THE IMPACT OF MONOPOLY POWER ON A
COMMERCIAL BANKING FIRM

by

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John Atwood Tribble
# Table of Contents

**Acknowledgments** .......................................................... ii

**List of Tables** ............................................................... v

**List of Figures** ............................................................... vi

**Abstract** ............................................................................ vii

Chapter

I  **Introduction** ................................................................. 1

   - The scope and purpose of the study ................................ 1
   - Bank regulations ...................................................... 2
   - Recommendations of the Hunt Commission ...................... 5
   - Outline of procedures ............................................... 7

II  **Review of the Literature on Commercial Banking and Monopoly Power** .......................... 8

   - Monopoly power ..................................................... 8
   - Traditional banking theories .................................... 14
   - Monopoly theories of banking ................................... 21
   - Empirical evidence of banking monopolies .................... 26
   - Literature on the appropriate time horizon .................. 29

III  **A Theoretical Model of a Commercial Bank** .................................................. 34

   - The profit seeking firm .......................................... 34
   - Commercial bank: monopolist and monopsonist .............. 37
   - Cost of loans and deposits ...................................... 40
   - Deposit-liability fluctuations .................................. 42
   - Transaction costs .................................................. 50
   - Market risk .......................................................... 52
   - Default risk ......................................................... 52
   - Maximization of expected profits .............................. 53
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV THE EMPIRICAL MODEL</td>
<td>55</td>
</tr>
<tr>
<td>The development of the empirical model</td>
<td>55</td>
</tr>
<tr>
<td>The data</td>
<td>68</td>
</tr>
<tr>
<td>V THE EMPIRICAL RESULTS</td>
<td>77</td>
</tr>
<tr>
<td>Assets and liabilities as a percent of total assets</td>
<td>77</td>
</tr>
<tr>
<td>Assets and liabilities for the average bank in the SFA</td>
<td>82</td>
</tr>
<tr>
<td>Assets and liabilities per capita in the SFA</td>
<td>85</td>
</tr>
<tr>
<td>Estimation of elasticities</td>
<td>88</td>
</tr>
<tr>
<td>First difference analysis</td>
<td>93</td>
</tr>
<tr>
<td>Critique of the empirical analysis</td>
<td>95</td>
</tr>
<tr>
<td>IV SUMMARY AND CONCLUSIONS</td>
<td>100</td>
</tr>
<tr>
<td>SELECTED BIBLIOGRAPHY</td>
<td>105</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Non-interest costs and bank scale</td>
<td>58</td>
</tr>
<tr>
<td>2.</td>
<td>Euler first order maximization conditions as a system of seven simultaneous equations</td>
<td>63</td>
</tr>
<tr>
<td>3.</td>
<td>Transformation of the Euler first order conditions</td>
<td>64</td>
</tr>
<tr>
<td>4.</td>
<td>Maximization conditions expressed as a function of the rates of interest</td>
<td>65</td>
</tr>
<tr>
<td>5.</td>
<td>Standard economic area classification</td>
<td>73</td>
</tr>
<tr>
<td>6.</td>
<td>Level of significance in the differences between average non-interest earning assets to total assets ratios, non-interest cost to total assets ratios, and non-interest revenue to total assets ratios between banks</td>
<td>75</td>
</tr>
<tr>
<td>7.</td>
<td>Two stage least squares analysis of eight bank classes using cross sectional data with assets and liabilities as a percent of total assets</td>
<td>78</td>
</tr>
<tr>
<td>8.</td>
<td>Two stage least squares analysis of eight bank classes using average assets and liabilities per bank</td>
<td>83</td>
</tr>
<tr>
<td>9.</td>
<td>Two stage least squares analysis of eight bank classes using average per capita assets and liabilities in the bank marketing area</td>
<td>86</td>
</tr>
<tr>
<td>10.</td>
<td>Average estimated elasticities of demand for state and local funds and loans and elasticity of time deposit supply by bank class based on estimates of demand and supply parameters using per capita assets and liabilities</td>
<td>89</td>
</tr>
<tr>
<td>11.</td>
<td>Two stage least squares analysis for four bank classes using first difference of average per capita assets and liabilities in the bank marketing area</td>
<td>96</td>
</tr>
<tr>
<td>12.</td>
<td>Average estimated elasticities of demand for state and local funds and elasticity of time deposit supply by bank class based on estimates of parameters using first difference of per capita assets and liabilities.</td>
<td>97</td>
</tr>
</tbody>
</table>


LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The multiple-product price discriminating bank</td>
<td>25</td>
</tr>
</tbody>
</table>
ABSTRACT

The Impact of Monopoly Power on a Commercial Banking Firm

by

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Department: Economics

The commercial banking industry is often criticized on the grounds that there is a high concentration of market power in the hands of a few firms. However, the appropriate measure of market power is Lerner's index of monopoly power, the elasticity of demand, not concentration ratios. The theoretical model developed in the paper is designed to permit the estimation of demand and supply elasticities in the banking industry. Specifically, two assets (loans and state and local funds) and one liability (time deposits) are investigated.

The empirical model focuses its attention on the demand and supply conditions. If the bank is a profit maximizer, then the banker adjusts the portfolio of assets and issues of liabilities in accordance with the Euler first order maximization conditions of the expected profits function. In this function administrative costs are expressed as a proportion of total assets. Default risks are ignored. At the optimal solution of the Euler first order conditions transaction costs generated by deposit-liability fluctuations are treated as scalars. These simplifying assumptions permit the estimation of the slope of the loan demand,
of the demand for state and local funds, and of time deposit supply, which can be used to estimate the elasticities of the respective functions.

The empirical results are based on cross-sectional data for 289 standard economic areas in those states where there is an absence of extensive branch banking. The observations are categorized into eight bank classes by per capita income level, by bank density per capita in the standard economic area, and by economic base (agricultural or non-agricultural) in the area. It is assumed that the demand and supply functions are identical for all banks within a bank class. Using the first order maximization conditions as behavioral equations the slopes of the supply and demand functions are estimated. These estimates are used to calculate elasticities of loan demand, state and local funds demand, and time deposit supply.

In general, it is concluded that those banks from low income areas have a lower elasticity of demand for loans than banks in high income areas. These banks have more monopoly power in the loan account. The elasticity of deposit supply is low for all classes of banks. This could be due to monopsony power, but it is more likely due to the legal ceiling on interest rates paid on time deposits. The analysis does not lead to any conclusions for the structural preconditions for the existence of monopoly power, but it does indicate that banks in certain markets may have some degree of monopoly power.
CHAPTER I
INTRODUCTION

The regulation of banks and financial institutions is a phenomenon steeped in the traditions of the western world. From the ancient usury laws enforced by the early church to the government run enterprises of the modern world the banking industry has never been free from market interference. The interference was justified on moral grounds, for financial market stability, and eventually for economic efficiency. Society's regulation has had two opposing influences on banking: one increasing competition and the other decreasing competition. The essential question of this paper is: do commercial banks have monopoly power with respect to loans and monopsony power with respect to time deposits.

The scope and purpose of the study

Market imperfections may necessitate the regulation of all financial intermediaries. However, there is one institution that is of particular importance, the commercial bank. Commercial banks are distinctive from all other financial intermediaries in that they are permitted to accept demand deposits. The aggregate volume of demand deposits exerts a vast impact on all sectors of the economy and is, therefore, a target for government regulations. However, much of this regulation is designed to enhance competition. This paper will address itself to exigency of regulation to promote economic efficiency in the commercial banking industry.
The concept of economic efficiency will be treated within the framework of market imperfections. Instead of using the traditional measures of market structure in the banking industry, (concentration ratios, loan-asset ratios, capital-asset ratios), an attempt will be made to ascertain whether the existence of monopoly power will cause banker's to alter their resource allocation. Monopoly power will be interpreted in terms of the elasticity of demand for funds from the bank and the elasticity of supply of funds to the bank. A model of the operation of a commercial bank will be proposed, which includes the possible existence of monopoly power. If the bank acts as if it has monopoly power, then the conclusion can be drawn that market imperfections do in fact alter the allocation of resources and the distribution of product.

Bank regulations

Under present conditions commercial banks are subject to regulation from three distinct sources. First, since the National Bank Act of 1863 the office of the Comptroller of the Currency has had the power to charter qualified institutions as national banks. The Federal Reserve Act of 1913 requires all national banks to be members of the Federal Reserve System and subject to Federal Reserve regulations. Second, commercial banks may be chartered by agencies of various state governments, being regulated by state law, and these banks may choose whether or not to be members of the Federal Reserve System. Third, all members of the Federal Reserve System, whether state or federal charter, have been obliged to participate with the Federal Deposit Insurance Corporation, since its creation in 1933. State banks that are not members of the
Federal Reserve System are free to choose not to participate with the Federal Deposit Insurance Corporation. The banking industry, as a whole, comes under the regulation of the state banking agencies, the Federal Reserve System, and the Federal Deposit Insurance Corporation.

From these three sources of regulation there arise four potential areas where competition or economic efficiency may be diminished.1 First, there may be a restriction of bank entry into the industry. The Banking Acts of 1933 and 1935, in the wake of monetary panic and concern with the problem of "over-banking," empowered the Comptroller of the Currency when considering any new charters to certify that he has examined the bank's

future earning prospects ... the convenience and needs of the community to be served by the bank.2

The Federal Reserve System and the Federal Deposit Insurance Corporation were given the same guidelines when accepting new members or issuing insurance to new banks. The policy, as stated, was to overtly restrict entry if new firms would dampen the earnings prospects for firms already in the industry.

Second, various state laws prohibit or restrict branch banking. As of 1970 there are nineteen states that permit state-wide branch banking. There are sixteen states where limited area branch banking prevails. In the remaining fifteen states only unit banking

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1 This rationale is described in Richard H. Timberlake and Edward B. Selby, Money and Banking (Belmont, Cal.: Wadsworth Publishing Company, Inc., 1972), pp. 207-224.

is permitted. 3 The law varies from state to state and the practice varies even more widely. Prohibitions of branch banking restricts competition and may permit the creation of local monopolies. On the other hand, the existence branch banking allows the growth of banking giants who by their mere size may inhibit competition. 4

Third, there are a variety of limitations placed on earning assets. "Country" banks are subject to one set of reserve requirements, "reserve city" another, and state chartered banks still other sets. Assets are restricted according to the size of the capital account under state law or under Regulation H of the Board of Governors of the Federal Reserve System. 5

Finally, there are a variety of limitations placed on interest rate payments. The Board of Governors of the Federal Reserve System uses Regulation Q to put a ceiling on rates of interest paid on time deposits. State agencies administer various usury laws which limit interest charged on loans. Both price restrictions and quantity restrictions may affect the degree of competition.

The net effect of the extensive regulation of the financial sector is difficult to judge. Clearly, there are various desirable social goals that the regulations are designed to further. Unfortunately, there are also costs associated with these regulations. ... There seems to be mounting

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4 This paper will not address the branch banking controversy specifically. A detailed discussion of the problem is given in Paul M. Horvitz and Bernard Shull, "The Impact of Branch Banking on Banking Performance," National Banking Review, 2 (December, 1964), 143-88.

5 Cf. Chapter IV, p. 60.
evidence that the net effect of regulation has been to create and sustain monopoly positions rather than protect the consumers or the financial system.6

Recommendations of the Hunt Commission

Given this structure of extensive regulation from almost all levels of government, with its dubious impact on competition and economic efficiency, in 1970 President Nixon established the President's Commission on Financial Structure and Regulation, later known as the Hunt Commission. The purpose of the commission was to study the operations, regulations, and structure of all private financial institutions in the United States and to propose a series of recommendations that would improve their performance. The following is a list of recommendations that pertain particularly to competition.

The commission recommends: (1) that all controls on interest rates paid on non-demand deposits be abolished (except on a standby basis for a period of ten years); (2) that financial institutions should not be allowed to pay interest on demand deposits; (3) that portfolio restrictions on financial institutions be substantially reduced; (4) that savings and loan associations and mutual savings banks be permitted to issue demand deposits and a wider range of liabilities; (5) that state laws be changed to encourage statewide branching of all financial institutions; (6) that rates on government guaranteed loans (particularly mortgages) be determined by market forces.7

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All of these recommendations were designed to enhance competition. First, removing all deposit rate restrictions should reduce disintermediation from one group of financial institutions to another when the general level of interest rates change. This means that all institutions will compete for deposits on an equal basis. The second recommendation is for the purpose of insuring that the needs of the small depositor are met. If interest payments were allowed on demand deposits a number of the services now available to small depositors would disappear. The third recommendation gives the bank or other financial institution a higher degree of autonomy in managing its own portfolio. In particular, savings and loan associations and mutual savings banks are permitted to purchase a wider range of assets, theoretically reducing the amount of risk in their entire portfolio. Also recommended is the elimination of geographical restrictions on the residence of borrowers, which were designed to insure that local funds were loaned locally.

The fourth recommendation, permitting savings and loan associations and mutual savings banks to issue demand deposits, puts these institutions in direct competition with commercial banks. The fifth recommendation concludes that branch banking enhances competition, instead of diminishing it. Finally, the sixth recommendation, which would remove the ceiling rates on mortgages, will increase mobility of resources in and out of the mortgage market. The increased liquidity will improve efficiency in the financial sector and reduce the gap between lending and borrowing rates of all financial institutions.  

This is a "set" of recommendations which taken as a whole are designed to increase competition. Collectively they would tend to cause the variety of distinctive financial institutions to become more similar. The essential legal differences between commercial bank, savings and loan associations, and mutual savings banks would be eliminated, thus increasing the total number of potential competitors in each market.

Outline of procedures

If under the present form of bank regulation there are restrictions on the degree of competition, this should be exhibited in the market behavior of commercial banks. In particular, it will be reflected in the elasticity of demand for funds from the banks. Chapter II will discuss the various measures of monopoly power and their application in banking markets. The chapter will also review the literature of banking theory and the empirical evidence of bank behavior with particular emphasis on models that affect the structure of the banking industry.

Chapter III builds a detailed theoretical model of a commercial bank, based on the review of the literature. This model recognizes the possible existence of monopoly power, but it is compatible with perfectly competitive markets, as well. An empirical model derived from the theoretical model is proposed in Chapter IV. The empirical model provides a testable hypothesis: that commercial banks act as if they have monopoly power. Chapter V will empirically test whether banks act as if their loan demand and deposit supply functions are less than perfectly elastic. Chapter VI summarizes the results and presents the conclusions.
CHAPTER II

REVIEW OF THE LITERATURE ON COMMERCIAL
BANKING AND MONOPOLY POWER

The literature on commercial bank portfolio determination is wide ranging and extensive. This review will be limited to those items that are of particular importance to this study. The review is intended to provide the foundation for the development of a theoretical model of commercial bank behavior. It is divided into five sections: (1) the concept of monopoly power; (2) traditional banking theories; (3) monopoly theories of banking; (4) empirical evidence of banking monopolies; and (5) literature on the appropriate time horizon.

Monopoly power

Monopoly power is the conceptualization of the idea that a business may have the capability of distorting the allocation of resources from their most economically efficient employment, whether that power is exercised or not. It is common usage to refer to the "degree of monopoly" as a recognition that monopoly power is being exercised. Strictly speaking, a monopoly exists whenever one firm is the only seller in a well-defined market of a well-defined product. Industries in which there are few competitors are said to exhibit some degree of monopoly. This implies, that while monopoly in the strict sense does not exist,

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the firms are capable of distorting the allocation of resources. Neither monopoly power nor degree of monopoly can be measured directly. Since they are merely the conceptualization of an idea it is difficult to assign a number to measure their relative intensities. A number of proxies have been suggested. These tend to fall into two classes: (1) those that are derived from the cause or structure of monopoly (numbers, concentrations, company and plant divergences); and (2) those that are derived from the effects of the existence of monopoly (rates of profit, price-inflexibility, marginal cost and price differentials, cross elasticities of demand).

The most obvious approach for measuring monopoly would be to count the number of firms in the industry. However, this approach quickly breaks down due to the difficulty in defining the market. This would be particularly true in the banking industry, where the number of firms in the nation or in the state may be large, but the larger portion of the deposits is controlled by only a few firms. The alternative is to measure the degree of monopoly by the concentration in the industry. That is the proportion of output controlled by the largest firm or the first four largest firms. But this measure is questionable, also, since the number of firms in the nation may be large and each firm relatively small, but each firm caters to a small well-defined market. Within this market each banking firm could have a great deal of monopoly power and market control, even though the concentration ratio for the industry as a whole is low. Another problem with concentration ratios is that firms do not produce a single product; instead they produce a variety of products. The firm has to be classified in one industry or another according to their major product and won’t be counted in other industries in
which they participate. The use of concentration ratios as a measure of degree of monopoly power in the banking industry does not appear to be promising.

It is often argued that the most obvious result of monopoly is abnormally high profits, and attempts have been made to measure the degree of monopoly power in terms of rates of profits. It is recognized that accounting profits are subject to many spurious influences, but Bain argues that profits may be adjusted to a comparable rate. The "theoretical rate" would adjust profits and value of "necessary net assets" to arrive at a rate which could be compared with competitive rates of profit as an indication of monopoly power. However, the adjustment process would be quite cumbersome, and the measure is still plagued with some theoretical considerations. For instance, an abnormal adjusted rate of profit might be the result of normal returns on investment or of abnormal returns on "necessary investment." There is no way to distinguish between the two.

