 19 | 1.88 |
| 2 | .10 | 11 | 1.04 | 20 | 1.98 |
| 3 | .21 | 12 | 1.15 | 21 | 2.08 |
| 4 | .31 | 13 | 1.25 | 22 | 2.19 |
| 5 | .42 | 14 | 1.35 | 23 | 2.29 |
| 6 | .52 | 15 | 1.46 | 24 | 2.40 |
| 7 | .63 | 16 | 1.56 | 25 | 2.50 |
| 8 | .73 | 17 | 1.67 | | |
| 9 | .83 | 18 | 1.77 | | |

Source: Buck (1979).

A more objective approach would determine risks and associated factors by analyzing the similarities of many loans created by many banks. Most banks do not possess such detailed information; but as explained next, Loan Pricing Corporation (LPC) has compiled a loan databank that has enabled them to do such analysis.

Pricing Matrix by Risk Factors

The Loan Pricing Corporation developed a pricing matrix that goes a step beyond Buck's method by devising an objective system to determine the risk factors and associated premiums by which to price loans. LPC developed its pricing matrix by analyzing the similarities of over 6,000 commercial loans to borrowers with sales over $500 million. Although much of their data were obtained from Security and Exchange Commission filings, they also incorporated proprietary loan data from over 45 banks nationwide.

LPC created its matrix by first using regression analysis to identify the factors that explained the spread of the contract loan price from LIBOR. After controlling for a number of variables, they found that spread pricing was statistically significantly dependent on borrower's risk, annual sales size, and the estimated usage level on the loan.[19] Loans were also analyzed by characteristics such as type (secured vs. unsecured), geographic location, and industry.

Essentially, the LPC method is similar to a multifactor capital asset pricing model where a sample of commercial loan "investments" have replaced the stock market portfolio. As a result, the LPC matrix identifies the premiums charged by banks for various risks and then uses these factors to identify the "market" price of a given transaction based on comparable deals.[20]

Pricing Loans Relative to Bonds

The price/risk structure created by the bond market can be a valuable reference point to bankers in their pricing of commercial loans. Specifically, because the bond market incorporates default risk into its return, it creates a risk structure for interest rates.

Maniktala (1991) argues that risk measures that rely on bond market data are superior to those based on historical data for two main reasons. First, because historical data are imbedded in a past environment, their forecasting ability is impaired when future conditions change. In contrast, the yield of bond market data reflects the market's estimate of future performance for a particular risk category.

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[19]Earlier analysis by LPC indicated that commitment size also explained a significant portion of the LIBOR spread, but it was not included in their analysis because of its correlation with borrower sales.

[20]Banks that purchase the LPC product are given personal computer software that enable them to compute a market loan price by entering into the program characteristics of the loan such as loan purpose as well as the firm's industry type, geographic location, and asset size.

Moreover, bond data change daily, reflecting the incorporation of new information about the future. Second, the availability and consistency of historical borrower-specific data is slim because the risk-scoring systems of most banks have not been in place for a very long period. Bond market data, on the other hand, are readily available for long periods of time.

Maniktala suggests the following three steps to price loans relative to the bond market. First, arrange annual corporate bond prices (available in *The Wall Street Journal*) by risk and maturity. Each risk-maturity combination should possess several bonds, while bonds with special option features should be excluded. Second, calculate the yield to maturity for each bond and the average yield for each risk-maturity combination. Finally, subtract the bank's cost of funds, represented by an adjusted secondary CD rate for an equivalent maturity, from each average yield to create the loan target. The resultant target, which shows the average return achievable in the public debt market for corporate bonds with an equivalent risk and maturity, can be used to determine the market-consistent return on bank loans that possess the same risk.

Table B.5 indicates how a bank's rating system might correlate with public bond ratings. For institutions using a 10-point risk rating system, a risk rating of 1 may correspond with the bond market rating of AAA.[21] Thus, the average return of the bank's portfolio of class 1 risks should be 0.23 percent.

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[21]Risk scores of 7 through 10 would be associated with bond ratings of CCC and below. Because these risk ratings represent problem credits, pricing is not a consideration.

