A STUDY OF ASYMME
COMMERCIAL BANK
LENDING BEHAVIOR

Thesis for the Degree of Ph. D.
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MANFERD OLIVER PETERSON
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ABSTRACT

A STUDY OF ASYMMETRIC COMMERCIAL
BANK LENDING BEHAVIOR

By

Manferd Oliver Peterson

This dissertation constitutes the specification and estimation of a model of individual commercial bank behavior. A multidimensional utility maximization model is adapted to commercial banking. Demands for loan equations for business loans, mortgage loans, and other loans are estimated from weekly balance sheet data for ten large commercial banks. The data cover the period of 1965-1967.

The null hypothesis that commercial banks do not adjust their loan portfolios asymmetrically during tight money versus non-tight money situations is tested. The results of this study indicate that the null hypothesis cannot be rejected.

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BANK LENDING BEHAVIOR

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Manferd Oliver Peterson

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and conclusions reached are the responsibility of the author and in no way represent a policy determination endorsed by the Federal Deposit Insurance Corporation.

I alone am responsible for any errors or omissions.

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CHAPTER 1

INTRODUCTION

1.1 Purpose

The purpose of this research is to specify and estimate a model of individual bank behavior. Particular attention will be given to the bank's loan policies.

The study of bank loan portfolios is important for at least two reasons: 1) The size of banks' loan portfolios is related to the expansion of credit and the money supply, and 2) the composition of banks' portfolios has implications for the channeling of funds and therefore for resource allocation and distribution of income.

The Federal Reserve System implements policy primarily through its effect upon individual banks. Thus, the answers to macroeconomic questions concerning monetary policy can be studied at least partially by investigating the behavior of individual bank units.

The question of the effectiveness of monetary policy is related to the question of expansion of bank credit. Monetary policy is presumably transmitted through the banking system by the interest rate mechanism or by non-price credit rationing. To transmit a tight money policy, banks either raise interest rates or restrict credit at the existing interest rates.

The question of the discriminatory effect of monetary policy is closely related to the question of the bank's choice of its loan portfolio. The question of whether or not a tight monetary policy discriminates against mortgage loans, consumer loans, and small business loans has not been considered explicitly as a question of bank portfolio choice. Certainly there are problems in handling this question in the context of an individual bank. First of all, one must specify what a tight money situation is for an individual bank. Secondly, one must define a discriminatory effect in terms of the behavioral parameters of the bank. These problems, together with the lack of individual bank data may have discouraged previous investigators.

However, the question has been approached on the macro level where an even more serious problem arises.[1] This problem involves essentially the difficulty in separating supply and demand effects. Consider the markets for mortgages and business loans. One would expect the demand for mortgage funds to be more interest elastic than the demand for business funds. Thus, an equal shift to the left in the supply of funds in each market would cause a greater decline in mortgage loans. The casual observer may conclude that this was "unfair discrimination," while in reality it was allocation by the price mechanism. Economic analysis at the macroeconomic level may have difficulty identifying the supply and demand effects. If, however, at the individual bank level, the demand for funds can be taken to be perfectly elastic at a rate of interest established in the market, the discriminatory effect, if any, can be identified.

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[1]See Chapter 2 of this dissertation.

1.2 Summary of Following Chapters

Chapter 2 is a brief summary of previous work in portfolio analysis. A cursory survey is made of general portfolio theory from Hicks through Markowitz and more recent developments. More specific attention is given to portfolio analysis as it is applied to commercial banks. Some problems of specific models are considered. The most detailed review is of the literature dealing specifically with the composition of the loan portfolio. The concepts of terms of lending, loan offer curve, credit availability, and credit rationing are discussed in this section. This chapter is concluded with a critique of the usefulness and feasibility of previous approaches for considering the problem of discriminatory effects of a tight money policy.