Another phenomenon of imperfect competition that might be used to measure monopoly power is price inflexibility. Noting that administered prices change only infrequently, it is argued that if an industry is able to stabilize its prices for long periods of time, it is apparently in a monopolistic position. Particularly during the depression


years, those industries whose prices were insensitive to the downward pressure of severe recession appeared to exhibit monopoly power. A serious defect of this measure is that it fails to account for the possibility of cost inflexibility. Margin flexibility is a measure of price flexibility net of variations in direct costs of production. Dunlop compares on a percentage basis price changes with changes in direct cost, implying that the ratio of price changes to changes in direct cost yields a measure of price flexibility which can be used to measure the degree of monopoly. While price inflexibility appears to be a phenomenon associated with monopoly, its existence is merely a theoretical proposition, not a direct result of monopoly. Under certain conditions of constant marginal costs for the monopolist this proposition may become a result, but one has no grounds for assuming constant marginal cost. In addition, measuring monopoly power in terms of price inflexibility ignores differences in the variability of demand over time. Some monopolist may experience unstable market demands and may therefore appear to have relatively high price flexibility, even though they are faced with downward sloping demand curves.

Abba Lerner proceeds directly from the theory of monopoly to a measure of the degree of monopoly power. Since the monopolist is faced with a downward sloping demand curve price will not be equal to marginal cost at the profit maximizing level of output. The relative gap between marginal cost and selling price will be a measure of monopoly power:

Lerner index = \( \frac{P - MC}{P} \)

If the price is equal to marginal cost the index is equal to zero and there is perfect competition. The larger the gap between price and marginal cost the closer the index is to one and the greater the degree of monopoly power. Lerner's index bears a close relationship to the elasticity of demand at the profit maximizing output, where marginal cost is equal to marginal revenue:

\[
\text{elasticity of demand} = \frac{AR}{AR - MR} = \frac{P}{P - MC} = (\text{Lerner index})^{-1}
\]

The implication is that the less elastic the demand curve the greater the degree of monopoly power for the profit maximizing firm.

Another attempt to measure monopoly directly from the demand curves was made by K. W. Rothschild.\(^1\) He compares the slope of the demand curve for the firm with the slope of the demand curve for the industry. The firm's demand curve is defined for this purpose as that pertaining when all competing firms change prices. The ratio of the slope of the firm's demand to the slope of the industry's demand curve is an index of monopoly power. If the ratio is equal to one the firm controls the entire market and is a pure monopolist. The more perfectly competitive

the firm the closer the ratio approaches zero. Comparing his measure with Lerner's, Rothschild notes that Lerner's index is probably the ideal measure if we want to deal with problems like social cost of monopoly, the allocation of resources under monopoly, the divergence from optimum output, and similar questions.\textsuperscript{15}

Rothschild's formula gives a better indication of potential monopoly power of a firm over an industry. The major weakness of Rothschild's proposal arises when there is competition from similar products outside of the industry definition. Here his industry demand curve does not indicate total consumer demand.

Robert Triffin approaches this particular problem in terms of the cross elasticities of demand.\textsuperscript{16} If the firm is a pure monopoly, then the cross-elasticity of demand between its product and the products of all other firms is zero. This concept is theoretically appealing, but it runs into problems of practical application, because cross-elasticities of products of different firms cannot be aggregated into a single index.

For the purposes of this paper the most appropriate measure of the degree of monopoly is the Lerner index. This will prove empirically desirable, as well as, the best theoretical measure available. Care has to be taken to avoid overextending the concept of monopoly power with the Lerner model. Price Theory texts point out the following problem:

\textsuperscript{15} Ibid., pp. 33-34.

Another common misconception is that the demand curve faced by a monopolist is inelastic. Most demand curves, with the exception of those faced by firms under conditions of pure competition, range from highly elastic toward their upper ends to highly inelastic toward their lower ends. ... The output that maximizes a monopolist's profits will always be within the elastic sector of his demand curve if he has any costs of production. Marginal cost is always positive; therefore, at the output at which marginal cost equals marginal revenue, marginal revenue must also be positive. ¹⁷

If the monopolist is faced with an upward shifting marginal cost curve, he will reduce his output and raise his price, moving up his demand curve. In moving from one profit maximizing output to another, the elasticity of demand may rise and the Lerner index of monopoly power falls. As the firm moves up its demand curve price rises at a slower rate than marginal cost (assuming that the firm is maintaining the profit maximizing output) and the relative gap between marginal cost and price is falling. Even though the monopolist is charging a higher price and selling a smaller output the degree of monopoly, as measured by the Lerner index, has fallen. The higher prices and smaller quantities reflect only the rising cost structure. Despite this criticism the Lerner index is the best available measure of monopoly power.

Traditional banking theories

A commercial bank's basic function is to act as a financial intermediary. As such, it purchases securities from "ultimate borrowers" and issues indirect debt for the portfolios of "ultimate lenders." The bank participates in two distinct markets: a market for primary securities and a market for indirect debt. The essential questions

which a commercial bank has to answer are: how much indirect debt should it issue and how much of each type of security should it purchase?

F. Y. Edgeworth answers that last question by assuming that the banker is playing a game of chance:

Probability is the foundation of banking. The solvency and profits of the banker depend upon the probability that he will not be called upon to meet at once more than a certain amount of his liabilities. ...

I have imagined a new game of chance, which is played in this manner: each player receives a disposable fund of 100 counters, part of which he may invest in securities not immediately realisable, bearing say 5 per cent. per ten minutes; another portion of the 100 may be held at call, bearing interest at 2 per cent. per ten minutes; the remainder is kept in the hands of the player as a reserve against certain liabilities. The demand which he has to meet is thus regulated. From time to time, say every two minutes, there is taken a certain number, say 22, digits at random from the pages of some mathematical or statistical table. The sum of these digits constitutes the demand which the player must meet. We need not consider the provision which is made to meet the average amount (99) of the demand. The special object of the reserve above mentioned is to provide against demands which exceed the average. If the player can meet this excess demand with his funds in hand, well; but if not he must call in part, or all, of the sum placed at call, incurring a forfeit of 10 per cent. on the amount called in. But if the demand is so great that he cannot even thus meet it, then he incurs an enormous forfeit, say 100 l. or 1000 l. ... The player who wins the most interest wins the game.17

Theories of bank portfolio management based on deposit-liability fluctuations have been refined, but they are still based on the same principles. The forfeitures can be thought of as transaction costs: brokerage costs, penalty payments, possible loss of principle. Bank portfolio models have been developed on the basis of differing

transaction costs being associated with different assets yielding different returns. One such model was developed by Kenneth Lyon.\textsuperscript{18} Considering three types of assets: loans, securities, and case, $A_1, A_2,$ and $A_3,$ respectively, with rates of return $i_1$ and $i_2$ ($i_3=0$) and transaction costs $t_1$ and $t_2$ ($t_3=0$) associated with each asset. The expected profits function is the interest earned on each asset if the asset is in the portfolio for the full time period minus the interest lost times the percent of the time the asset is expected to be absent from the portfolio minus the expected transaction costs incurred in moving the asset in and out of the portfolio.

$$E(P) = E(\text{interest earned}) - E(\text{interest lost}) - E(\text{transaction costs})$$

where $E$ is the expectations operator. Letting $\gamma$ (with a density $f(\gamma)$) be the random variability of deposits, the probability that some loan assets will not be in the portfolio is:

$$\int_{A_1}^{A_1 - \gamma} f(\gamma) \, d\gamma$$

The probability that some security assets will not be in the portfolio is:

$$\int_{A_1}^{A_1 + A_2} (A_1 + A_2 - \gamma) f(\gamma) \, d\gamma$$

\textsuperscript{18}Kenneth Lyon, "Theory of Commercial Bank Portfolio Selection: The Simplified Model," Utah State University, unpublished paper.
The probability that all of the security assets are out of the portfolio is:

\[ \int_{0}^{A_1} f(\gamma) \, d\gamma \]

These probabilities may be interpreted as the percent of the time the assets are not in the portfolio. Therefore, the expected interest loss may be expressed as the interest rate times the percent of the time assets are expected to be out of the portfolio.

Transaction costs are incurred whenever the level of assets changes, either up or down; "whenever a level of assets below \( Z \) is followed by a level of assets above \( Z \)"\(^{19}\) or vice versa. Therefore, the probability of transacting the \( Z \)th asset is the joint probability of the two events:

\[ g(Z) = \int_{0}^{Z} f(\gamma) \, d\gamma \int_{Z}^{\infty} f(\gamma) \, d\gamma \]  \hspace{1cm} (2)

The expected profits function is:

\[ E(P) = i_1A_1 + i_2A_2 - i_1 \int_{0}^{A_1} (A_1 - \gamma) f(\gamma) \, d\gamma \]

\[ -i_2 \int_{A_1}^{A_1+A_2} (A_1+A_2 - \gamma) f(\gamma) \, d\gamma - i_2A_2 \int_{0}^{A_1} f(\gamma) \, d\gamma \]  \hspace{1cm} (3)

\[ -t_1 \int_{0}^{A_1} f(Z) \, dZ - t_2 \int_{A_1}^{A_1+A_2} g(Z) \, dZ \]

\(^{19}\text{Ibid., p. 7.}\)
Profits are maximized with respect to the three assets and the portfolio is allocated in accordance with the first order Euler maximization conditions. The determination of the portfolio is dependent on the random variability of deposits, the rates of interest received on loans and securities, and the transaction costs of loans and securities.

Another approach to bank portfolio management is centered around the assumption that operating cost differentials are the most significant variable. The cost associated with the "output" of each type of product and with the "input" of each type of resource will determine the banks holdings of assets and liabilities. The most difficult problem associated with this approach is in defining output:

In defining variables, there appears to be fairly general agreement on the relevance of current operating expense - as shown in Income and Dividend Statements - as a measure of cost. However, no similar consensus exists with respect to output definition. Measures used include total deposits, total assets, earning assets, number of loans and deposit accounts, and synthetic indexes.\(^{20}\)

George Benston has been the leading researcher in marginal costs associated with banking output. His approach to the output definition is described as follows:

For many problems of economic analyses, it is useful to think of the amount of loans and investments as product sold, the amount of deposits as a factor of production, and the amount of operations expenses as a cost of production. However, a better measure of bank output for study of the costs of banking operations [my underline] is the number of deposit accounts and loans processed.

The "work" of a bank consists of transferring funds on demand, holding and investing funds for time depositors, and making loans and investments. The operations costs incurred are a function of the services performed. Since these services are related primarily to the number of deposit account and loans processed rather than dollars loaned, economies-of-scale should be measured against this concept of output.21

Costs depend on the output mix: the cost of "producing" demand deposits, time deposits, mortgage loans, installment loans, business loans, and securities. Many of these costs are jointly dependent, since the "number" of assets may also affect the "number" of liabilities. Benston's statistical estimates indicate that the marginal cost curves for mortgage loans slopes upwards at a decreasing rate; the installment loan curve is U-shaped, and the business loan curve is downward sloping. He observes that this is consistent with studies indicating that larger banks tend to have a lower proportion of real estate and installment loans-to-total loans and investments, and that for smaller banks the proportion of business loans-to-total loans and investments is lower. On the liability side, the marginal cost curve associated with demand deposits is downward sloping and with time deposits the cost curves are flat. This is consistent with general observations that larger banks tend to issue a larger proportion of demand deposits than time deposits.22,23

A third approach to bank portfolio management is to assume that each bank determines its optimal portfolio in accordance with

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22 Ibid., p. 544.
23 Benston has recently updated and refined his original work applying it to savings institutions. "Savings Banking and the Public Interest," Journal of Money, Credit, and Banking, 4 (February, 1972), 133-224.
regulation and requirements administered by bank examiners. It is assumed that each bank knows the volumes of demand and time deposits, rates of interest, and the banks net worth. The banker is concerned with two basic restrictions: reserve requirements and "balanced portfolios." The "balanced portfolio" is defined in terms of "rules-of-thumb" used by bank examiners, i.e., upper limits on the ratio of debt to net worth, or of total assets to net worth. Bank examiners establish a "leverage" function, which is a linear combination of primary and secondary reserve, minimum risk assets, intermediate assets, and portfolio assets (and subsets of these). The "leverage" functions become a constraint, or more specifically a series of constraints, defined in terms of the asset variables. The banker maximizes profits subject to these constraints over a five-year period time horizon. This linear programming problem yields the optimal amount of each asset to be held in the portfolio. Chambers and Charnes have provided a tool for "optimal" portfolio decision making based upon the responsiveness of the bankers to bank examiners' guidelines, but their analysis does not answer the question of whether bankers actually behave in this way.

A commercial bank, like all intermediaries, is faced with the problem of what kinds of assets it is to hold in its portfolio and what combinations of debt issues it is to maintain. A variety of theories have been advanced on the basis of portfolio diversification. Edgeworth's and Lyon's models are founded on risk and transaction costs.

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25 Ibid.
Benston's model of marginal cost is based on the imperfect divisibility of assets (with output measured in number of accounts, instead of dollars). Chamber's and Charnes' model is based on the non-financial aspects of the portfolio, as they try to conform to bank examiners guidelines. It will be a major contention of this paper that a model based on price discriminating monopoly power is also of interest.

Monopoly theories of banking

With limitations placed on entry into the banking industry and restrictions on the establishment of branch banks one would expect that the industry would be characterized by some degree of monopoly. Instead of facing perfectly elastic demand curves of perfect competition, banks appear to be faced with downward sloping demand curves:

Individual banks also possess a degree of freedom in determining the interest rates to be charges on their loans to customers. To each bank the demand curve for its loans does not appear to be a horizontal line at the "ruling" market rate ... an increase in the bank's rate will not lead to a complete disappearance of the demand for its loans any more than a reduction of its rate will bring to it an infinite demand.26

Based on the number of alternatives that potential borrowers in a particular market have available to them, a commercial bank may find that its demand curve for a particular type of loan may be downward sloping. Bernard Shull and Paul Horvitz in a comparative study of banking structure defined the appropriate markets as local markets

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because for the vast majority of banks and bank-borrowers and depositors, neither the entire United States nor the individual state represent realistic geographic markets. The bank business is principally local in nature. 27

Within these local banking markets they conclude that concentration ratios are high. However, high concentration ratios are not a sufficient condition for the existence of monopoly. Monopoly power implies that firms in the industry have demand curves that are less than infinitely elastic.

A monopoly banking model was proposed by Bernard Shull. He describes a commercial bank as a multiple-product price discriminating monopolist. 28 The exposition of this model is conducted under conditions of absolute certainty. The following assumptions are made:
1. there are three types of assets (business loans, residential mortgages, and government securities);
2. the marginal cost of producing each of these assets is identical (marginal costs are independent of the composition of the portfolio);
3. there are no required reserves and no borrowed reserves;
4. there is no risk of default on any of the three types of loans;
5. there are no fluctuations in deposit-liabilities creating unforeseen demands for reserves;
6. there are no transaction costs in the purchase of any of the assets;


(7) the bank will maximize the change in net worth within a specified time horizon; and (8) in lieu of risks, there exists barriers to entry and prevention of relending that enable the banking firm to be a price discriminator.

The bank, beginning in a position with no earning assets in its portfolio, will make the loan that brings in the greatest amount of revenue. If ordering the loans shows the marginal revenue associated with the first unit of business loans to be greater than the marginal revenue of the first units of residential mortgages or government securities, then the bank will enter the market for business loans first. The bank will expand its business loans until the marginal revenue on business loans falls below the marginal revenue associated with the first units of residential mortgage loans. Assuming yields on some of the latter exceed the yield on government securities, the bank will then increase its holdings of both assets keeping their declining marginal revenues equal. This expansion of assets will continue as long as marginal costs are below marginal revenue.

Eventually, the marginal revenues associated with business loans and residential mortgages will decline to the level of the marginal revenue on government securities. The demand for government securities from this commercial bank may be perfectly elastic. If this is the case, the marginal revenue will remain constant as the bank expands its purchases of these securities until the marginal revenue is equal to marginal cost. Once the bank begins the purchase of government securities, it will not make any more business loans or mortgage loans,
since this would involve marginal revenues lower than could be gained in the government securities market.

Figure 1 graphically depicts Shull's model. If it is assumed that profit maximization \((MR_{BL} = MR_{RM} = MR_{GS} = MC)\) defines a stable equilibrium for the banks portfolio, then the bank will hold \(Oa\) of its assets in business loans, \(ab\) in residential mortgages, and be in government securities. (All of its assets are earning assets.) The interest rates charged on all three types of loans are defined as their average revenues, \(i_{BL}\), \(i_{RM}\), and \(i_{GS}\), respectively. The existence of downward sloping demand (i.e., monopoly power) is sufficient to cause a bank to diversify its portfolio.

Shull's model considers the commercial bank as a price discriminating monopolist, who restricts certain credit lines by charging higher prices. A number of models have been proposed, which consider those banks with monopoly power to be non-price credit rationers. Jaffee and Modigliani argue that, under certain circumstances, it may be rational for a bank to be a complete price discriminator, charging each customer a different price, but that in the banking system of the United States the necessary conditions are not met. Instead, at the ceiling rate of interest the bank's demand for loans may be greater than the bank is willing to offer. The bank will have to ration credit among its customers.