**Table B.5: Average Target Loan Rates (Spread Over Secondary CDs)**

| Risk Rating S&P | Market Returns (%) Fourth Quarter 1990 | Bank's Comparable Risk-Rating System |
|---|---|---|
| AAA | 0.23 | 1 |
| AA | 0.36 | 2 |
| A | 0.61 | 3 |
| BBB | 1.14 | 4 |
| BB | 3.07 | 5 |
| B | 6.78 | 6 |

Source: Maniktala (1991).

An advantage of using the bond market to price loans is that it reminds decision makers of opportunity costs. Maniktala points out, for example, that a bank should not price the loan of a BBB risk company at LIBOR + 75 basis points when it could synthetically create bonds with similar pricing characteristics of the same company yielding LIBOR + 120. As such, this method also gives decision makers justification to deny loans in markets where competitive factors have driven loan prices too low. In addition, a market-driven pricing target should also improve customer negotiations since the prices are similar to those the customer would receive from the public markets.

Differences between the markets for bonds and loans, however, limit a direct transfer of a bond price matrix to loan pricing. For example, the correlation between the risk scores of a bank and the risk scores of bond ratings are not always exact, particularly when dealing with small to middle market companies.[22] Indeed, Goodhart (1987) and Murton (1989) point out that some firms borrow from

[22]In fact, pricing relative to bonds is typically used for upper market loans. Moreover, merchant (transaction) banks would be more apt to use this pricing method.

banks because public information on their economic condition is so limited that alternative public financing is too expensive or not available. Finally, loans tend to possess stricter covenants but more flexibility with regard to repayment under default while bonds possess the advantage of being more liquid.

Summary

Many different types of specific risks effect commercial bank loans. Identifying and pricing these risks will enable a bank's loan pricing policies to more closely approximate the true market price and more efficiently allocate available funds. A final risk that must be considered in pricing is the general risk of loans relative to the bank's total loan portfolio.

## Portfolio Approach to Pricing

Portfolio theory indicates that loans should be priced according to their risk-return relationship with a bank's entire loan portfolio. This theory shows that when a loan that possesses a negatively correlated return with the bank's loan portfolio is added to the portfolio, it reduces the overall variability of returns to the portfolio because it acts as a hedge against movement in the rest of the portfolio.[23] Consequently, negatively correlated loans should be priced lower than loans that are positively correlated to the portfolio, *ceteris paribus*.

Morsman (1991) noted that "Commercial loan portfolio management is in an embryonic state in most commercial banks--contrary to what many bankers might believe." Indeed, applying portfolio theory to commercial bank loan pricing is difficult because it is hard to measure the risk and expected return of loans which

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[23]This theory is explained further in Chapter III, *op cit.*, under portfolio pricing theory.

are needed to apply the model. Given these difficulties, the literature contains little practical application of portfolio theory to pricing commercial loans. As a result, this section reviews only one approach: measuring risk concentrations to adjust loan contract prices relative to its contribution to the portfolio's risk.

Diversifiable and Nondiversifiable Risk

Goodman (1981) considers the loans in a bank's portfolio to less developed countries (LDC) that are not members of the Organization of Petroleum Exporting Countries (OPEC). Because rate-of-return figures are not available, proxies are developed to estimate the country risk considerations that are assumed to affect the loan's rate of return.

The proxies chosen to estimate country risk represent possible problems that may hinder a country's ability to repay its debts: growth in exports, money supply, international reserves, and the ratio of imports to reserves. For each proxy, a quarterly time series was compiled and an index for each proxy was constructed with each country weighted by its borrowing share. A regression was performed for each country as given by the equation:

(8.1) $X_i = \alpha_i + \beta_i\hat{X} + e_i$

where ${}_i\hat{X}$ represents the index for a given country risk measure, $X_i$ is the country risk measure X for country i, and $\alpha_i$ and $\beta_i$ are constants. The systematic or nondiversifiable variance for country i for a given risk measure is equal to the squared $\beta_i$ constant from the regression times the variance of the index $[(\beta_i\sigma)^2]$. The nonsystematic or diversifiable variance is the squared standard error of the regression times (N-2)/N where N is the number of observations.