Chapter 3 adapts the lexicographic vector ordering theory to commercial banking. This gives theoretical justification for abstracting from the portfolio choice among cash, securities, and loans, and for concentrating on the choice among various loan categories. The commercial bank is assumed to make decisions according to priorities. First priority is given to attaining a satisfactory level of liquidity. If the bank has reached the satisfactory level of liquidity, it behaves as an ordinary expected profit maximizer. The demand for various loan assets is viewed as a derived demand and is a function of the same variables as the profit function. These demands for loan functions are linearized and a partial stock adjustment process is introduced.

Chapter 4 considers various statistical problems involved in estimating the model and testing the hypothesis that commercial banks discriminate against mortgage loans when credit is restricted. The system of demand equations will be estimated using detailed weekly balance sheet data for ten large banks in the New York Federal Reserve District. The data cover the period of 1965-1967.

The results of the estimates and tests of hypothesis will be presented.

Chapter 5 will draw conclusions based on the above mentioned estimates and tests. The implications of the results for the impact of monetary policy upon resource allocation will be discussed. Limitations of the research will be examined and areas for future research in this and related areas will be mentioned.

CHAPTER 2

BRIEF REVIEW OF EXISTING LITERATURE

2.1 Introduction to General Portfolio Analysis

The foundations of modern portfolio analysis can be found in Hicks' 1935 article entitled, "A Suggestion For Simplifying the Theory of Money."[1] Hicks argues that the theory of money could benefit from the use of the "sheet-anchor" of value theory, the theory of relative marginal utilities. The choice for an individual of holding money or something else, at any point in time, depends upon "the dates at which he expects to make payments in the future, the cost of investment, and the expected rate of return on investment."[2] With this concept of expectations comes the concept of risk. The *particular* expectation of a *certain* state is replaced by a range of possible outcomes. Hicks makes the implicit assumption of risk-aversions by individuals, and thus concludes that a greater dispersion of possible outcomes will, *ceteris paribus*, cause a decrease in investment in earning assets, and an increase in the demand for money.

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[1] J.R. Hicks, "A Suggestion for Simplifying the Theory of Money," *Economica*, New Series, Vol. 2 (1935), pp. 1-19. Reprinted in *Readings in Monetary Theory*, Chicago: Richard D. Irwin, Inc., 1951, pp. 13-32. References will be from the later source.

[2] *Ibid*., p. 19.

Hicks also points out that by diversifying his portfolio, the individual may be able to reduce risk to a level lower than the level of risk associated with investing all his capital in one asset.[3]

To predict the behavior of our representative individual, we must know how he will respond to changes in expected yield and to changes in total wealth (an analogy to the substitution and income effects in price theory). When this has been accomplished, we will be better equipped to understand business cycles and propose policies for monetary stability.

Examples of the development of concepts suggested by Hicks are found in the works of Harry M. Markowitz[4] and James Tobin.[5] The application of utility analysis to portfolio choice is expressed in terms of mathematical statistics and modern expected utility theory.[6]

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[3]Ibid., p. 22.

[4]Harry Markowitz, "Portfolio Selection," The Journal of Finance, Vol. 7 (March, 1952), pp. 77-91. Reference will be confined to a later work: Harry Markowitz, Portfolio Selection; Efficient Diversification of Investment, New York: Wiley, 1959.

[5]James Tobin, "Liquidity Preference as Behavior Toward Risk," Review of Economic Studies, Vol. 25 (February, 1958), pp. 65-86, and James Tobin, "The Theory of Portfolio Selection," in F.H. Hahn and F.P.R. Brechling, eds., The Theory of Interest Rates, London: Macmillan, 1965.

[6]For further reference on utility theory see: John von Neumann and Oskar Morgenstern, Theory of Games and Economic Behavior, New York: John Wiley & Sons, 1964. Jacob Marschak "Rational Behavior, Uncertain Prospects, and Measurable Utility," Econometrica, Vol. 18 (April, 1950), and Milton Friedman and L.J. Savage, "The Utility Analysis of Choices Involving Risk," Journal of Political Economy, Vol. 56 (August, 1948), pp. 279-304.