In the presence of risk as to the outcome of the loan, reducing the size of the loan will increase the expected return, by reducing the expected loss from insolvency of the firm. It is,

therefore, quite understandable that a bank faced with a higher opportunity cost (whether from a rise in the market rate or in lending opportunities) and unable to raise the return by raising rates, will find it profitable to raise its return at least by upgrading the quality of its portfolio through a reduction of risk; the upgrading may take the form of shifting funds toward less risky customers, and/or of reducing loans made to the same customer.30

This analysis depends crucially upon the concept of default risk and upward limitations (non-market) on rates of interest. In the absence of default risk it would be irrational for a banker to use non-price credit rationing. In the presence of default risk and interest rate limitations the banker would not become a price discriminator of the

30 Ibid., p. 865.
first degree.\textsuperscript{31} According to Jaffee and Modigliani, it would be irrational for the banker to attempt to capture all the consumer surplus. Instead, the banker will classify his customers into specific groups, charging the same price within the group, but different prices to different groups. In the presence of default risk the banker will use methods of non-price rationing to limit credit within a group, while credit is still rationed with price differentials between groups. This is not first degree price discrimination as described by Pigou, but it is akin to the multiple-product price discrimination described by Eli Clemens,\textsuperscript{32} on which Shull bases his model. Shull's model is proposed in a risk free world and would under those assumptions be consistent with Jaffee and Modigliani's model with the introduction of risk.

\textbf{Empirical evidence of banking monopolies}

Franklin Edwards, proceeding from the idea of limited borrower alternatives for small business firms, attempts to test two hypotheses:

(1) that, ceteris paribus, the level of business loan rates is higher in markets having relatively high concentration; and (2) that, ceteris paribus, business loan rates are less flexible in markets having relatively high concentration.\textsuperscript{33}

Using a sample of forty-nine Standard Metropolitan Areas (SMA) as constituting the appropriate markets and measuring concentration by


the percentage of deposits held by the three largest banks in each SMA, Edwards draws the following inferences:

concentration in banking markets should not be permitted to increase because of its adverse affect on price competition; ... since high concentration is associated with rigid price behavior, a more concentrated banking structure would make more difficult certain monetary policy objectives; and since increasing concentration would probably raise rates charged small borrowers, by more in relation to rates charged large borrowers, the result might be discriminatory reallocation of funds from small to large borrowers.34

In a study by George Kaufman based on observations of individual banks in the state of Iowa the structure of the banking industry is related to the "performance" of the banks.35 Kaufman suggests five possible measures of bank "performance": (1) gross interest rate charged on loans and (2) interest rate paid on time and savings deposits (price measures); (3) the ratio of loans to total assets and (4) the ratio of time deposits to total deposits (activity measures); and (5) net current before tax earnings as a percentage of total assets. He relates these performance variables to three indicators of market structure and to five factors effecting market demand. The three structural variables are: (1) the ratio of total savings and loan associations assets to total commercial bank deposits; (2) the distance from the nearest major financial center; and (3) either the number of banks or a concentration ratio. The five factors of demand that are incorporated into the analysis are: (1) population size; (2) population growth; (3) median family income; (4) growth of

34 Ibid., p. 300.

family income; and (5) ratio of nonagricultural employment to total employment. Based on regressions of the structural and demand variables on the performance variables, Kaufman concludes:

The greater was the number of banks or the lower was the percentage of deposits held by the largest bank, the lower were effective rates charged on loans, the higher were interest rates paid on time deposits and the greater was the ratio of time deposits to total deposits. In addition, the greater was bank concentration, the greater were pretax earnings on assets.36

Shull's model has not, as yet, been subjected to a rigorous empirical test. He points out that casual observation of the behavioral characteristics of the banking industry is consistent with the theory, but this does not constitute a rigorous test. However, some attempts have been made to utilize this theory in estimating the monopoly of a commercial bank.37 Eric Brucker uses the analysis to calculate the elasticity of demand for loans. Assuming that the government securities market is perfectly competitive (AR_{GS} = MR_{GS}), he uses the fact that marginal revenues of all the assets will be the same to estimate the elasticities of demand:

$$e_{RM} = \frac{AR_{RM}}{AR_{RM} - MR_{RM}} = \frac{AR_{RM}}{AR_{RM} - MR_{GS}} = \frac{AR_{RM}}{AR_{RM} - AR_{GS}} = \frac{i_{RM}}{i_{RM} - i_{GS}}$$

$$e_{BL} = \frac{AR_{BL}}{AR_{BL} - MR_{BL}} = \frac{AR_{BL}}{AR_{BL} - MR_{GS}} = \frac{AR_{BL}}{AR_{BL} - AR_{GS}} = \frac{i_{BL}}{i_{BL} - i_{GS}}$$

36 Ibid., p. 438.

Having estimated the elasticities on the basis of interest rate observations, Brucker compares the use of the loan-asset ratio and the elasticity of demand as measures of monopoly power and he finds that the elasticity of demand measure is far superior. The general argument with regard to the loan-asset ratios is that those banks which hold a high percentage of their loan portfolio in a highly competitive loan class would be less competitive, since they are restricting their loans in the noncompetitive class. Both Kaufman and Edwards use loan-asset ratios as an activity indicator of monopoly power. In a doctoral dissertation Michael Klein tests a recursive model of choice in determining the loan-asset ratio. His approach follows the analysis of Shull and indicates that price differences between loans and other assets (government securities) may depend on the elasticity of supply of the primary security to the bank. Although Klein's model is not derived directly from Shull's, his conclusions lend support to the contention that monopoly power is an important determinant of a commercial bank's portfolio.

**Literature on the appropriate time horizon**

The three empirical studies cited do not consider the profit maximizing motives of the bank. Instead they look only at the conditions of demand. In order to consider the bank as a profit maximizer it is necessary to know over what period of time the banker bases his decisions. The theoretical model of this paper outlines three distinct

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planning horizons: (1) an annual period over which the bank adjusts its portfolio to maximize profits; (2) an intermediate time period during which the bank is able to adjust some of its assets to conform to changing market conditions; (3) and the short run period where the bank is subject to random variations beyond its own control.

Problems arise with the optimal time planning horizon for banking operations. The reaction time for different types of situations differs. For instance, a change in general market conditions may affect the demand for loanable funds from the bank, but several months may be required for the bank to adjust to this change in condition. On the other hand, fluctuations in deposits may necessitate immediate adjustment of the asset portfolio or changes in rates paid on government securities may initiate an immediate revision of the bank's portfolio. With these time differences it is natural to ask what the appropriate planning period for a bank is. Should the bank maximize the flow of profits at all times? Should the bank maximize the annual change in net worth, or should the time horizon be much longer?

William Bryan and Willard Carleton in an analysis of the day to day fluctuations in a single bank conclude that their study supports the image of an individual commercial bank which at all times seeks to minimize its holdings of nonearning assets and which makes adjustments to shifts in deposits and loan demand by changing its borrowing position. While excess reserve position appears to be responsive to changes in the yield foregone in that asset nearest to cash, U.S. Treasury bills, it appears to be unresponsive to shifts in loan demands or to movements in deposits.40

Bryan and Carleton's study initiated further research on the actual mode of the adjustment process to deposit variability or changes in loan demand. The studies are conflicting and inconclusive.

Donald Hester and James Pierce argue that

the ease of purchase and sale clearly differs among assets. Cash can be exchanged instantaneously at zero cost. Treasury bills can be purchased or sold quickly at low cost. ... Transaction fees for other U.S. government securities are higher than those for bills. ... Mortgages can be acquired quickly and in volume only if the bank is willing to incur high promotional expense and/or make rate concessions. ... While the purchase of other loans involves the same sort of costs of rapid and extensive acquisitions as mortgages, there is no organized secondary market for these assets. ... ... If a bank were to receive an increase in the level of its deposits, even if it knew with certainty that the funds would not be withdrawn, it would not attempt to place them immediately in an illiquid form.41

The bank will adjust slowly, buying first those assets with which lower transaction costs are associated (and also lower rates of return). After some longer period of time the bank will acquire high return assets completing the adjustment process.

William Dewald and Richard Dreese argue in a similar fashion:

Banks facing reserve deficits because of deposit withdrawals or excess accumulation of earning assets have several alternatives open to them to meet their reserve requirements: earning assets can be sold; deposits can be attracted; or funds can be borrowed from the Federal Reserve or others. ... The reserve adjustment instruments include assets with short maturities traded in well-established markets and hence with little risk of depreciation in the immediate run.

... Portfolio adjustments would be made until each alternative adjustment offered equal marginal net yield. If a reserve loss is expected to be permanent, a bank would dis-invest in that asset for which the marginal yield was expected to be the smallest. In the case of reserve losses that were expected to be reversed, however, a bank would consider the net cost of selling an asset and subsequently buying it back.

Temporary reserve changes would lead banks to a different portfolio position than reserve positions that were expected to be permanent.\(^{42}\)

Dewald and Dreese argue that specific assets may serve as vehicles for the adjustment process. Which assets serve as the vehicle depends on whether a change in deposits or loans demand is considered permanent or temporary.

Donald Fraser and Peter Rose investigating the role of selected assets in the adjustment process for a sample of five individual banks come to conclusions that concur with Hester and Pierce's analysis.\(^{43}\) They find that short-run changes of excess reserves are not responsive to changes in interest rates, but that given a random "shock" which disturbs the banks actual holdings of excess reserves, the bank returns to its desired level at most within a few weeks. With government securities, as well as with excess reserves, Fraser and Rose find that the securities are unresponsive to interest rate differentials, but that they do respond to deposit fluctuations. Their model incorporates a stock adjustment formula to explain a gradual adjustment to a new optimal level of the stock of assets.

In the theoretical model presented in this paper it will be assumed that certain assets operate as adjustment vehicles. The bank will maximize the expected flow of net revenues from these adjustment vehicles over the intermediate time horizon.\(^{44}\) Other assets do not

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\(^{44}\)Cf., Chapter III, p. 44.
enter directly into the adjustment process. The net revenue of all assets is assumed to be maximized over a longer but finite period of time (i.e., a year).
CHAPTER III
A THEORETICAL MODEL OF A COMMERCIAL BANK

The purpose of this chapter is to develop an overall framework for the operations of a commercial bank. It is within the context of this framework that monopoly power in commercial banking will be scrutinized. The theory presented here will not be tested. Its purpose is to elucidate the simplifying assumptions made in the empirical model which will be tested. For this reason an attempt will be made to make the theory relatively comprehensive. In previous investigations of monopoly power in commercial banking, models have been developed and criticized for exhibiting peculiar aspects of the commercial bank while ignoring other aspects. Each simplifying assumption is a potential source of error. The theoretical model will provide a systematic check for the possible sources of error in the empirical model.

The profit seeking firm

The commercial bank is a business firm whose basic objective may be considered to be the accumulation of net revenues. The typical bank begins its business life by establishing a capital fund. This may come in the form of a single proprietorship, a closed corporation, or an open corporation. In these respects, the commercial bank does not differ from any other commercial venture. Once its physical facilities have been set up, its everyday operations resemble those of a department store. It acquires inputs of primary securities and cash and is prepared to provide indirect debt for sale to its customers.
The basic function of the commercial bank is to act as a financial intermediary. As such, it purchases primary securities (in part by extending loans) from "ultimate borrowers" and issues indirect debt (receives deposits) for the portfolios of the "ultimate lenders." The bank participates in two distinct markets: a market for primary securities and a market for indirect debt.

The product of intermediation is the indirect financial asset coined from the underlying primary security and bearing its own bundle of utilities. The reward for intermediation arises from the difference between the rate of return on primary securities and the interest or dividend rate they pay on their indirect debt.45

The assets and liabilities of the financial intermediary are highly specialized. As a department store would, the commercial bank treats its customers at utility maximizers and provides a number of alternatives designed to meet the needs and desires of specific groups of "ultimate borrowers" and "ultimate lenders" respectively. It is here that a commercial bank differs from any other business venture, either commercial or financial. One of the liabilities devised to meet the needs of "ultimate lenders" is demand deposits. This makes them unique among business ventures. As an institution commercial banks create demand deposits, i.e., money. Commercial banks are the only business firms that are legally permitted to issue indirect debt in the form of demand deposits. The legal framework that surrounds the commercial banking system has been developed because of the peculiar nature of the liability, demand deposits, as money.

If the commercial bank chooses the maximization of annual profits as a goal, then the bank will maximize the difference between revenues derived from the purchase of primary securities and the cost incurred in the sale of indirect debt, ignoring administrative and operating cost for the time being. If these revenues and costs are expressed in terms of rates of interest, then the commercial bank will maximize:

\[ P = A i - L r, \]  

where \( P \) is profits, \( A \) is the total amount of primary securities (assets), \( L \) is the total amount of indirect debt (liabilities), \( i \) is the rate of interest paid to the bank on the primary securities, and \( r \) is the rate of interest paid by the bank on indirect debt.

Since commercial banks, within the institutional structure and under governmental regulation, develop different types of indirect debt and primary securities for their customers, one would expect different prices to be associated with each form of debt and security. The profit equation could be expressed as:

\[ P = \sum_{j=1}^{n} A_j i_j - \sum_{k=1}^{m} L_k r_k, \]  

where there are \( n \) types of assets and \( m \) forms of liabilities.

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46 As expressed, these interest rates \( i \) are average rates, which depend on the maturity composition of the portfolio, and are weighted averages of the amount of primary securities purchased at past time period still in the portfolio and the prevailing rates of interest at the time. If the assets increase, adding more newer assets to the portfolio, the weight of the current interest rate will increase. Special empirical treatment will be given to this problem, see Chapter IV, p. 68.
Commercial bank: monopolist
and monopsonist

The legal framework within which a commercial bank operates encompasses four basic areas: (1) restrictions on bank entry; (2) branching barriers; (3) limitations on earning assets; and (4) interest payment limitations. The last two areas are direct restrictions on a bank's asset portfolio and liability holdings. These institutional restrictions (reserve requirements, regulation Q, capitalization restrictions, etc.) will not be dealt with at this point.  

The first two areas may directly affect the intensity of competition in the banking industry. Commercial banks have to obtain a charter from either the Comptroller of the Currency or a state banking agency. These agencies in the past have been concerned with the problem of "over-banking" within geographical areas and therefore tended to restrict the number of charters issued. Restrictions on branch banking in thirty-four of the fifty states similarly tends to diminish the degree of competition. The existence of monopoly power or monopsony power is characterized by a downward sloping demand curve for the firms product and an upward sloping supply curve for the firms inputs. With a downward sloping demand curve the monopolist banker is no longer a price-taker, he is able to control the quantity of his product demanded by either raising or lowering the price. On the other hand the monopsonist in the input market can affect the quantity of the input supplied to him changing the price for the input. Since people voluntarily deposit funds in a bank,

47 These aspects will be incorporated into the empirical model in Chapter IV.
the bank may change its customers decisions by altering the rate of interest paid on deposits. The same applies for changes in loans: the bank extends a greater amount of loans by lowering the rate of interest charged.\footnote{48}

Let $A_j$ denote the demand function for the $j$th type of loan:\footnote{49}

$$A_j = A^j (i_j)^{50}$$

\footnote{48}Note that this concept is open to debate. In David A. Alhadeff and Charlotte P. Alhadeff, "An Integrated Model for Commercial Banks" The Journal of Finance, 12 (March 1957), 26. Alhadeff writes, "In determining portfolio composition bankers generally avoid rate competition. At any moment of time, therefore, bankers accept the going rate for different kinds of credit and adjust their portfolios to the existing rate schedule." However, Eric Brucker in "A Micro-economic Approach to Banking Competition," Journal of Finance, 25 (December 1970), 1140, concludes that commercial banks do exhibit the tendencies of price fixers. "By viewing the bank as a multiple-product price-discriminating firm, a measure of bank output performance was developed which has shown to have a closer relationship to the theoretical concept of monopoly power than the often used operating ratios. ... The empirical evidence generated by the application of this model ... suggests that the elasticity measure may prove to be a meaningful indicator of the bank's relative competitive position." For a more detailed discussion see Chapter III.

\footnote{49}Following common usage, the demand for credit extended by the bank is referred to as the "demand for loans." Strictly speaking (see above), it is funds which are demanded, and loans (as primary securities) are supplied to and held by the bank as assets. The same considerations apply to "deposits," which are referred to here as being "supplied" to the bank.

\footnote{50}The following notation will be used throughout the paper. Functional relationships are denoted by superscripts. Number values are denoted by the subscripts. Where there is no question of ambiguity, the arguments of the functional relationships will be omitted.
and let \( L_k \) denote the supply function for the \( k \)th type of deposit:
\[
L_k = L^k (r_k) .
\] (8)

Expressed in this form both the loan market and the deposit market may or may not be perfectly competitive. Note, also, that one of the \( A_j \)'s may be cash or reserves to which is attached an \( i_j = 0 \) and that one of the \( L_k \)'s may be demand deposits to which is attached \( r_k = 0 \).

If the markets are monopolistic or monopsonistic then the bank controls the rate of interest and thereby indirectly affects the volume of deposits and loans.51 Equation (7) and (8) may be substituted into equation (6) to give a profit function:
\[
P = \sum_{j=1}^{n} i_j A^j(i_j) - \sum_{k=1}^{m} r_k L_k(r_k) \] (9)

For purposes of exposition define the following inverse functions:
\[
i^j(A_j) = A^{j-1}
\]
\[
r^k(L_k) = L^{k-1}
\] (10)

For the functions \( i^j \) and \( r^k \), defined in equation (10), in the markets where there is no monopsony or monopoly power the first partials with respect to the \( A_j \)'s and \( L_k \)'s will be zero. If these functions

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51 Dwight Jaffee and Franco Modigliani argue that monopoly power will cause intermediaries to ration credit rather than raise interest rates. "A Theory and Test of Credit Rationing," American Economic Review, 59 (December 1969), 850-871. However, this view is modified in terms of the time constraints. "In the long run, a rational banker would select the rate which maximizes his expected profits; but other constraints may preclude immediate full adjustment in the short run" p. 855.
were left in their original form the first partial with respect to rates of interest would be infinite for perfectly competitive markets. The profit function may now be rewritten as:

$$P = \sum_{j=1}^{n} i_j A_j - \sum_{k=1}^{m} r_k L_k$$

(11)

The bank which chooses to maximize profits will maximize equation (11) subject to the constraint that assets are equal to liabilities plus net worth (where one of the $A_j$'s is cash). The bank will maximize the Lagrangian expression:

$$\mathcal{L}(P) = \sum_{j=1}^{n} i_j A_j - \sum_{k=1}^{m} r_k L_k - \beta(\sum_{j=1}^{n} A_j - \sum_{k=1}^{m} L_k - N)$$

(12)

where $\beta$ is a Lagrangian multiplier and $N$ is the capital account.