Although this method presents an alternative to quantifying diversifiable and nondiversifiable without using rate-of-return figures, it also has some drawbacks. First, bias may be introduced if measurement errors exist in the proxies. Second, although these measures may capture an ability to pay, they do not account for a willingness to pay. Finally, this method can be applied to only a small number of loans (non-OPEC LDCs) within a bank's portfolio.

Although the next article reviewed was also written with global bank lending in mind, its application of portfolio theory possesses greater general application.

Measuring Risk Concentrations

Common underlying factors exist within every loan portfolio that cause changes in the financial status of many borrowers. As a result, a group of loans that react similarly to the same events can cause a bank's loan portfolio to act as if it contained just a few large loans. For this reason, identifying covariances among loans based on such factors as exchange rates and geographic concentration, is important to the diversification process because it highlights sources of risk to the portfolio.[24]

Bennett (1984) uses the concept of covariance and risk concentrations to create a method that takes into account the bank's current portfolio structure to guide future decisions in exposure and pricing. Bennett presents this method by using a hypothetical bank loan portfolio analyzed at the customer level. Specifically, his method identifies the current credit rating and exposure of each customer and then uses economic theory to consider the likely impact on customer ratings of different events such as a $10 drop in oil prices, a 2% slower growth

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[24]In addition, loan covariances might include interest rates, commodity prices, major local events, and particular stages of the business cycle.

rate of European countries, and a 25% depreciation of the dollar. This portion of the analysis identifies borrowers that are sensitive to a common set of events and thus indicates where the portfolio's risks are concentrated by showing how each event would affect the quality of the loan portfolio.[25]

The result of the event analysis can be condensed into a single portfolio risk measure by giving specific value weights to the proportion of the portfolio in each risk category. The value weights reflect the notion that negative events will have a more adverse affect on the ability of weak credits to service debt than on that of strong credits. Moreover, a portfolio risk contribution index value can be created for each loan by considering whether the loan intensifies or mitigates the impact of each event on the bank's entire loan portfolio. Each borrower's portfolio risk contribution index value can then be used to guide future pricing.[26] For example, a borrower that contributes significantly to portfolio risk should be charged a price higher than the standard markup for its risk rating while a borrower that hedges the portfolio risk should be priced lower than the standard markup.

Summary

The portfolio approach encourages a bank to take a broader perspective and view individual credits in light of their affect on overall bank profitability rather than the profit on an isolated transaction. Moreover, pricing loans based on a portfolio approach implicitly rations credit to highly risky candidates. Specifically, if a bank is highly concentrated in an industry with a particular earnings pattern, then

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[25]Chirinko and Guill (1991) suggest a more sophisticated method that uses macroeconomic and input/output models to estimate loan losses associated with specific events.

[26]The price related to the risk contribution value is added to the price which reflects its original risk rating.

additional firms with the same earnings pattern could be charged a higher loan contract price while firms possessing opposite earnings patterns (yet the same default rate) would be charged a lower contract rate.

The portfolio approach is not without its problems, however. This approach is difficult to implement because the expected return on bank loans is difficult to determine given the many factors that are represented in the price of a loan. Also, like other statistical methods, a portfolio approach to pricing loans cannot fully substitute for the informed judgement of individual lending officers or credit analysts, but should be used in a supplemental manner.

## APPENDIX C
## PRESENTATION OF GENERALIZED LEAST SQUARE RESULTS

The following tables replicate the tests shown in Chapter 5, but generalized least squares (GLS) is used rather than ordinary least squares (OLS). As noted in Chapter 5, most of the OLS regressions tested positively for heteroscedasticity. The data are not corrected for heteroskedasticity, however, because the nonnested J-test and Cox-text were created for OLS regression results. In addition, parameter estimates remain unbiased and consistent in the presence of heteroskedasticity, even though they are inefficient. For the interested reader, however, GLS results are shown here.