The work of Markowitz and Tobin limits choice criterion to the mean and variance of expected returns. A more recent approach by Hadar and Russell allows examination of the entire probability distribution.[7]

Markowitz develops techniques using quadratic programming for choosing the set of "efficient" portfolios. "If a portfolio is 'efficient,' it is impossible to obtain a greater average return without incurring greater standard deviation; it is impossible to obtain smaller standard deviation without giving up return on the average."[8] Given the set of efficient portfolios, "the individual should act as if 1) he attaches numbers, called their utility, to each possible outcome, and 2) when faced with chance alternatives he selects the one with the greatest expected value of utility."[9] Specifically, if the individual's utility function is of the form

$$u = r - A\, r^2$$

where u is utility

r is return

and $0 < A < \frac{1}{2r}$

he "will select one of the efficient portfolios ... based on expected return and variance."[10]

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[7]Josef Hadar and William Russell, "Rules for Ordering Uncertain Prospects," American Economic Review, Vol. 59 (March, 1969), pp. 25-34.

[8]Markowitz, op. cit., p. 22.

[9]Ibid., p. 208.

[10]Ibid., p. 209.

While the work of Markowitz is largely normative in nature, Tobin uses the above portfolio analysis to develop a positive theory of the choice between money, an asset bearing no market yield and having no risk, and consols, assets bearing a positive market yield and also having risk. Tobin justifies concentrating on the mean and standard deviation of return by assuming, as did Markowitz, that the utility function is quadratic.[11]

Although the concentration upon the mean and variance of returns provides an operational method of selecting efficient portfolios,[12] it involves several theoretical difficulties. First of all, expected utility need not depend only on the first two moments of the probability distribution, but in the most general case will depend on all moments. Limiting the criterion of choice to only the mean and variance can be legitimately done only in special cases, i.e., only for special utility functions (such as the quadratic utility function), or for special distributions, whose properties can be completely specified by their mean and variance.

In addition to this problem, concentration on the moments of the probability distribution does not allow one to determine preference between alternative "efficient" portfolios without specific knowledge of the utility function. The sign and the magnitude of the derivatives of the utility function must be known.

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[11]Tobin, "Liquidity Preference ..." op. cit.

[12]For a comparison of the performance of actual portfolios with the performance of "Markowitz efficient" portfolios, see Donald E. Farrar, The Investment Decision Under Uncertainty, Englewood Cliffs, New Jersey: Prentice-Hall, 1962.

The recent article by Hadar and Russell[13] presents a theory of choice which overcomes these theoretical difficulties. It considers the entire probability distribution of returns rather than only particular moments. Two rules are presented for ordering uncertain prospects. "Under the stronger of these rules, distributions may be ordered according to preference, given any utility function, while under the weaker rule orderability obtains for any utility function which exhibits nonincreasing marginal utility everywhere."[14]

Let $f(x)$ and $g(x)$ be probability density functions defined over the set X, and $F(X_i)$ and $G(X_i)$ be the respective cumulative distributions. First-degree stochastic dominance (FSD) of g over f exists if and only if:

$$G(X_i) \leq F(X_i) \qquad \text{for all } x_i \text{ contained in X}$$

In words, the density g dominates f because the probability of a return less than X_i is smaller with g than with f. The authors prove that if g dominates f in the sense of FSD, then g is at least as preferred as f for all utility functions. Also, "if g is preferred to f for all utility functions, then g is larger than f in the sense of FSD."[15]

Second-degree stochastic dominance (SSD) of g over f holds if and only if:

$$\int_{x_1}^{x} G(y)dy \leq \int_{x_1}^{x} F(y)dy, \quad \text{for all x contained in the interval } I = x_1 - x_n$$

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[13]Hadar and Russell, *op. cit.*

[14]*Ibid.*, p. 22.

[15]*Ibid.*, p. 28.

SSD holds when the area under the cumulative distribution of g is less than or equal to the area under the cumulative of f.