Cost of loans and deposits

It is argued that the most important costs may not be the interest costs. Associated with each type of asset and each type of liability there are managerial costs. These are research costs for loans, advertising costs for deposits, computer costs, accounting costs, secretarial costs, and the like. Different types of assets and liabilities have different costs associated with them. These costs may be given a functional expression:

\[ C_j = C^j(A_j) = C^j(A^j(i_j)) \quad , \quad j=1,\ldots,n \quad (13) \]

\[ C_k - C^k(L_k) = C^k(L^k(r_k)) \quad , \quad k=1,\ldots,m \]

where \( C_j \) is the total cost of administering \( A_j \) units of the \( j \)th type of asset and \( C_k \) is the total cost of administering \( L_k \) units of the \( k \)th type of liability. These cost functions may contain fixed, as well as variable, costs. The Lagrangian expression for constrained profits is now:

\[ \mathcal{L}(P) = \sum_{j=1}^{n} i^j A_j - \sum_{k=1}^{m} r^k L_k - \sum_{j=1}^{n} C^j - \sum_{k=1}^{m} C^k - \beta \left( \sum_{j=1}^{n} A_j - \sum_{k=1}^{m} L_k - N \right) \quad (14) \]

The first order Euler maximization conditions are:

\[ \frac{\partial \mathcal{L}(P)}{\partial A_j} = i^j + \frac{\partial i^j}{\partial A_j} A_j - \frac{\partial C^j}{\partial A_j} - \beta = 0 \quad , \quad j=1,\ldots,n \quad (15a) \]

\[ \frac{\partial \mathcal{L}(P)}{\partial L_k} = -r^k - \frac{\partial r^k}{\partial L_k} L_k - \frac{\partial C^k}{\partial L_k} - \beta = 0 \quad , \quad k=1,\ldots,m \quad (15b) \]

\[ \frac{\partial \mathcal{L}(P)}{\partial \beta} = \sum_{j=1}^{n} A_j - \sum_{k=1}^{m} L_k - N = 0 \quad (15c) \]

In this case \( \beta \) is equal to the marginal revenue associated with the \( j \)th type of asset or the marginal cost associated with the \( k \)th type of liability.
Deposit-liability fluctuations

Thus far, the model has been developed within the confines of absolute certainty and a riskless world. It is completely deterministic. Once the supply and demand functions are known, the banker merely adjusts the interest rates (and thus his portfolio) until his profits are maximized. However, the commercial banks supply of deposits and demand for loans are not absolutely certain. Associated with both deposits and loans is a degree of variability over time. It will be assumed that this variability is random. If there is an unexpected increase in deposits, adjustment will have to be made in the asset portfolio as cash is accumulated. If there is an unexpected decline in deposits, adjustments will have to be made in the asset portfolio as cash is depleted.

At this point it is useful to distinguish between two classes of assets: (1) assets that are relatively liquid, which are used to handle short-term fluctuations; (2) assets that are relatively illiquid, which are not sold to cope with short-term fluctuations. The first type of asset includes those such as case, U.S. Treasury Securities, Securities for Federal Agencies, and other similar assets with low default risk. Markets for this type of security may be assumed to be perfectly competitive, i.e., the demand for loans through these securities is not a function of the rate of interest paid by the bank. The bank controls the volume of these assets:

\[ A_j = A_j^0, \quad j=1,\ldots,h \]  

(16a)
where there are \( h \) types of assets in this class. The demand for the
second class of assets is a function of the rate of interest and this
demand is subject to random variation:

\[
A_j = A^j(i_j) + \eta_j, j = h+1, \ldots, n
\]  

(16b)

where \( \eta_j \) is the random variation associated with the demand for the
\( j \)th type of asset. It is assumed that \( E(\eta_j) = 0 \) or that \( E(A_j) = A^j(i_j) \). These assets are not liquidated to handle deposit fluctuations.

Supplies of liabilities are functions of the rate of interest and
are subject to random variation:

\[
E(L_k) = L^k(r_k) = \epsilon_k, k = 1, \ldots, m
\]  

(16c)

where \( \epsilon_k \) is the random variation associated with the \( k \)th liability
and by assumption \( E(\epsilon_k) = 0 \) or \( R(L_k) = L^k(r_k) \).

Equations (16a) may be written as (17a) and (16b) and (16c) and after
taking expectations may be solved for their inverses in terms of the
interest rates (17b) and (17c).

\[
i_j = i_j^0, \quad j = 1, \ldots, h
\]  

(17a)

\[
i_j = i_j^j(E(A_j)) = A^{j-1}(i_j), \quad j = h+1, \ldots, n
\]  

(17b)

\[
r_k = r_k^k(E(L_k)) = L^{k-1}(r_k), \quad k = 1, \ldots, m
\]  

(17c)

Note that the arguments of the interest rate functions are expected
values of the volume of assets and liabilities, not the actual volumes.

The accounting identity that assets are equal to liabilities plus
net worth can now be written as:
\[ \sum_{j=1}^{n} A_j - \sum_{k=1}^{m} L_k - N = 0 \]  

\[ \sum_{j=1}^{h} A_j + \sum_{j=h+1}^{n} (A^j + \eta_j) - \sum_{k=1}^{n} (L^k + \epsilon_k) - N = 0 \]

\[ \sum_{j=1}^{h} A_j + \sum_{j=h+1}^{n} A^j - \sum_{k=1}^{m} L^k - N = \sum_{k=1}^{m} \epsilon_k - \sum_{j=h+1}^{n} \eta_j \]

\[ \sum_{j=1}^{h} A_j + \sum_{j=h+1}^{n} A^j - \sum_{k=1}^{m} L^k - N = \gamma \]

where \( \gamma \) is a random variable which is a convolution of the \( \eta_j \)'s and \( \epsilon_k \)'s, and has a density function \( f(\gamma) \), which is likewise a convolution of the density function of \( \eta_j \)'s and \( \epsilon_k \)'s. It will be assumed that \( E(\gamma) = 0 \) and that \( f(\gamma) \) is symmetric in its domain from minus infinity to positive infinity. \( ^{53} \)

It is convenient to visualize the bank as operating under three distinct time horizons. First, there is the very short run. This is the day to day, hour to hour period where changes in the asset portfolio are not planned, but are merely induced. If there is a random fall in the level of deposits, the depositors are paid with cash, thus there is an induced change in the cash account of the asset portfolio.

\( ^{53} \)Since the \( A_i \)'s, \( A^j \)'s, \( L^k \)'s, and \( N \) are stocks that are held or planned to be held by the bank over a given planning horizon, the random variation may be considered flows in or out of the stocks of assets or liabilities.
Second, there is a slightly longer horizon during which the bank may alter its holdings of liquid assets. As the cash account is depleted, due to a random rise in the loan account or a random fall in deposits, the net marginal return from the cash account may rise above the net marginal return for other assets. During the second time horizon, which may be a week or a reserve week, the bank may sell some of its liquid assets in such a way that the net marginal return for each of the liquid assets is equated. Third, there is a long horizon of time (i.e., a year) over which the expected profits of the bank are maximized. This is the planning horizon for the bank on which all of its portfolio decisions are made.

Whenever the random variable $\gamma$ is positive, cash is depleted in the first time period by an amount $\gamma$. For the second time horizon the bank may consider changing its liquid asset holdings (including cash) by an amount $\gamma$, in order to equalize the net marginal return for all the liquid assets. It is possible that the net marginal return for cash is unchanged, in which case the entire random variation would be absorbed in the cash account.

Starting with the random variation ($\gamma$) equal to zero, expected profits would be maximized with:

$$\frac{\partial E(P)}{\partial A_j} = \beta, \; j=1, \ldots, h$$

(19)

As random variation occurs in the first time horizon, the net marginal return to cash may change. In the second time horizon the bank will act so as to equate the net marginal returns for the liquid assets:
\[
\frac{\partial E(P)}{\partial A_1} = \frac{\partial E(P)}{\partial A_2} = \ldots = \frac{\partial E(P)}{\partial A_h}
\] (20)

Note that these partials are no longer necessarily equal to $\beta$ since equality is a condition for profit maximization over the third time horizon.

Since $\gamma$ is the difference between the optimal amount of assets and the actual amount assets in the portfolio at a point in time.

\[
\gamma = A^* = A_{1}^* + A_{2}^* + \ldots + A_{h}^*
\] (21)

where $A_j^*$ is the amount of the $j$th asset removed from the portfolio.

If all the random variation happens to be absorbed in the cash account:

\[
\gamma = A^* = A_{1}^*
\]

\[
A_{j}^* = 0, \ j=2,\ldots,h
\]

In this case the bank makes no change between the first time horizon and second time horizon. It just accepts the induced cash depletion from the first time horizon. However, if the net marginal return to cash rises, some of the other assets will not be in the portfolio during the second time period. They will be removed in such a way as to satisfy equation (16). Therefore, for small $A^*$ and ignoring the cross effects, the $A_j^*$ may be expressed according to:54

54 Take the differential such that equation (30) is continuously satisfied.
The difference between the optimal amount of the $j$th asset and the actual amount in the portfolio in the second time horizon is a portion of total change in assets in the first time horizon. The portion is a function of the second partials of the expected profits function with respect to the liquid assets (first $h$ assets).

This portion of assets differing from the optimal may be expressed in functional form as:

$$
\rho^j = \frac{1}{h} \sum_{s=1}^{h} \frac{\frac{\partial^2 E(P)}{\partial A_{j_s}^2}}{\frac{\partial^2 E(P)}{\partial A_{s}^2}}
$$

(23)

The interest payments lost when assets are not in the portfolio is the sum of the products of the rates of interest and the probability that $A^*_j$ of the $j$th type of asset will not be in the portfolio. This probability may be interpreted as the percent of the time that $A^*_j$ is not in the portfolio.

The expected value of $A^*_j$ of the $j$th asset will be:

$$
E(A^*_j) = \rho^j \int_{-\infty}^{\gamma} f(\gamma) \, d\gamma
$$

(24)

and the expected interest loss where $\gamma > 0$ is:
\[
\sum_{j=1}^{h} \rho^j \int_{0}^{\infty} \gamma f(\gamma) \, d\gamma
\]

This expression allows \( A^*_j \) to be greater than \( A_j \), so that a non-negativity restriction must be placed on the \( A_j \). One way to construct such a restriction is to order the first \( h \) assets in ascending order of the values for their second partials and write the expected interest loss as:

\[
\sum_{j=1}^{h} \rho^j \int_{0}^{\infty} \gamma f(\gamma) \, d\gamma
\]

This expression may be interpreted as the interest rate times the percent of the time that some of the \( j \)th asset is not in the portfolio. The formulation assumes that the probability that \( \gamma \) is greater than \( A_j \) is zero. However, it also prevents \( A_j \) from becoming negative. There is the possibility of an interest gain when \( \gamma \) is negative. \( \gamma \) less than zero implies that deposits have randomly increased or loans have randomly decreased and that during the first time period cash has been accumulated. The extra cash may cause the net marginal return to cash to be below the net marginal return to other assets. Therefore, during the second time horizon some of the cash is exchanged for other assets, and an increased amount of other assets is held for the second time horizon. The conditions for the exchange of assets is the same as above. During the second time horizon liquid assets are held in such proportions that net marginal returns to the first \( h \) assets is equal. The expected interest gain in this case is:
The expected interest gain is not symmetrical with the expected interest loss. For the expected interest loss there is a maximum amount of each of the $j$ assets that may not be in the portfolio (e.g., the non-negativity restriction on the $A_j$'s). In addition, at or near optimally the $\rho_j^j$ will be the same increased amounts of $A_j$ and for decreased amounts. However, for larger $|\gamma|$ the $\rho_j^j$ may become different, and the expected interest loss-gain function will not be symmetrical.

However, since it has already been assumed that the $\eta_j$'s and $\epsilon_k$'s have means zero and symmetrical density functions, the convolutions of these random variables will also have mean zero and a symmetrical density function. Since the non-negativity restriction assumes that the probability that $\gamma$ is greater than the sum of the assets is zero, this implies that the negative $\gamma$ cannot be less than the negative value of the sum of the asset. In addition, the $\rho_j^j$'s are not evaluated for different values of $\gamma$, instead, they are evaluated only at the optimal solution. Which together implies that the interest gain is symmetrical with and offsets the interest loss and these terms will drop out of the expected profits function.

The bank now maximizes expected profits. The constrained Lagrangian of the expected profits function is:

$$\sum_{j=1}^{h} i_j \rho_j^j \int_{-\infty}^{0} y f(y) \, dy$$

---

\[ L(E(P)) = \sum_{j=1}^{h} i_j A_j + \sum_{j=h+1}^{n} k^j A_j - \sum_{k=1}^{m} r^k L_k \]

\[ - \sum_{j=1}^{n} C^j - \sum_{k=1}^{m} C^k \]

\[ - \beta \left( \sum_{j=1}^{h} A_j + \sum_{j=h+1}^{n} A_j - \sum_{k=1}^{m} L_k - N \right) \]

where \( A_j \) and \( L_k \) are mean values as determined by \( i^j \) and \( r^k \).

**Transaction costs**

Equation (25) assumes that the sale of assets is costless. In fact, the sale of an asset may involve numerous costs: "transaction costs, time cost with the bank plus the money charged by the dealer, and forfeiture costs, ... and cost associated with interest rate changes."\(^{56,57}\) Transaction costs will be incurred on \( A_j^* \) units on the \( j \)th type of asset whenever \( A_j^* \) is bought or sold. The probability that the asset is in the portfolio times the probability that the asset will be removed from the portfolio. This is so, since one event must follow the other in order for a transaction to be made. This may be expressed as a joint probability distribution.

Let \( A^* \) be the change in total assets that may take place at any point in time. Let \( \tilde{A}_j \) be the optimal amount of the \( j \)th type of asset


\(^{57}\) Costs associated with the interest rate changes refers to the concept of market risk, which is treated in a separate section.
\[ \tilde{\alpha}_j = \rho^j A^* \]

is the amount of the jth asset that will be in the portfolio at any point in time

\[ \int_{-\infty}^{\infty} f(\gamma) \, d\gamma = \int_{-\infty}^{A^*} f(\gamma) \, d\gamma \]

is the joint probability distribution function that \( A^* \) assets will be bought or sold. Let \( t_j \) be the cost of transaction $1 worth of the jth type of asset. The expected transaction cost will be the sum of the probability that each dollars worth of asset will be transacted times the transaction cost for that portion \((\rho^j)\) of the jth asset that will be transacted

\[
E(T_c) = \sum_{j=1}^{h} t_j \sum_{z=-\tilde{\alpha}_j}^{\tilde{\alpha}_h} \rho^j A^* f(\gamma) \, d\gamma \int_{-\infty}^{\infty} \gamma f(\gamma) \, d\gamma 
\]

where \( \tilde{\alpha}_h \) is the sum of the optimal values of the first \( h \) assets

\[
\tilde{\alpha}_h = \sum_{q=1}^{h} \tilde{\alpha}_q
\]

For the continuous case:

\[
E(T_c) = \sum_{j=1}^{h} t_j \int_{-\tilde{\alpha}_h}^{\tilde{\alpha}_h} \rho^j A^* f(\gamma) \, d\gamma \int_{-\infty}^{\infty} \gamma f(\gamma) \, d\gamma \, dA^*
\]

The total expected transaction cost is the integral of the probability distribution function evaluated over the entire range of each of the jth assets times the cost of transacting the jth type of asset.
Market risk

Part of the transaction costs are "cost associated with interest rate changes." Interest rates for the first $h$ assets are not controlled by the bank, they are determined by the banking industry, financial markets, and monetary authorities. If the interest rate on the $j$th security should increase then the price of the $j$th security falls. If it is assumed that interest rate variations for the nation as a whole are random, the price changes of the primary securities will also be random and the transaction cost can be expressed as a function of random variation. Let $\lambda_j$ represent the random variation of the price of the $j$th type of asset, with $g_j$ as its density function. Also let $t_j$ be the transaction cost at the time the $j$th asset is acquired. Then the transaction cost per dollar of the $j$th type of security is a function of the random variable $\lambda_j$.

$$t_j(\lambda_j) = t_j + \int_{-\infty}^{\infty} \lambda_j g_j(\lambda_j) d\lambda_j \quad (28)$$

The expression for transaction cost in equation (24) can be substituted into the expected transaction cost function. It should be noted that the first $h$ securities tend to be short term in nature and, therefore, not subject to wide price swings.