The Park-Glejser statistic, which results from these tests is not used to weight the data. Rather, in order to use the same weighting system for all of the models, the variables are transformed by dividing them by the amount of the loan.[1] Because the data in this chapter are transformed by the original amount of the loan, the coefficients should be interpreted with caution. The coefficients reflect the mean expected return per dollar amount of the loan relative to the ratio of the independent variable in question per dollar amount of the loan.

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[1]It is necessary to use the same weighting system for all models because the dependent variables on the competing models must be the same in order to assess the relative explanatory power of the independent variables associated with each model.

**Table C.1: Generalized Least Squares (Heteroscedastic Consistent) Results where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis (Observations = 1,670)**

| | Portfolio Theory | Credit Rationing | Customer Relationships H,K&M | Customer Relationships Sharpe |
|---|---|---|---|---|
| A* | 1.683580 | 0.841012 | 4.941727 | 5.312480 |
| | (34.24)* | (1.82)*** | (60.54)* | (22.94)* |
| VAR | -0.012331 | | | |
| | (-28.70)* | | | |
| $VAR^2$ | -0.000002 | | | |
| | (-1.63) | | | |
| CORR | -1.504214 | | | |
| | (-8.33) | | | |
| Intercept | -0.000000 | -0.000000 | -0.000001 | -0.000001 |
| | (-14.23)* | (-2.15)** | (-2.81)* | (-3.29)* |
| M | -0.000911 | -0.002669 | -0.003012 | -0.003036 |
| | (-17.69)* | (-51.47)* | (-34.99)* | (-35.04)* |
| RATE | | 0.152893 | | |
| | | (1.67)*** | | |
| $RATE^2$ | | 0.035675 | | |
| | | (8.42)* | | |
| GROWTH | | | -0.006474 | |
| | | | (-3.18)* | |
| DEPOSITS | | | -0.000002 | |
| | | | (-3.28)* | |
| TIME | | | -0.000040 | |
| | | | (-2.09)* | |
| Log(TIME) | | | | -0.087110 |
| | | | | (-2.59)* |
| Adjusted $R^2$ | 0.67 | 0.80 | 0.45 | 0.45 |
| F-Statistic | 673.41* | 1647.60* | 276.50* | 446.11* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares transformation.

**Table C.2: Results of J-Test: Predicted Values for Re-estimated Equations, T-Statistics in Parenthesis**
**Dependent Variable: Expected Return on Loans**

| | Predicted Values for: Credit Rationing | Customer Relationships H,K&M |
|---|---|---|
| $H_0$: Credit Rationing<br>$H_1$: H,K&M Customer Relationship | -0.232683<br>(-2.10)** | |
| $H_0$: H,K&M Customer Relationship<br>$H_1$: Credit Rationing | | 1.012713<br>(53.72)* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.

**Table C.3: Results of Cox Test (q Statistic)**
**Dependent Variable: Expected Return on Loans**

| | q Statistic |
|---|---|
| $H_0$: Credit Rationing<br>$H_1$: H,K&M Customer Relationship | -1.227 |
| $H_0$: H,K&M Customer Relationship<br>$H_1$: Credit Rationing | -415.479* |

*Significant at the 1 percent level.

**Table C.4: Reconsidering the Portfolio Theory Specification Generalized Least Squares (Heteroscedastic Consistent) Results, T-Statistics in Parenthesis (Observations = 1,670)**

| | Dependent Variables | | | |
|---|---|---|---|---|
| | Expected Return | Premium | Premium | Expected Return |
| A* | 1.683580 (34.24)* | 1.357528 (34.11)* | 2.905803 (12.10)* | 4.852976 (17.50)* |
| VAR | -0.012331 (-28.70)* | 0.0046077 (13.25)* | | |
| $VAR^2$ | 0.000002 (-1.63)* | 0.000011 (10.05)* | | |
| RISK | | | 0.4791333 (7.77)* | -0.0271419 (-0.37) |
| CORR | -1.504214 (-8.33) | -1.491842 (-10.20) | -0.0819936 (-0.28) | -0.3929100 (-1.14) |
| Intercept | -0.000000 (-14.23)* | -0.000000 (-17.16)* | -0.000001 (-3.30)* | -0.000001 (-3.32)* |
| MATURITY | -0.000911 (-17.69)* | 0.000214 (5.12)* | -0.000957 (-13.30)* | -0.003079 (-36.07)* |
| Adjusted $R^2$ | 0.67 | 0.41 | 0.14 | 0.44 |
| F-Statistic | 673.41* | 228.58* | 66.61* | 331.99* |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares transformation.