Default risk

Another form of uncertainty that exists for the bank is default risk. Associated with every type of primary security there is a probability that the loan will be in default. Let $\delta_j$ be the random percentage of the $j$th asset that will be in default: $\delta_j$ will have a
domain of 0 to 100 percent. Let $u_j^j(\delta_j)$ be the density function of the random percentage

$$
\int_0^{100\%} \delta_j^j u_j^j(\delta_j) \, d\delta_j
$$

is the expected value of the percentage of the jth asset that will be in default, the probability that $A_j^j$ of the jth primary securities will default. The expected default loss is:

$$
E(DL) = \sum_{j=1}^{n} A_j^j \int_0^{100\%} \delta_j^j u_j^j(\delta_j) \, d\delta_j
$$

(29)

Maximization of expected profits

Transaction costs, market risk, and default risk may all be incorporated into single expected profits function, which the banker may choose to maximize with respect to the volume of each of his assets and liabilities and the rates of interest charged and paid:

$$
(E(P)) = \sum_{j=1}^{h} i_j \rho_j A_j + \sum_{j=h+1}^{n} k_j^j A_j - \sum_{k=1}^{m} r^k L^k_k
$$

- $\sum_{j=1}^{n} C_j - \sum_{k=1}^{m} C^k$

- $\sum_{j=1}^{n} t_j^j(\lambda_j) \int \rho^j A^* \left\{ \int \gamma^f(\gamma) \, d\gamma + \int \gamma^f(\gamma) \, d\gamma \right\} \, dA^*$

(30)

- $\beta \left( \sum_{j=1}^{n} A_j - \sum_{k=1}^{m} L^k_k - N \right)$
If the banker chooses to maximize profits he will use the Euler first order conditions to determine his portfolio decisions. Maximizing with respect to the volume of the first \( h \) assets, and the expected values of the other assets and liabilities (note that this implies that the banker controls the interest rates and not the actual volume of these financial instruments):

\[
\frac{\partial E(P)}{\partial A_j} = 0, \quad j=1,\ldots,h
\]

\[
\frac{\partial E(P)}{\partial E(A_j)} = 0, \quad j=h+1,\ldots,n
\]

\[
\frac{\partial E(P)}{\partial E(L_k)} = 0, \quad k=1,\ldots,m
\]

\[
\frac{\partial E(P)}{\partial \beta} = 0
\]

Whether or not the banker has some degree of monopoly power he will allocate his portfolio of assets and issues of liabilities in accordance with the Euler maximization conditions. The partials of the expected profits function will contain partials of the loan demand and deposit supply function. If these partials can be estimated on the basis of the bankers behavior, then the Lerner index of monopoly power can be used to measure the degree of monopoly prevalent in various banking markets. The empirical model presented in the next chapter provides a method of estimating the partial of loan demand and deposit supply with respect to volume of assets held and liabilities issued.
CHAPTER IV
THE EMPIRICAL MODEL

The purpose of this chapter is to construct a testable hypothesis which will indicate whether a monopsony-monopoly model is of interest in the study of commercial banking behavior. The theoretical concepts introduced in Chapter III are the foundations for the model proposed here. The chapter is divided into two parts: (1) the development of an empirical model; and (2) a discussion of the data.

The development of the empirical model

The constrained expected profits function is expressed in the following form:

\[
(E(P)) = \sum_{j=2}^{3} i_{j} A_{j} + \sum_{j=4}^{5} i_{j} A_{j} + R_{1} \sum_{j=1}^{5} A_{j} - r L_{2}^2 - C \left( \sum_{k=1}^{2} L_{k} + N \right) - \frac{3}{\varepsilon} E(TrC_{j}) \tag{32}
\]

\[
- \beta \left( \sum_{j=1}^{5} A_{j} \right) + R_{2} \left( \sum_{j=1}^{5} A_{j} \right) - L_{1} - L_{2} - N
\]

The first term is the interest earned on liquid assets: \( A_{1} \) is cash on which no interest is earned; \( A_{2} \) is U.S. Treasury Securities; and \( A_{3} \) is securities of other Federal Agencies. The second term is the interest earned on the less liquid assets over which the bank may have some monopoly power; \( A_{4} \) is state and local securities; \( A_{5} \) is loans.
The third term is non-interest revenue earned by the bank. This revenue is assumed to be a constant proportion \((R_1)\) of the sum of the first five classes of assets; it includes income from trust departments, service charges, and other related activities. The fourth term is the interest paid on time deposits \((L_2)\). \(L_1\) is demand deposits on which no interest is paid. The fifth term considers the administrative costs to be a fixed proportion \((C)\) of the volume of total liabilities plus capital account. The sixth term is the expected transaction costs, which are a function of the first three assets, serving as short-run adjustment vehicles, and the total random variability of deposits and loan demand. The seventh term is the accounting identity that assets equal liabilities plus net worth times the Lagrangian multiplier. In the seventh term the subterms are: (1) the first five assets; (2) other assets as a proportion \((R_2)\) of the first five assets; (3) \(L_1\) is the expected level of demand deposits; (4) \(L_2\) is time deposits; and (5) \(N\) is net worth. Some of these terms need further explanation.

Administrative cost, as expressed in the fifth term, implies several assumptions: (1) costs for the management of different types of assets and different types of liabilities do not differ (or that costs do not depend on the asset and liability mix); (2) all administrative costs are variable; and (3) there are no economies of scale. As mentioned above, the first assumption is open to considerable debate and may be a possible source of error.\(^{58}\) The second assumption is less questionable, since fixed assets on the average amount to only 1.5 percent of total

assets and net occupancy expenses amount only to 2.3 percent of total operating expense. Though there may be other fixed costs, these should be relatively small. The third assumption implies that a bank is a constant cost firm. Table 1 shows the noninterest expense as a percentage of total operating expense for different size banks. Due to the lack of individual bank data, it is not possible to establish a test of the significance of the difference between these averages. However, under casual observation there appears to be some problem with the smaller banks, but the larger banks appear to exhibit constant costs. In any event, the total range of variability is less than 4 percent of the total operating revenue and this approximates constant costs.

As stated in the expected transaction cost in the expected profits function is a function of the first three asset classes (cash, U.S. Treasury Securities, and securities of other federal agencies) and the random variation of deposits and loan demand. Many different approaches to measure the random variation have been suggested. Dewald and Dreese utilize two different measures of deposit variability. First, a coefficient of variation of the daily average of deposits is used:

\[
SD = \sqrt{\frac{1}{N-1} \sum_{t-1}^{N} (X_t - \bar{X})^2} \frac{\bar{X}}}{\sum_{t-1}^{N} (X_t - \bar{X})^2} \]

\[ (33) \]

---

60 Dewald and Dreese, "Bank and Behavior and Deposit Variability," p. 874.
Table 1. Non-interest costs and bank scale

<table>
<thead>
<tr>
<th>Banks with total deposits (in millions)</th>
<th>All banks</th>
<th>Under 5</th>
<th>5-10</th>
<th>10-25</th>
<th>25-100</th>
<th>Over 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-interest expense as a % of total operating revenue</td>
<td>44.0</td>
<td>47.1</td>
<td>43.0</td>
<td>42.2</td>
<td>42.6</td>
<td>43.3</td>
</tr>
<tr>
<td>As a % of total assets</td>
<td>2.63</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Number of banks</td>
<td>13342</td>
<td>4228</td>
<td>3436</td>
<td>3382</td>
<td>1745</td>
<td>551</td>
</tr>
</tbody>
</table>

*aFDIC, Bank Operating Statistics.
bComparable data not available for different size banks.

Second, they use a coefficient of variation of an estimate of deposits:

\[
DV = \sqrt{\frac{1}{N-22} \sum_{t=1}^{N} (X_t - \hat{X}_t)^2 \over \bar{X}}
\]  

(34)

where \(X_t\) is total deposits on the \(t\)th day, \(\bar{X}\) is average total deposits, and \(\hat{X}_t\) are the estimated total deposits (based on seasonality and trend in deposits). The 22 represents the degrees of freedom lost in estimating deposits. Dewald and Dreese find that the second measure is superior in its ability to interpret bank behavior.  

However, both

61 Similar measures of deposit variability have been used. Frederick M. Struble and Carroll H. Wilkinson calculate an index of weekly variability based on the deposit mix in "Deposit Variability at Commercial Banks," Monthly Review of the Federal Reserve Bank of Kansas City (July-August 1967), 27-32. C. Rangarajan also bases his measure of variability on the mix between time and demand deposits in "Deposit Variability in Individual Banks," National Banking Review 4 (September 1966), 61-71. By treating variability as a scalar at optimality all of these problems are avoided.
measures require day to day observation of a sample bank. Comparable
data for this study does not include day to day fluctuations. Therefore, this problem will be avoided by considering expected transaction
costs to be a scalar at the optimal (profit maximizing) allocation of
the portfolio.

The last term in the expected profits function constrains assets
to be equal to liabilities plus net worth. The first five assets are
assumed to be control variables. The first three asset classes are con-
trolled directly by the bank. The fourth and fifth assets (state and
local securities and loans) are controlled by the bank indirectly through
the rates of interest charged on these assets. (Note that the demand
equation for either of these assets can be specified for a competitive or
an imperfectly competitive market. State and local securities are in-
cluded in this group of assets because the literature indicates that they
do not serve as part of the adjustment mechanism for short-term deposit-
liability fluctuations.) 62 The sixth type of asset includes all those
assets elsewhere excluded (fixed assets, trading account securities,
other securities, and other assets). Some of these assets service the
first five types of assets and others are completely independent. It
is assumed that all are proportional to the volume of first five assets.

The bank which maximizes its expected profits will do so with
respect to \( A_j, j=1, \ldots, 3 \) (cash, U.S. Treasury Securities, and securities
of other federal agencies); \( E(A_1), j=4, 5 \) (the interest charged on state
and local securities and on loans); \( E(L_2) \) (the interest paid on time
deposits); and \( \beta \) (the Lagrangian multiplier). The mean level of demand

62 Cf. Chapter II, p. 32.
deposits is an exogenous variable as far as the bank is concerned, since they are unable to pay interest on these deposits. Differences in services and service charges will be ignored. The level of the capital account for a particular planning horizon is taken as a given value, not as a control variable.

This calls for some comment, since Federal law, as well as state laws, require a minimum amount of capital for the organization of a new bank or the establishment of branch offices. In addition, in recent years supervisory authorities have often required new operations to start with more than the legal minimum. The supervisory authority for the Federal Reserve member banks comes from Regulation H of the Board of Governors and Section 9 of the Federal Reserve Act, which provides that banks shall hold an "adequate" amount of capital. The Board of Governors and various state agencies have established "rules of thumb" concerning the adequacy of capital financing. In taking the level of capital account as a given value, the assumption is made that the "rule of thumb" constraint is not operative within the planning horizon. Since enforcement of the "rule" is by moral suasion and is not uniform, one is justified in assuming that within the portfolio planning horizon capital accounts are not a control variable. However, over the longer planning horizon the bank may be undercapitalized (or even overcapitalized). In either case the profit maximizing bank would adjust the size of its capital account.

63 D. Chambers and A. Charnes in "Inter-Temporal Analysis and Optimization of Bank Portfolios," build a "leverage requirement" into their model of a banks portfolio. This requirement is a capital constraint based on the Board of Governors "rule of thumb."
Another account similar to the capital account is the loan reserve account. These are reserves for bad debts, which are established from pretax income in accordance with a formula permitted by the Internal Revenue Service. Each year the bank is allowed to take out of the pretax income a certain amount based on a twenty-year moving average of bad debts for that bank, which is placed in the loan reserve account. The loan reserve account is not permitted to exceed three times the twenty-year moving average of bad debts. For the current year the loan reserve account cannot be altered, but only in future years in those cases where the maximum has not been reached. The account may be used in the same manner as the capital account to instill confidence in depositors and to make additional purchases of primary securities. Therefore, the loan reserve account is included in the variable N as part of the capital account.

The bank which maximizes its expected profits will allocate its portfolio in accordance with the Euler first order maximization conditions:

$$\frac{\partial \tilde{E}(P)}{\partial A_1} = R_1 - \frac{\partial E(Tc)}{\partial A_1} - \beta - \beta R_2 = 0$$

$$\frac{\partial \tilde{E}(P)}{\partial A_2} = i_2 + R_1 - \frac{\partial E(Tc)}{\partial A_2} - \beta - \beta R_2 = 0$$


65 The permitted addition could be taken as a proxy for $F(\delta)$ in the measure of default risk. See Chapter II, p. 25 and Chapter III, p. 47.
\[
\frac{\partial E(P)}{\partial A_3} = i_3 + R_1 - \frac{\partial E(TrC)}{\partial A_3} - \beta - \beta R_2 = 0
\]

\[
\frac{\partial E(P)}{\partial A_4} = i_4 + \frac{\partial i^4}{\partial A_4} \cdot A_4 + R_1 - \beta - \beta R_2 = 0
\]

\[
\frac{\partial E(P)}{\partial A_5} = i_5 + \frac{\partial i^5}{\partial A_5} \cdot A_5 + R_1 - \beta - \beta R_2 = 0
\]

(35)

\[
\frac{\partial E(P)}{\partial L_2} = -r^2 - \frac{\partial r^2}{\partial L_2} \cdot L_2 - C - \beta = 0
\]

\[
\frac{\partial E(P)}{\partial \beta} = (1 + R_2) \sum_{j=1}^{5} A_j - \bar{L}_1 - L_2 - N = 0
\]

Note that \(\bar{L}_1\) is not a control variable and the expected profits functions is not maximized with respect to demand deposits.

Table 2 expresses the Euler conditions as a system of simultaneous equations. Table 3 performs two substitutions and reduces the system to five equations. Table 4 solves the system of five equations in terms of the rates of interest which will be treated as endogenous variables. The exogenous variables will be the asset portfolio and the liabilities. The assignment of exogenous and endogenous variables is not intended to imply causation. Any monopolist has the choice of choosing to control either quantity or price, but he cannot control both. The assets and liabilities may be chosen as endogenous, or the rates of interest, but not both.

Table 4 expresses the structural form of the model that will be tested. The interest rates are the endogenous variables and the assets
Table 2. Euler first order maximization conditions as a system of seven simultaneous equations

- \( \partial E(TrC)/\partial A_1 + R_1 \) \[ \beta(1+R_2) \] = 0
- \( \partial E(TrC)/\partial A_2 + R_1 \) \[ \beta(1+R_2) + i_2 \] = 0
- \( \partial E(TrC)/\partial A_3 + R_1 \) \[ \beta(1+R_2) + i_3 \] = 0

+ \( R_1 \) \[ \beta(1+R_2) + i_4 + \partial i^4/\partial A_4 \cdot A_4 \] = 0
+ \( R_1 \) \[ \beta(1+R_2) + i_5 + \partial i^5/\partial A_5 \cdot A_5 \] = 0

\( \beta - C - r^2 - \partial r^2/\partial L_2 \cdot L_2 = 0 \)

\( (1+R_2) \sum_{j=1}^{3} A_j - \bar{L}_1 - N \) \[ + (1+R_2)A_4 + (1+R_2)A_5 - L_2 = 0 \)
Table 3. Transformation of the Euler first order conditions

\begin{align*}
- \frac{\partial E(\text{TrC})}{\partial A_2} + R_1 - \beta(1+R_2) + i_2 &= 0 \\
- \frac{\partial E(\text{TrC})}{\partial A_3} + R_1 - \beta(1+R_2) + i_3 &= 0 \\
+ \frac{\partial E(\text{TrC})}{\partial A_1} + i^4 + \frac{\partial i^4}{\partial A_4}A_4 &= 0 \\
+ R_1 - \beta(1+R_2) + i^5 + \frac{\partial i^5}{\partial A_5}A_5 &= 0 \\
\beta &= -r^2 - C - \frac{\partial r^2}{\partial L_2}(1+R_2) \sum_{j=1}^{3} A_j - \bar{L}_1 - N - \frac{\partial r^2}{\partial L_2}(1+R_2)A_4 - \frac{\partial r^2}{\partial L_2}(1+R_2)A_5 = 0
\end{align*}

\[ ^a \text{The first equation in Table 2 is solved for } \beta(1+R_2) \text{ and substituted into the fourth equation. The seventh equation in Table 2 is solved for } L_2 \text{ and substituted into the sixth equation.} \]
Table 4. Maximization conditions expressed as a function of the rates of interest

\[ i_2 = \frac{\partial E(TrC)}{\partial A_2} - R_1 + \beta(1+R_2) \]

\[ i_3 = \frac{\partial E(TrC)}{\partial A_3} - R_1 + \beta(1+R_2) \]

\[ i_4 = \frac{\partial E(TrC)}{\partial A_1} - a_4^1/a_4 \cdot A_4 \]

\[ i_5 = - R_1 + \beta(1+R_2) - a_5^5/a_5 \cdot A_5 \]

\[ r^2 = \beta - \partial r^2/\partial L_2 \cdot A_4 - \partial r^2/\partial L_2 \cdot A_5 - C - \partial r^2/\partial L_2 \{(1+R_2) \sum_{j=1}^{3} A_j \} - \bar{L}_1 - N + R_2 A_4 + R_2 A_5 \]
and liabilities are the exogenous variables. Additional exogenous variables are $R_1$, $(1+R_2)$, $C$, and $N$. In its structural form the parameters of the endogenous variables is the identity matrix. The parameters of the reduced form of the system of simultaneous equations is the negative of the parameters of exogenous variables in the structural system. Both the order and rank conditions for identification are met. The model is overidentified due to constraints that are placed on the parameters of the structural system: first, the parameters of the endogenous variables are constrained to be zero or one in the equation in which they appear; second, the coefficient of $R_1$ is constrained to -1 in the first, second, and fourth equations; third, the coefficients of $(1+R_2)$ are equal in the first, second, and fourth equations and they are all equal to the intercept term in the fifth equation; and fourth, the coefficients of $A_4$, $A_5$, and the last exogenous variable in the fifth equation are all equal. Therefore, the system is a constrained system of simultaneous equations.

Through a series of algebraic reductions the system can be simplified. The constraints on the coefficients can be used to define new variables. When two endogenous variables are combined the result is an endogenous variable. When two exogenous variables are combined the result is an exogenous variable. When an endogenous and an exogenous variable are combined the result is an endogenous variable.\[66\]

Defining one new exogenous variable and one endogenous variable.

\[ y_2 = i^5 + R_1 - R_2(r^2 + C) \]  
(38)

\[ DL = R_2 ((1+R_2) \sum_{j=1}^{5} A_j - L_1 - N) \]  
(39)

The system of equations that is estimated using two stage least squares is:

\[ i^4 = \frac{\partial E(TrC)}{\partial A_1} - \frac{\partial i^4}{\partial A_4} \]  
(40)

\[ y_2 = \beta - \frac{\partial i^5}{\partial A_5} + \frac{\partial r^2}{\partial L_2} DL \]

The equations of system (40) are behavioral relations for the profit maximizing banker. Observations on a single bank over time would allow the estimation of the slopes of the demand for loans \((\partial i^5/\partial A_5)\), the slope of the demand for state and local funds \((\partial i^4/\partial A_4)\), and the slope of the time deposit supply \((\partial r^2/\partial L_2)\). However, over any extended period of time one would expect these demand curves to be relatively unstable. Another approach would be to use cross-sectional observations on banks that are expected to have identical demand functions. Here banks can be
classified according to characteristics of the markets within which they operate. The slope parameters of the supply and demand equations can be estimated from observations on the banks of a given class. This second approach will be employed in this study.

The expected profits function (equation (32)) assumes that all the assets in a class (e.g., loans) earn the same rate of interest. However, from observed data on a bank's portfolio each asset will earn the current rate at the time that the security was purchased by the bank. Interest earned on a class of assets is a weighted average of past rates of interest. The rationale applies to time deposits. Interest paid on time deposits is a weighted average of past rates depending on the maturity mix of the debt issues. Is the weighted average of past rates or is the current rate of interest the appropriate decision variable for the banker? In an effort to answer this question the results of the cross-sectional estimation of the slope parameters will be corroborated by applying first difference data to equation system (40). The first difference of the interest data will more closely reflect the current market rate than the weighted average of past rates of interest.

The data

The most desirable source of data for this type of study would be observations on individual banks from a variety of economic regions. However, while it is possible to obtain balance sheet data of this type, interest and income data is held in the strictest confidence and is difficult to obtain.
Therefore, a secondary data source is used. The Federal Deposit Insurance Corporation (FDIC) publishes balance sheet, interest, and income data by standard economic area. The Bureau of the Census describes a standard economic area (SEA) "as a county or a group of counties within a state, which are homogeneous in general livelihood and socio-economic characteristics." The FDIC and Census definitions differ in areas where there is a significant overlapping of banking services. In those states where branch banking is prevalent, the FDIC does not delineate SEA's. Since both SEA definitions are based on counties, discrepancies can be accounted for and Census data can be made compatible with FDIC definitions.

The aggregate banking data for each SEA will be considered an observation on an individual bank. This type of aggregation is justifiable when there are no economies of scale with respect to the volume of assets or liabilities. Benston's work has indicated that economies of scale are relevant when the size of individual accounts increases, but not necessarily when the dollar volume of accounts increases. Since SEAs with different market conditions will be considered separately, within a given bank class it is assumed that there are no significant differences in the size of accounts.

The use of aggregate bank data necessitates a normalization of the data so SEAs of different sizes may be compared. SEAs may differ in

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68 Ibid., p. 2.

69 George Benston, "Economies of Scale and Marginal Costs in Banking," pp. 540-541.
size because the number of banks within each SEA differ and because the size of banks between SEAs may differ. Three distinct methods of normalization will be used: (1) each asset and liability is expressed as a percent of total assets; (2) assets and liabilities are given for the average bank in the SEA; and (3) assets and liabilities are expressed on a per capita basis within the SEA.

In order to apply cross sectional data to the system expressed in equation (40) it is necessary to observe banks which would be expected to have similar loan demand and deposit supply functions. Similarity of demand and supply functions can be discussed at two levels; the industry and the firm. Each banking market defines an industry within which several banks may compete. Some banking markets may be expected to differ from others and, therefore, the banks within the respective markets would be expected to have different deposit supply and loan demand functions. For instance, in an agricultural community the principle borrowers are farmers. They borrow to meet the needs of the farm, which are seasonal and subject to the whims of the weather. The elasticity of demand for loans from farmers depends on the production function and the expected demand for crops. On the other hand the banks in an industrial area are faced with an entirely different set of borrowers seeking loans for entirely different reasons. In these two banking markets the loan demand function for the market may be expected to differ. Alternatively, at the level of the firm agricultural areas are generally rural and can be characterized by the average distance the prospective customers live from their banking alternatives. Because of the greater
anticipated distance from customer to banking alternative in an agricultural area, one would expect the firm to have a more inelastic deposit supply and loan demand function than a bank in an industrial area where the proximity of competitive banking services is much greater.

At the level of the industry the income of people in the banking market may affect the industry demand for loans and supply of deposits. People with higher incomes have a tendency to save more than people with lower incomes. People with higher incomes will tend to borrow a larger amount of funds for larger projects than people with lower incomes. At the level of the firm people with higher income will have a broader range of opportunities for seeking banking services than people with lower income. If a bank's customers have lower income one would expect the loan demand and deposit supply to be more inelastic than for a bank with more affluent customers.

At the level of the firm the number of banking competitor's may be expected to affect the elasticities of loan demand and deposit supply. A bank with fewer competitors would be expected to have more inelastic demand and supply functions.

The banks in the sample will be divided into eight different classes, on the presumption that banks within each class will experience approximately the same demand and supply functions. Three criteria will be used to categorize banks: (1) Economic base of the banking market (agricultural or non-agricultural): An index of the ratio of agricultural employment to total employment for the banking market divided by the same ratio for the nation is used to classify a market as agricultural or non-agricultural. If the index is greater than one the area is classified as agricultural; otherwise nonagricultural.
George Kaufman uses a similar ratio as a demand variable. Eric Brucker uses a loan mix variable (ratio of agricultural loans to total loans). Both Brucker and Kaufman use these variables in the specification of demand functions. The approach in this paper is to separate banks according to these characteristics, rather than to incorporate the ratios into the demand function.  

(2) Income of the banking market: an index of per capita income similar to the economic base index is used to divide banking markets into "rich" markets and "poor" markets. Brucker, in his attempt to estimate structural variables (loan/asset ratios and elasticity of loan demand) includes an income variable to "enable the separation of poor regions from rich regions." Likewise, Kaufman includes income as a demand variable.  

(3) Bank density: Banks are classified according to the number of banks per capita within the appropriate banking market. An index is calculated using the ratio of the market density to the national average. Both Brucker and Kaufman use this index as a structural variable.  

The FDIC delineates 289 SEA's in thirty-four states. The remaining states were not subdivided into SEA's since extensive branch banking would make the disaggregated data meaningless. Table 5 depicts the division of SEA's into eight classes; four agricultural and four non-agricultural. As shown, the breakdown on the density and income indices differ between the agricultural and non-agricultural communities.

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72 Ibid., p. 1138.
Table 5. Standard economic area classification

<table>
<thead>
<tr>
<th>Bank class</th>
<th>Number of observations</th>
<th>Economic base</th>
<th>Bank density</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>non-agricultural index &lt; 1</td>
<td>low density index &lt; .5</td>
<td>poor index &lt; 1</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>non-agricultural index &lt; 1</td>
<td>low density index &lt; .5</td>
<td>rich index &gt; 1</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>non-agricultural index &lt; 1</td>
<td>high density index &gt; .5</td>
<td>poor index &lt; 1</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>non-agricultural index &lt; 1</td>
<td>high density index &gt; .5</td>
<td>rich index &gt; 1</td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>agricultural index &gt; 1</td>
<td>low density index &lt; 1</td>
<td>poor index &lt; .93</td>
</tr>
<tr>
<td>6</td>
<td>29</td>
<td>agricultural index &gt; 1</td>
<td>low density index &lt; 1</td>
<td>rich index &gt; .93</td>
</tr>
<tr>
<td>7</td>
<td>65</td>
<td>agricultural index &gt; 1</td>
<td>high density index &gt; 1</td>
<td>poor index &lt; .93</td>
</tr>
<tr>
<td>8</td>
<td>47</td>
<td>agricultural index &gt; 1</td>
<td>high density index &gt; 1</td>
<td>rich index &gt; .93</td>
</tr>
</tbody>
</table>
The reason for this is that the density on a per capita basis is on the average higher in rural communities due to lower population. Similarly, average income per capita is higher in nonagricultural areas. Therefore, if the density index is less than .5 in the nonagricultural community, the SEA is considered one of low bank density. If the income index is less than .93 in the agricultural community, the SEA is considered a poor region.

Since the demarcation between bank classes is somewhat arbitrary an attempt is made to illustrate the significant differences between the classes. Table 6 shows the level of significance in the differences between the average non-interest earning assets to total assets ratios ($R_2$), the average non-interest revenue to total assets ratios ($R_1$), and the non-interest cost to total assets ratios (C), between bank classes. A level of significance of .1 means that there is a 10 percent chance that the difference in the means between the two bank classes is due to random variation. The table indicates that all bank classes are significantly different in at least one respect. Seven groups are significantly different in only one respect. The remaining twenty combinations are significantly different in at least two respects. Twelve combinations are significantly different in all three respects. Therefore, it is concluded that the eight different bank classes represent different types of markets.

Population, income, and workforce data is taken from the 1970 census. Where the SEA definitions of the Bureau of the Census differ

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Table 6. Level of significance in the differences between average non-interest earning assets to total assets ratios, non-interest cost to total assets ratios, and non-interest revenue to total assets ratios between banks

### \( R_2 \) - non-interest earning assets to total assets

<table>
<thead>
<tr>
<th>Bank class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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### \( R_1 \) - non-interest revenue to total assets

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<tr>
<th>Bank class</th>
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### \( C \) - non-interest cost to total assets

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<tr>
<th>Bank class</th>
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from FDIC definitions, county data is referred to and SEA data is adjusted to conform with FDIC definitions. Interest data is reported by the FDIC in dollars of income earned on a class of assets or paid on a class of deposits. This data is converted to an interest rate by dividing the interest income by the volume of the asset held by the bank on the balance sheet date, ignoring the distortion caused by the fluctuations in asset holding over the year. Therefore, the interest rate is a weighted average of interest rates charged this year and in past years. Assets and liabilities are also reported in dollar figures. To allow the comparison of banks of different sizes these data are converted to percentages of total assets. When profits are calculated from these data, they are normalized profits. To get actual profits one must multiply by the total expected assets of the bank.

74See Chapter V, p. 81.
CHAPTER V
THE EMPIRICAL RESULTS

This chapter explores several alternatives for estimating the parameters of the system of equations (40). In order to compare banks of different sizes it is necessary to normalize the data. Three distinct procedures are used. The first approach is to use data which expresses assets and liabilities as a percent of total assets. Second, each observation is treated as the average bank in the SEA. Third, assets and liabilities are expressed in terms of the dollars of assets per capita in the banking market. The parameters of equation system (40) are the slopes of the demand for state and local funds, the demand for loans, and the supply of time deposits. Estimates of these parameters are used to estimate the elasticity of demand for state and local funds, the elasticity of demand for loans, and the elasticity of time deposit supply. These elasticities are used as an ordinal measure of monopoly or monopsony power. In addition, an attempt to focus on the impact of the current rates of interest is made by using the first difference between 1970 observations and 1969 observations of assets, liabilities, and rates of interest.

Assets and liabilities as a percent of total assets

Table 7 summarizes the results of a two stage least squares estimation of the parameters of equation system (40) for eight bank classes.
Table 7. Two stage least squares analysis of eight bank classes using cross sectional data with assets and liabilities as a percent of total assets

<table>
<thead>
<tr>
<th>Bank class</th>
<th>$i_1^4$</th>
<th>$\partial i_1^4 / \partial A_4$</th>
<th>$i_5^5 / \partial A_5$</th>
<th>$\partial i_5^5 / \partial L_2$</th>
<th>$R^2$</th>
<th>Degrees of freedom</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$i_1^4 = 0.0322$</td>
<td>$0.0510 A_4 / (0.0693)$</td>
<td>$0.0658$</td>
<td>$0.0110 A_5 / (0.0553)$</td>
<td>$0.8229 DL / (0.6489)$</td>
<td>$0.0431$</td>
<td>(1, 12)</td>
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<tr>
<td>2</td>
<td>$i_1^4 = 0.0423$</td>
<td>$0.0282^b A_4 / (0.0139)$</td>
<td>$0.0816$</td>
<td>$0.0010 A_5 / (0.0129)$</td>
<td>$0.1303 DL / (0.1230)$</td>
<td>$0.0562$</td>
<td>(1, 69)</td>
</tr>
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<tr>
<td>3</td>
<td>$i_1^4 = 0.0390$</td>
<td>$0.0122 A_4 / (0.0275)$</td>
<td>$0.0747$</td>
<td>$0.0184 A_5 / (0.0500)$</td>
<td>$0.7740^b DL / (0.5761)$</td>
<td>$0.0109$</td>
<td>(1, 18)</td>
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<tr>
<td>4</td>
<td>$i_1^4 = 0.0468$</td>
<td>$0.0508^b A_4 / (0.0358)$</td>
<td>$0.0797$</td>
<td>$0.0158 A_5 / (0.0351)$</td>
<td>$0.5529^b DL / (0.3564)$</td>
<td>$0.1009$</td>
<td>(1, 18)</td>
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Table 7. Continued

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<thead>
<tr>
<th>Bank class</th>
<th>( \frac{\partial i^4}{\partial A_4} )</th>
<th>( \frac{\partial i^5}{\partial A_5} )</th>
<th>( \frac{\partial r^2}{\partial L_2} )</th>
<th>( R^2 )</th>
<th>Degrees of freedom</th>
<th>( F )</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>.0424 (.0029)</td>
<td>.0274* A_4 (.0208)</td>
<td></td>
<td>.0764</td>
<td>(1,21)</td>
<td>1.737</td>
</tr>
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<tr>
<td></td>
<td></td>
<td>.0875 (.0094)</td>
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</tr>
<tr>
<td>6</td>
<td>.0335 (.0038)</td>
<td>+ .0326 A_4 (.0285)</td>
<td></td>
<td>.0463</td>
<td>(1,27)</td>
<td>1.312</td>
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<td></td>
<td></td>
<td>.0825 (.0139)</td>
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</tr>
<tr>
<td>7</td>
<td>.0401 (.0023)</td>
<td>- .0158 A_4 (.0186)</td>
<td></td>
<td>.0113</td>
<td>(1,63)</td>
<td>.722</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>.0670 (.0115)</td>
<td>+ .0173 A_5 (.0239)</td>
<td>.0293</td>
<td>(2,62)</td>
<td>.935</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.0413 (.0030)</td>
<td>- .0252 A_5 (.0259)</td>
<td></td>
<td>.0206</td>
<td>(1,45)</td>
<td>.948</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>.0806 (.0116)</td>
<td></td>
<td>.0152</td>
<td>(2,44)</td>
<td>.339</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Significant at the 90 percent level, using the students t-statistic and recognizing that it is only a proxy for the appropriate test statistic for simultaneous equations.

bSignificant at the 95 percent level.
Data which express assets and liabilities as a percent of total assets are used. In all cases the $R^2$ is relatively low, but the parameter estimates appear to follow the expected pattern. It is anticipated that the sign of $\partial i^4/\partial A_4$ in the first equation be negative. It is estimated as a negative value in all cases, except class 1 and class 6, and in these cases the standard error of the estimate is high relative to the parameter estimate. The sign of $\partial i^5/\partial A_5$ in the second equation is expected to be negative. It is estimated as a negative value in all cases, except classes 1 and 7, where, again, the standard error of the estimate is high relative to the size of the parameter estimates. The sign of $\partial r^2/\partial L_2$ in the second equation is expected to be positive. It is estimated as a positive value in all cases, except classes 2 and 8, where, again the standard error of the estimate is relatively high. The fact that the parameter estimate has the expected sign does not imply that the bank class has a high degree of monopoly power, but only that the elasticity of demand may be less than infinity. The actual degree of monopoly should be measured by the elasticity of demand.

Little is known about the small sample properties of the above estimators. It is understood, however, for such systems of equations that the $F$ and $t$-statistics are not necessarily the appropriate test-statistics. However, convention suggests that both the $F$ and the $t$ be used as proxies for the appropriate test-statistics. If the $F$-statistic is a proxy for the appropriate test-statistic, the estimated equations for classes 4, 5, and 6 have a .75 probability of explaining more than just the average variation in the endogenous variable. For classes 4, 5, and 6 the $t$-statistic indicates that the slope of the
deposit supply function is significantly different from zero. In classes 4 and 5 the slope of the demand for state and local funds is significantly different from zero. In class 5 the slope of the loan demand is significantly different from zero. In the other bank classes one would conclude that the data does not exhibit monopoly power, since the slopes of the demand and supply functions are not significantly different from zero and this implies that the elasticities of supply and demand are not significantly different from infinity.

There are a number of possible explanations for the low $R^2$'s:

(1) The use of aggregate bank data may incorporate spurious variation. Within each SEA size of banks extends over a wide range. Aggregating bank data from banks of different sizes may produce a distorted variation, with the actions of a small bank being overwhelmed by the actions of a large bank. (2) The interest rate calculations (interest earned divided by the volume of assets) may not reflect the current market rate. If the current market rates are used, they affect bankers' decisions with regard to additions to the portfolio of assets, but not with regard to those assets already in the portfolio. (3) The use of asset and liability data implies that an additional constraint is placed on the data. The sum of the assets must equal one, as well as being equal to the sum of the liabilities and net worth. The expression of data in this form was necessary so that banks (SEAs) of different sizes may be compared. The additional constraint may cause a downward bias in the value of $R^2$.