**Table C.5: Portfolio Theory: Results of Generalized Least Squares (Heteroscedastic Consistent) by Loan Size where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis**

| | Loan Size | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| A* | 1.605442<br>(10.00)* | 3.331680<br>(44.20)* |
| VAR | 0.001954<br>(0.62) | -0.014471<br>(-37.94)* |
| $VAR^2$ | -0.000030<br>(-3.81)* | -0.000006<br>(-6.98)* |
| CORR | -0.807830<br>(-1.36) | 1.434785<br>(6.43)* |
| Intercept | -0.000000<br>(-2.59)* | -0.000001<br>(-12.63)* |
| M | -0.807830<br>(-1.36) | -0.000976<br>(-14.65)* |
| Adjusted $R^2$ | 0.54 | 0.59 |
| F-Statistic | 59.12* | 402.06* |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares transformation.

**Table C.6: Credit Rationing: Results of Generalized Least Squares (Heteroscedastic Consistent) by Loan Size where the Dependent Variable is the Expected Return on the Loan, T-Statistics in Parenthesis**

| | Loan Size | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| A* | -7.079922<br>(-6.02)* | 1.171030<br>(2.29)* |
| RATE | 2.527107<br>(5.99)* | 0.094720<br>(0.94) |
| $RATE^2$ | -0.154076<br>(-4.27)* | 0.038061<br>(8.18)* |
| Intercept | -0.000000<br>(1.05) | -0.000000<br>(-3.66)* |
| M | -0.003358<br>(-20.51)* | -0.002651<br>(-46.93)* |
| Adjusted $R^2$ | 0.64 | 0.80 |
| F-Statistic | 64.40* | 1405.90* |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares transformation.

**Table C.7: Customer Relationship (H,K&M): Results of Generalized Least Squares (Heteroscedastic Consistent) where the Dependent Variable is the Expected Return on Loan, T-Statistics in Parenthesis**

| | Loan Amount | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| A* | 1.590129 | 4.976604 |
| | (10.35)* | (55.17)* |
| GROWTH | -0.001848 | -0.006279 |
| | (-0.43) | (-2.86)* |
| DEPOSITS | -0.000000 | -0.000001 |
| | (-2.06)** | (-2.33)** |
| TIME | -0.000062 | -0.000041 |
| | (-1.74)*** | (-1.96)** |
| Intercept | -0.000000 | -0.000001 |
| | (-1.72)*** | (-4.69)* |
| M | -0.002508 | -0.002969 |
| | (-13.62)* | (-31.70)* |
| Adjusted $R^2$ | 0.46 | 0.46 |
| F-Statistic | 42.33* | 240.01* |
| Observations | 257 | 1410 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares transformation.

**Table C.8: Customer Relationship (Sharpe): Results of Generalized Least Squares (Heteroscadastic Consistent) where the Dependent Variable is the Expected Return on Loan, T-Statistics in Parenthesis**

| | Loan Amount | |
|---|---|---|
| | > = $1 Million | < $1 Million |
| A* | 3.144442<br>(6.15)* | 5.350655<br>(21.40)* |
| Log(TIME) | -0.210364<br>(-3.12)* | -0.085661<br>(-2.36)** |
| Intercept | -0.000000<br>(-2.01)** | -0.000007<br>(-5.39)* |
| M | -0.002428<br>(-13.49)* | -0.002987<br>(-31.73)* |
| Adjusted $R^2$ | 0.44 | 0.45 |
| F-Statistic | 67.55* | 390.51 |
| Observations | 257 | 1413 |

*Significant at the 1 percent level.
**Significant at the 5 percent level.
***Significant at the 10 percent level.
A* = 1/A due to generalized least squares.

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