75 The FDIC data may be disaggregated into banks of different sizes on a statewide basis, but not for an individual standard economic area. Therefore, it is not possible to accurately estimate the range of bank sizes within an SEA.
Assets and liabilities for the average bank in the SEA

Instead of normalizing assets and liabilities with respect to total assets, the data for the SEA may be converted to an average volume of assets and liabilities by dividing SEA assets and liabilities by the number of banks in the SEA. The use of average bank data implies that one would expect the size of all banks within a class to be the same. Using the aggregated data for an SEA is valid if all banks within the SEA are the same size, so that the aggregate bank data reflects an observation on a single bank. Using average bank data to estimate the parameters of demand and supply functions for a bank class, implies that the bank sizes within each class, as well as within each SEA, are expected to be the same for all banks.

Table 8 presents the results of two stage least squares estimation of equation system (40) where average bank data for each SEA are used. Again using the F-statistic, the first equations for bank classes 3, 4, 5, and 6 have a .90 probability of explaining more than just the average variation in the endogenous variable. The second equation is significant at the .75 level for class 3, the .90 level for class 4, and the .50 level for classes 5 and 6. These four bank classes appear to exhibit some degree of monopsony or monopoly power. Based on the t-statistic, recognizing its limitations, the parameter estimates of some of the variables are significantly different from zero, with the standard error less by some multiple than the estimated value of the coefficients. It is interesting to note that this analysis does not find the slope of the loan demand function \( \frac{\partial l}{\partial A_5} \) in class 5 to be different from zero.

---

76 See Chapter IV, p. 70.
Table 8. Two stage least squares analysis of eight bank classes using average assets and liabilities per bank

<table>
<thead>
<tr>
<th>Bank class</th>
<th>$\frac{\partial y_2}{\partial A_4}$</th>
<th>$\frac{\partial y_2}{\partial A_5}$</th>
<th>$\frac{\partial r^2}{\partial L_2}$</th>
<th>$R^2$</th>
<th>Degrees of freedom</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0369 + 0.0000034 A_4 (0.0044)</td>
<td>$-$ 0.0000049 A_5 (0.0000045) + 0.000232 A_5 (0.0000145)</td>
<td>0.0141</td>
<td>(1,12)</td>
<td>0.171</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_2$ = 0.0806 (0.0048)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.0384 + 0.0000002 A_4 (0.0006)</td>
<td>+ 0.0000003 A_5 (0.0000003) - 0.0000075 A_5 (0.0000084)</td>
<td>0.0049</td>
<td>(1,69)</td>
<td>0.340</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_2$ = 0.0786 (0.0007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.0402 - 0.0000151 A_4 (0.0015)</td>
<td>$-$ 0.0000184 A_5 (0.0000118) + 0.0000358 DL (0.0000392)</td>
<td>0.2002</td>
<td>(1,18)</td>
<td>4.504</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_2$ = 0.0829 (0.0050)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.0451 - 0.0000158 A_4 (0.0290)</td>
<td>$-$ 0.0000018 A_5 (0.0000051) + 0.0000285 A_5 (0.0000138)</td>
<td>0.1637</td>
<td>(1,18)</td>
<td>3.523</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_2$ = 0.0716 (0.0050)</td>
<td></td>
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</tr>
</tbody>
</table>
Table 8. Continued

<table>
<thead>
<tr>
<th>Bank class</th>
<th>( \frac{\partial i^4}{\partial A_4} )</th>
<th>( \frac{\partial i^5}{\partial A_5} )</th>
<th>( \frac{\partial r^2}{\partial L_1} )</th>
<th>( R^2 )</th>
<th>Degrees of freedom</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>( i^4 = .0418 ) ( .0019 )</td>
<td>( .00000145^{a} ) ( .00000083 )</td>
<td>( y_2 = .0750 ) ( .0040 )</td>
<td>+ ( .00000001 ) ( A_5 ) + ( .0000187 ) ( DL ) ( .00000063 ) ( .000178 )</td>
<td>( .1269 )</td>
<td>( (1, 21) )</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>( i^4 = .027 ) ( .0076 )</td>
<td>( .00000185^{b} ) ( A_4 )</td>
<td>( y_2 = .0751 ) ( .0036 )</td>
<td>+ ( .00000008 ) ( A_5 ) + ( .0000152 ) ( DL ) ( .00000056 ) ( .0000155 )</td>
<td>( .1169 )</td>
<td>( (1, 21) )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>( i^4 = .0393 ) ( .0013 )</td>
<td>( .00000116 ) ( A_4 )</td>
<td>( y_2 = .0790 ) ( .0033 )</td>
<td>- ( .00000072 ) ( A_5 ) + ( .0000236 ) ( DL ) ( .00000120 ) ( .0000313 )</td>
<td>( .0114 )</td>
<td>( (1, 63) )</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>( i^4 = .0377 ) ( .0010 )</td>
<td>( .00000059 ) ( A_4 )</td>
<td>( y_2 = .0748 ) ( .0021 )</td>
<td>+ ( .00000017 ) ( A_5 ) - ( .00000017 ) ( DL ) ( .00000068 ) ( .00001788 )</td>
<td>( .0166 )</td>
<td>( (1, 45) )</td>
</tr>
</tbody>
</table>

\( ^{a} \)Significant at the 90 percent level, using the students t-statistic and recognizing that it is only a proxy for the appropriate test statistic for simultaneous equations.

\( ^{b} \)Significant at the 95 percent level.
The analysis of Table 7 finds the value of this parameter to be negative and significantly different from zero. Likewise, in class 6 the value of the slope of the loan demand function is estimated as a positive value, where the previous analysis had estimated it to be negative. Also, for class 6 the estimate of $\frac{\partial^4}{\partial A^4}$ is negative and significantly different from zero, where the analysis of data expressing assets as a percent of total assets estimates the parameter to be positive. All of these discrepancies may be due to a wide variation in bank size within each bank class. Estimates of $\frac{\partial^4}{\partial A^4}$ and $\frac{\partial^5}{\partial A^5}$ for bank class 3 are significantly different from zero, which reinforces the results of the previous case.

Assets and liabilities per capita in the SEA

To avoid making the assumption about the identical size of banks for all SEAs in a bank class, the following approach is taken. The bank data is normalized by the number of people in the SEA. This implies that a certain amount of banking service (assets per capita) is provided for each person in the banking market and that increasing the number of people in the SEA will proportionately increase the demand for banking services.

Table 9 presents the results of two stage least squares estimation of equation system (40) using bank data per capita. Using the F-statistic, the probability that the first equation explains more than just the average variation in the endogenous variable is .90 in classes 4 and 5 and .75 in class 3. The probability that the second equation explains more than just the average variation in the endogenous variable
Table 9. Two stage least squares analysis of eight bank classes using average per capita assets and liabilities in the bank marketing area

<table>
<thead>
<tr>
<th>Bank class</th>
<th>( i^4 / \partial A_4 )</th>
<th>( i^5 / \partial A_5 )</th>
<th>( r^2 / \partial L_2 )</th>
<th>( R^2 )</th>
<th>Degrees of freedom</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.0423 (.0058)</td>
<td>.0052 A_4 (.0081)</td>
<td>.0058 A_5 (.0036) + .1147 DL (.1117)</td>
<td>.0325</td>
<td>(1,12)</td>
<td>.405</td>
</tr>
<tr>
<td></td>
<td>.0909 (.0071)</td>
<td>.0169 (1,69)</td>
<td>.1961 (2,11)</td>
<td>.0169</td>
<td>(1,12)</td>
<td>.405</td>
</tr>
<tr>
<td>2</td>
<td>.0399 (.0013)</td>
<td>.0016 A_4 (.0014)</td>
<td>.0003 A_5 (.0008) - .0117 DL (.0179)</td>
<td>.0093</td>
<td>(2,68)</td>
<td>.305</td>
</tr>
<tr>
<td>3</td>
<td>.0401 (.0020)</td>
<td>.0042 A_4 (.0029)</td>
<td>.0109 A_5 (.0055) + .1356 DL (.0916)</td>
<td>.1015</td>
<td>(1,18)</td>
<td>.2033</td>
</tr>
<tr>
<td>4</td>
<td>.0459 (.0032)</td>
<td>.0071 A_4 (.0037)</td>
<td>.0011 A_5 (.0029) + .0913 DL (.0571)</td>
<td>.1720</td>
<td>(1,18)</td>
<td>.3739</td>
</tr>
<tr>
<td></td>
<td>.0747 (.0066)</td>
<td>.0169 (1,69)</td>
<td>.1469 (2,17)</td>
<td>.0169</td>
<td>(1,12)</td>
<td>.405</td>
</tr>
</tbody>
</table>
Table 9. Continued

<table>
<thead>
<tr>
<th>Bank class</th>
<th>( \frac{\partial i^4}{\partial A_4} )</th>
<th>( \frac{\partial i^5}{\partial A_5} )</th>
<th>( \frac{\partial y^2}{\partial L_2} )</th>
<th>( R^2 )</th>
<th>Degrees of freedom</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>( 0.0420 ) ((0.0022))</td>
<td>( 0.0490 ) ((0.0031))</td>
<td>( -0.009 ) ((0.0026))</td>
<td>( 0.1032 )</td>
<td>((1,21))</td>
<td>2.415</td>
</tr>
<tr>
<td></td>
<td>( 0.0815 ) ((0.0051))</td>
<td>( -0.009 ) ((0.0026))</td>
<td>( 0.0780 ) ((0.0555))</td>
<td>( 0.0803 )</td>
<td>((2,20))</td>
<td>0.873</td>
</tr>
<tr>
<td>6</td>
<td>( 0.0364 ) ((0.0031))</td>
<td>( 0.0017 ) ((0.0039))</td>
<td>( -0.007 ) ((0.0021))</td>
<td>( 0.0067 )</td>
<td>((1,27))</td>
<td>0.183</td>
</tr>
<tr>
<td></td>
<td>( 0.0765 ) ((0.0061))</td>
<td>( -0.007 ) ((0.0021))</td>
<td>( 0.0720 ) ((0.0450))</td>
<td>( 0.0925 )</td>
<td>((2,26))</td>
<td>1.325</td>
</tr>
<tr>
<td>7</td>
<td>( 0.0378 ) ((0.0019))</td>
<td>( 0.0004 ) ((0.0026))</td>
<td>( -0.003 ) ((0.0013))</td>
<td>( 0.0005 )</td>
<td>((1,63))</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>( 0.0853 ) ((0.0036))</td>
<td>( -0.003 ) ((0.0013))</td>
<td>( 0.0316 ) ((0.0403))</td>
<td>( 0.0868 )</td>
<td>((2,62))</td>
<td>2.945</td>
</tr>
<tr>
<td>8</td>
<td>( 0.0376 ) ((0.0006))</td>
<td>( 0.0008 ) ((0.0004))</td>
<td>( -0.003 ) ((0.0007))</td>
<td>( 0.1005 )</td>
<td>((1,45))</td>
<td>5.026</td>
</tr>
<tr>
<td></td>
<td>( 0.0753 ) ((0.0012))</td>
<td>( +0.003 ) ((0.0007))</td>
<td>( -0.0083 ) ((0.0248))</td>
<td>( 0.0038 )</td>
<td>((2,44))</td>
<td>0.084</td>
</tr>
</tbody>
</table>

\( a \)Significant at the 90 percent level, using the students t-statistic and recognizing that it is only a proxy for the appropriate test statistic for simultaneous equations.

\( b \)Significant at the 95 percent level.
is .975 in class 3, .75 in classes 4 and 6, and .50 in class 5. The estimates of $\frac{\partial i_4}{\partial A_4}$ is negative, except for classes 6, 7, and 8. The estimates for $\frac{\partial i_5}{\partial A_5}$ are positive only for classes 2 and 8. The estimates for $\frac{\partial r_2}{\partial L_2}$ are negative only for classes 2 and 8. Equations (40) do not explain the data for classes 2 and 8. Class 2 is nonagricultural, high income, and low bank density. It is also highly urban. Ninety-six percent of the SEAs in class 2 contain a standard metropolitan statistical area. These are not the conditions under which one would expect to find bank monopoly or monopsony power. Bank class 8 is agricultural, high income, and high bank density. Even though it is rural (only 6 percent of the SEAs contain standard metropolitan statistical areas), the high income and high bank density would lead one to expect a more competitive market.

**Estimation of elasticities**

Using the three methods of expressing assets and liabilities some of the bank classes appear to exhibit some degree of monopoly or monopsony power, with the slope parameters significantly different from zero (using the t-statistic as a proxy for the appropriate test-statistic). However, the best measure of monopoly power is not the slope of the demand function, but the Lerner index or the elasticity of demand. Because the F-statistics are consistently higher for the third method of normalizing assets and liabilities, the parameter estimates from assets and liabilities per capita are used to estimate elasticity.

Table 10 presents estimates of elasticities of demand and supply based on the parameter estimates in Table 9. An elasticity is calculated for each SEA in the bank class and all elasticities within the class are
Table 10. Average estimated elasticities of demand for state and local funds and loans and elasticity of time deposit supply by bank class based on estimates of demand and supply parameters using per capita assets and liabilities

<table>
<thead>
<tr>
<th>Bank class</th>
<th>State and local funds</th>
<th>Loans</th>
<th>Time deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated</td>
<td>Upper(^a)</td>
<td>Lower(^a)</td>
</tr>
<tr>
<td>1</td>
<td>-12.37</td>
<td>-22.2</td>
<td>-5.4</td>
</tr>
<tr>
<td></td>
<td>(-(\infty), -4.8)(^c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-36.59</td>
<td>-169.7</td>
<td>-14.3</td>
</tr>
<tr>
<td></td>
<td>(-292.5, -19.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-14.75(^b)</td>
<td>-37.0</td>
<td>-8.7</td>
</tr>
<tr>
<td></td>
<td>(-47.7, -8.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-8.24(^b)</td>
<td>-25.5</td>
<td>-3.9</td>
</tr>
<tr>
<td></td>
<td>(-17.2, -5.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-12.98(^b)</td>
<td>-29.1</td>
<td>-7.7</td>
</tr>
<tr>
<td></td>
<td>(-35.3, -8.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) Elasticities are estimated at the mean of per capita assets and liabilities.
\(^{b}\) Indicates that the elasticity is statistically significant at the .05 level.
\(^{c}\) Indicates that the elasticity is statistically significant at the .01 level.
Table 10. Continued

<table>
<thead>
<tr>
<th>Bank class</th>
<th>State and local funds</th>
<th>Loans</th>
<th>Time deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated</td>
<td>Upper&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Lower&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>6</td>
<td>50.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.3</td>
<td>19.0</td>
</tr>
<tr>
<td></td>
<td>(9.1,∞)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>128.80</td>
<td>251.1</td>
<td>78.5</td>
</tr>
<tr>
<td></td>
<td>(17.3,∞)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>62.86&lt;sup&gt;b&lt;/sup&gt;</td>
<td>126.3</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>(41.9,125.6)</td>
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<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>The estimated elasticity is calculated by dividing the slope of the demand or supply function into the ratio of interest rate to volume of the asset or liability for each SEA and averaging for all SEA's in a bank class. The upper figure is the highest elasticity for an SEA in the banking class and the lower figure is the lowest elasticity for an SEA in the banking class.

<sup>b</sup>Based on parameter estimates which the "t-statistic" indicates are significantly different from zero.

<sup>c</sup>In order to indicate a range of possible elasticity estimates elasticities were calculated for values of the parameter that are one standard deviation above and below the estimated parameter value.
averaged to yield an estimated elasticity for the bank class. Table 10 also indicates the high and low elasticity for SEAs in each bank class. The upper and lower elasticities represent a range of estimates elasticities within a bank class, but it does not represent a confidence interval. Without knowing the exact distribution of the parameter estimates it is impossible to establish a confidence interval for the estimated elasticity. However, a range over which the estimates may be considered reliable may be established by calculating the elasticities for values of the parameters that are one standard deviation above and below the estimated value of the parameter. For instance, the estimated average elasticity of demand for state and local funds in bank class 1 is -12.37. In bank class 1 the lowest elasticity for an SEA is estimated at -5.4 and the highest is -22.2. If the parameter value was one standard deviation less than its estimated value, the elasticity of demand would have risen to infinity; if the parameter were one standard deviation more, the elasticity would be -4.8. The elasticity estimate, though low, is not significantly different from infinity.

The Lerner index is an ordinal ranking device. If the absolute value of elasticity of demand is lower for one bank than another, then it may be said that the former has a higher degree of monopoly power. However, the index cannot be used to measure monopoly power without a reference point. For ease of exposition, an elasticity of 10 is arbitrarily chosen as a reference point. If the absolute value of the elasticity is less than 10 the bank is said to have monopoly power in a relative sense. If the elasticity is greater than 10, the bank is said to be relatively non-monopolistic.
The estimates of the elasticities of demand for state and local funds in all cases are relatively high and could not be considered as representing monopoly power for the bank. Only in class 4 is the elasticity less than 10.

The estimates of the elasticities of demand for loans are significantly lower for the low income bank classes 1, 3, 5, and 7 (-5.17, -2.85, -10.92, and -8.63 respectively). For the high income bank classes the elasticity of loan demand is not significantly different from infinity.

The estimates of the elasticities of deposit supply are all very small. However, for classes 2, 7, and 8 the estimates are not significantly different from infinity. The estimates in the other five classes are all less than one. These consistently low estimates of the elasticity of time deposit supply are to be regarded as questionable. The inelastic supply may mean that the bank has monopsony power. There is, however, another plausible explanation. That is, that regulation Q is in effect putting a ceiling on the rate of interest paid on time deposits. If this is the case the bank will act as if its supply of deposits is perfectly inelastic and the rate paid will be the maximum rate. The bank will be unable to attract more funds by paying a higher rate. The only way the bank could pay a higher rate would be to change the maturity mix of its deposits, and this would not necessarily attract more deposits.

The period 1970 was chosen for the sample due to the relatively stable interest rates during the year. In the early part of the year interest rates were rising. In the latter part of the year they were falling. It is fairly clear that regulation Q was an effective
constraint at the beginning of 1970, since the Federal Reserve deemed it necessary to raise the maximum rates in January of 1970.

As money-market rates skyrocketed during 1969, commercial bank rates on time deposits remained at their regulation Q ceilings and consequently, business and individual savers withdrew substantial amounts of deposits from banks and placed those funds in other instruments with high rates of return. Although regulation Q ceilings were raised in January 1970, that change came too late to halt the heavy deposit outflow around the turn of the year, especially the outflow of large-denomination time certificates.77

An interest rate survey for the last three months of 1970 indicates that rates paid on time deposits moved quickly to their new ceiling rates.78 Eighty-one percent of the banks were paying the ceiling rate on saving accounts. Ninety-seven percent of the banks were paying the ceiling rate on time account less than twelve months less than $100,000. Ninety-one percent of the banks were paying the ceiling rate on time accounts of one to two years. Ninety-five percent of the banks were paying the ceiling rate on time accounts of more than two years. Only for accounts of more than one year and more than $100,000 were a large number of banks paying less than the ceiling rate.

First difference analysis

In order to focus on the current rate of interest the first difference of equation system (40) can be taken. Interest rates calculated by dividing interest earned on the class of assets by the volume of the assets are weighted averages of past interest rates. Assuming that each asset earns its interest annually, the first difference


between interest earned in the current year and interest earned in the previous year is the interest earned on the newly acquired assets.

\[ i_{70}^{4} - i_{69}^{4} = -\frac{\partial i^{4}}{\partial A^{4}} (A_{70}^{70} - A_{69}^{69}) \]  

(41)

\[ y_{2}^{70} - y_{2}^{69} = -\frac{\partial i^{5}}{\partial A^{5}} (A_{70}^{70} - A_{69}^{69}) + \frac{\partial r^{2}}{\partial L_{2}} (DL_{70} - DL_{69}) \]

When the first difference is taken the constant term drops out. If the demand equations are assumed to be stable from year to year at the optimal solution (profit maximization according to the Euler first order conditions) one would expect the difference between the variables to be zero. In order to have a stock adjustment between 1969 and 1970 there must be a change in the supply and demand functions. If it is assumed that there is a trend change in the supply and demand functions, then there will be a stock adjustment which can be measured in terms of a modification in equation (41):

\[ di^{4} = T_{1} - \frac{\partial i^{4}}{\partial A^{4}} dA^{4} \]  

(42)

\[ dy_{2} = T_{2} - \frac{\partial i^{5}}{\partial A^{5}} dA^{5} + \frac{\partial r^{2}}{\partial L_{2}} dDL \]

Here \( T \) represents the trend variable. It is assumed that this trend is such that the positions of the supply and demand functions change but that at the optimal solution the slopes of the supply and demand functions have not changed.

The first difference analysis is made for classes 3, 4, 5, and 6. In the three methods of measuring assets and liabilities the F-statistic indicated that equation system (40) appeared to explain more
than average variation in the endogenous variables for these four classes of banks. Assets and liabilities are normalized on a per capita basis, since the F-statistic is consistently higher using this method than for the percent of total assets or the average bank data methods.

Table 11 summarizes the results of two stage least squares estimates of equation (42) using first difference of per capita bank data for four classes of banks. The parameter estimates for $\partial r^2/\partial L_2$ are not significantly different from zero in any of the bank classes. This implies that there is no stock adjustment for time deposits, which is reasonable since interest rates could be changed within the years time period for most of the deposits. Or if regulation Q is in effect interest rates won't change, there will be no trend associated with time deposits. Based on the F and t-statistics, the estimates of all other parameters are significantly different from zero.

Table 12 calculates the average elasticities for the four bank classes based on the parameter estimates. The estimated elasticities indicate that a monopoly model is of value in analyzing the short run activities of banks in these classes. Classes 3, 5, and 6 are essentially rural areas; classes 3 and 5 are low income areas; classes 5 and 6 are low bank density areas; but class 4 is high income, high bank density, nonagricultural, urban area. It is impossible to establish any decisive conclusions on the structural preconditions for the existence of monopoly power.

**Critique of the empirical analysis**

In evaluating the empirical evidence presented in this paper two specific questions should be asked: Does the empirical evidence support
Table 11. Two stage least squares analysis for four bank classes using first difference of average per capita assets and liabilities in the bank marketing area

<table>
<thead>
<tr>
<th>Bank class</th>
<th>$\partial_4^i / \partial A_4$</th>
<th>$\partial_5^i / \partial A_5$</th>
<th>$\partial r^2 / \partial L_2$</th>
<th>$R^2$</th>
<th>Degrees of freedom</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>$di^4 = .0034$</td>
<td>- .0114$^a$ $dA_4$</td>
<td>( .0011) ( .0085)</td>
<td>.0906</td>
<td>(1,18)</td>
<td>1.794</td>
</tr>
<tr>
<td></td>
<td>$dy_2 = .0081$</td>
<td>$- .0145$ $^b$ $dA_5$</td>
<td>( .0015) ( .0043)</td>
<td>.4183</td>
<td>(2,17)</td>
<td>6.113</td>
</tr>
<tr>
<td>4</td>
<td>$di^4 = .0034$</td>
<td>$- .0155$ $^b$ $dA_4$</td>
<td>( .0008) ( .0063)</td>
<td>.2507</td>
<td>(1,18)</td>
<td>6.033</td>
</tr>
<tr>
<td></td>
<td>$dy_2 = .0074$</td>
<td>$- .0144$ $^b$ $dA_5$</td>
<td>( .0020) ( .0043)</td>
<td>.4110</td>
<td>(2,17)</td>
<td>5.930</td>
</tr>
<tr>
<td>5</td>
<td>$di^4 = .0050$</td>
<td>$- .0205$ $^b$ $dA_4$</td>
<td>( .0011) ( .0091)</td>
<td>.1939</td>
<td>(1,21)</td>
<td>5.051</td>
</tr>
<tr>
<td></td>
<td>$dy_2 = .0069$</td>
<td>$- .0136$ $^b$ $dA_5$</td>
<td>( .0019) ( .0043)</td>
<td>.1737</td>
<td>(2,20)</td>
<td>2.103</td>
</tr>
<tr>
<td>6</td>
<td>$di^4 = .0060$</td>
<td>$- .0314$ $^b$ $dA_4$</td>
<td>( .0018) ( .0132)</td>
<td>.1728</td>
<td>(1,27)</td>
<td>5.641</td>
</tr>
<tr>
<td></td>
<td>$dy_2 = .0053$</td>
<td>$- .0066$ $^b$ $dA_5$</td>
<td>( .0013) ( .0032)</td>
<td>.1429</td>
<td>(2,26)</td>
<td>2.167</td>
</tr>
</tbody>
</table>

$^a$Significant at the 90 percent level, using the students $t$-statistic and recognizing that it is only a proxy for the appropriate test statistic for simultaneous equations.

$^b$Significant at the 95 percent level.
Table 12. Average estimated elasticities of demand for state and local funds and loans and elasticity of time deposit supply by bank class based on estimates of parameters using first difference of per capita assets and liabilities

<table>
<thead>
<tr>
<th>Bank class</th>
<th>State and local funds</th>
<th>Loans</th>
<th>Time deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated Upper&lt;sup&gt;a&lt;/sup&gt; Lower&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Estimated Upper&lt;sup&gt;a&lt;/sup&gt; Lower&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Estimated Upper&lt;sup&gt;a&lt;/sup&gt; Lower&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>-5.38&lt;sup&gt;b&lt;/sup&gt; (-21.2, -3.1)</td>
<td>-2.13&lt;sup&gt;b&lt;/sup&gt; (-3.0, -1.6)</td>
<td>-5.31 (-∞, .25)</td>
</tr>
<tr>
<td>4</td>
<td>-3.75&lt;sup&gt;b&lt;/sup&gt; (-6.3, -2.7)</td>
<td>-1.73&lt;sup&gt;b&lt;/sup&gt; (-2.5, -1.3)</td>
<td>-2.24 (-∞, -3.7)</td>
</tr>
<tr>
<td>5</td>
<td>-3.10&lt;sup&gt;b&lt;/sup&gt; (-5.0, -2.1)</td>
<td>-2.30&lt;sup&gt;b&lt;/sup&gt; (-4.5, -1.5)</td>
<td>21.71 (3.7, ∞)</td>
</tr>
<tr>
<td>6</td>
<td>-1.58&lt;sup&gt;b&lt;/sup&gt; (-2.7, -1.4)</td>
<td>-3.57&lt;sup&gt;b&lt;/sup&gt; (-6.9, -2.4)</td>
<td>1.33 (.28, ∞)</td>
</tr>
</tbody>
</table>

<sup>a</sup>The estimated elasticity is calculated by dividing the slope of the demand and supply function into the ratio of interest rate to volume of the asset or liability for each SEA and averaging for all SEA's in a bank class. The upper figure is the highest elasticity for an SEA in the banking class and the lower figure is the lowest elasticity for an SEA in the banking class.

<sup>b</sup>Based on parameter estimates which the "t-statistic" indicates are significantly different from zero.

<sup>c</sup>In order to indicate a range of possible elasticity estimates elasticities were calculated for values of the parameter that are one standard deviation above and below the estimated parameter value.
the theoretical argument of monopoly power? Does the empirical evidence indicate that monopoly and monopsony power are of importance in the commercial banking industry?

In answer to the first question, the theoretical model is based on the profit maximizing motives of commercial bankers. Asked the question, "Do bankers maximize profits?", a banker, would probably answer that they maximize service to the community and in that process they may or may not maximize profits. "Do they act as if they are maximizing profits?" is an empirical question. "Is the service to the community that they maximize a function of the constraints of regulation?" is also an empirical question. All the estimations explain less than half of the total variation of the endogenous variables. One possible explanation is that bankers do not operate as profit maximizers.

There is another more serious criticism of the theoretical model, and that is that the calculus of the Euler first order conditions is only defined where the functions are continuous. The existence of inequality constraints, that are operative (e.g. regulation Q or regulation H) if they are incorporated into the objective function may create a mathematical programming problem, rather than a problem of classical optimization.

The theoretical model also encounters problems with the appropriate definition of the interest rate. The interest rate used is a weighted average of all past interest rates. The first difference of the weighted averages is the current rate. The problem with this approach is that the maturity mix of asset and liability categories differs, and the adjustment of different categories to current market
rates will proceed at different paces. Under these conditions a dynamic stock-flow model would be more appropriated than the static stock model utilized in this paper. However, the data necessary on the maturity mix of bank portfolios is not available.

Realizing the limitations of the theoretical model, does the empirical evidence indicate that monopoly power is a relevant consideration in the commercial banking industry? The answer to this question has to be mitigated in light of the data source used in the empirical analysis. Aggregated bank data, while the best available source for a cross sectional study is full of all sorts of "noise." Individual bank data would have been more appropriate for the study. In spite of the weaknesses of the data some conclusions can be drawn. Table 10 indicated that the elasticity of loan demand in low income areas was substantially below those in high income areas. Table 12 indicated that in four bank classes the adjustment for interest rate changes from year to year appears to be subject to some degree of monopoly power. Due to the possible incursion of regulation Q into the analysis, no conclusions can be drawn with respect to the existence of monopsony power.
CHAPTER IV
SUMMARY AND CONCLUSIONS

The commercial banking industry is often criticized on the grounds that there is a high concentration of market power in the hands of a few firms. However, the appropriate measure of market power is Lerner's index of monopoly power, not concentration. Lerner's index measures the difference between marginal cost and price as a percentage of the price. On the assumption that firms are profit maximizers (marginal costs equals marginal revenue) the index is the inverse of the elasticity of demand: the higher the elasticity of demand, the lower the index of monopoly power. The theoretical model developed in the paper is designed to permit the estimation of demand elasticities in the banking industry.

The theoretical model assumes that banks are profit maximizers. In his efforts to maximize profits the banker considers the cost of maintaining and administering different assets \( C_j(A_j) \) and liabilities \( C_k(L_k) \), the risk of default on different assets \( DR_j \), transaction costs and market risks associated with deposit liability fluctuations \( TrC_j \), the average and marginal revenue associated with each assets \( i_j A_j \), and the average and marginal cost associated with each liability \( r^k L_k \). The banker maximizes an expected profits function:

\[
E(P) = \sum_{j=1}^{n} (E(i_j A_j) - E(C^j(A_j)) - E(DR_j) - E(TrC_j))
- \sum_{k=1}^{m} (E(r^k L_k) + E(C^k(L_k))
\]

(43)
where the expected values are based on the random variation of deposits and/or loans. The expected profits function is maximized subject to the constraint that assets equal liabilities plus net worth. The bank adjusts its portfolio of assets and issues of liabilities in accordance with the Euler first order maximization conditions of the expected profits function. The Euler first order conditions specify the slopes of the asset demand functions and the liability supply functions.

The empirical model focuses its attention on the demand and supply conditions. Specifically, two assets (loans and state and local funds) and one liability (time deposits) are investigated. The prices of all other assets and liabilities are assumed to be determined in perfectly competitive markets. If the elasticity of demand for loans or for state and local funds is low, the bank is said to have monopoly power. If the elasticity of time deposit supply is low, the bank is said to have monopsony power. In order to estimate these elasticities, it is necessary to make several simplifying assumptions: administrative costs are expressed as a proportion of total assets; default risks are ignored; and at the optimal solution of the Euler first order conditions transaction costs generated by deposit-liability fluctuations are treated as scalars. The empirical expected profits function is:

\[
E(P) = \sum_{j=1}^{n} i_j A_j - \sum_{k=1}^{m} r_t L_k - \sum_{j=1}^{n} C(\sum A_j) - E(TrC)
\]  

The Euler first order maximization conditions of the above function dictates a set of behavioral equations for the profit maximizing bank. These behavioral equations can be used to estimate the slope of the loan
demand, the slope of the demand for state and local funds, and the slope of the time deposit supply function, which in turn can be used to estimate the elasticities of the respective functions.

The empirical results are based on cross-sectional data for 289 standard economic areas in those states where there is an absence of extensive branch banking. These observations are categorized into eight bank classes by per capita income level, by bank density per capita in the standard economic area, and by economic base (agricultural or non-agricultural) of the area. This classification groups banks with similar market conditions together. It is assumed that banks experiencing similar market conditions will have identical demand and supply functions. The Euler first order conditions are used to estimate the slopes of the supply and demand functions within each class of banks. The slope estimates are then used to calculate an average elasticity for loan demand, state and local funds demand, and time deposit supply for each class of banks.

In general, it can be concluded that those banks from low income areas have a lower elasticity of demand for loans than banks in high income areas. Table 10 gives the range of the estimates of loan demand elasticity in low income areas from -2.84 to -10.82; the range of the estimates for the high income areas is from -12.83 to ∞. Banks in lower income areas have more monopoly power in the loan account.

The elasticity associated with state and local funds is relatively high approximating a perfectly competitive market. The range of estimated elasticities is from -8.24 to ∞. For only one bank class (non-agricultural, high bank density, and high income) is the absolute value
of the elasticity less than 10. All other classes of banks have estimates elasticities that would have to be considered consistent with perfectly competitive markets.

The estimates of the elasticity of deposit supply is low for all classes of banks. For six classes of banks it is less than 1. This could be due to monopsony power, but it is more likely due to the legal ceiling on interest rates paid on time deposits (regulation Q).

The data for two classes of banks do not appear to be consistent with the empirical model of monopoly power. The class of banks representing nonagricultural areas with high income and high bank density per capita, which includes the major urban areas of the country, does not appear to exhibit a measurable degree of monopoly or monopsony power. Also, the rural class of banks from agricultural areas with high bank density and high income does not appear to exhibit any measurable degree of monopoly or monopsony power. One would not expect to find monopoly power in either of these classes. In the former, even though bank density is low, financial markets are well developed and communication among customers is good leading one to expect a perfectly competitive market. In the latter bank class, the high income and high bank density would lead one to expect the perfectly competitive market, even though the area is rural.

For selected bank classes a first difference analysis is made of the Euler first order conditions. This is done in an effort to isolate the current market rate of interest from past rates of interest. Interest rates calculated by dividing interest earned by the volume of an asset in the portfolio are weighted averages of past interest rates.
The first difference between any two years reflects the current interest rates in those years. This analysis did not indicate the presence of monopsony power and it is consistent with the implications of regulation Q. Monopoly power appears to be present especially in the loan account where the range of estimated elasticities is from -1.73 to -3.57. The conclusion can be drawn that in the short run customers are reluctant or unable to switch banks. For a year to year change the bank exerts monopoly power over its loan demand. This conclusion can only apply to the short run. Over the longer period customers may have more alternatives open to them. This analysis of first difference does not lead to any conclusions for the structural preconditions for the existence of monopoly power, but it does indicate that banks in certain markets may have some degree of monopoly power.

A monopoly model of bank behavior explains some of the portfolio decisions of some banks. However, it is not appropriate for studying the behavior of all banks. Banks in well developed urban financial markets or rural markets with high income and high bank density are characterized by perfect competition. In other markets a monopoly model is useful in interpreting bank behavior.
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