The following theorems are then proven:

> "If g is at least as large as f in the sense of SSD, and marginal utility is everywhere nonincreasing, then g is at least as preferred as f... If g is preferred to f for all utility functions with non-increasing marginal utility, then g is larger than f in the sense of SSD."[16]

The advantage of the "dominance method" over the "moment method" is in the dominance method's generality. The dominance method is more general since it requires no restrictions on the class of admissible distributions, and only weak restrictions on the utility function, (the most restrictive case requiring a concave utility function). It will thus allow ordering of certain "Markowitz efficient" portfolios without specific knowledge of the utility function.

There appears to be some difficulty in making this theory operational. No empirical work using the dominance method has yet been published.

2.2 Application to Bank Portfolios

A particularily popular and important contribution of portfolio analysis is its application to the field of banking. The approach has probably been so popular because of the availability of published data in the form of bank balance sheets.

The remainder of this section will consider the main contributions to various bank portfolio problems. Portfolio decisions can be decisions about allocation of funds between the large categories of bank assets: cash, securities, and loans. In addition, a portfolio

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[16] Ibid., pp. 30-31.

decision involves the allocation of funds within each of these categories. Most studies have concentrated on one of these problems, and thus, in the following review we will classify the analysis according to which decision is being considered. A further distinction is often made in the literature between theoretical and empirical models of portfolio behavior. This distinction will be discussed in the context of models concerning the "cash versus securities versus loans" choice.

2.2.1 Theoretical Models

In this section we will discuss briefly four of the best known and most frequently cited theoretical approaches to bank portfolios.

Theoretical models explaining a bank's choice among the asset categories cash, securities, and loans usually start with the following balance sheet identity.

$$C + S + L = D + CS$$

where

C = Cash

S = Securities

L = Loans

D = Deposits

CS = Capital Stock

The assumption is made that each asset category is internally homogeneous, and possesses some characteristics not possessed by the other asset categories. For example, Porter[17] makes the following assumptions: cash is assumed

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[17]Richard C. Porter, "A Model of Bank Portfolio Selection," in Donald D. Hester and James Tobin, eds., Financial Markets and Economic Activity, New York: Wiley, 1967, pp. 12-54.

> 1) to provide no earnings and 2) to be completely free of risk of capital value change. Securities will be assumed to include a homogeneous group of securities 1) without default risk, 2) readily salable upon established markets, 3) with maturity date beyond the end of the bank's present planning horizon and 4) with a fixed coupon rate per bond per planning period.
>
> Loans are assumed 1) to be not callable during the planning period, 2) to be not marketable, and 3) to be "shiftable" only to the extent that they are eligible as collateral for borrowing from the Federal Reserve Banks.[18]

These are the typical assumptions made explicitly or implicitly by most portfolio models concerned with this asset choice problem.

The problem at this point is to specify the relevant profit or utility maximization model. The usual certainty profit maximization model is inadequate, since it implies that banks would specialize in the asset with the highest yield. The model must account for profit (or utility) maximization under various conditions of risk. The main types of risk considered are 1) future changes in the level of deposits, 2) changes in the market value of securities, 3) default of loans, and 4) changes in demand for loanable funds.

Porter assumes that the bank's portfolio choice behavior depends entirely on events expected in the next period and not on past events or previous portfolio choices, except as past events may influence the bank's assessment of the future. It is assumed that the bank does not suffer from "locked-in" effects, but is free to choose any level of cash, securities, or loans it desires.

The risk of deposit withdrawals depends upon the expected "deposit-low." That is, in the ensuing period, the bank must be able

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[18] *Ibid.*, p. 15.

to meet its greatest deposit withdrawals. It is assumed that the deposit low occurs at the end of the planning period. Given the risk of deposit withdrawals, change in the capital value of securities, and risk of default, the bank will attempt to arrange its portfolio of cash, securities, and loans so as to maximize the expected addition to net worth. The optimum proportion of loans in the total portfolio is a function of net worth, the minimum possible "deposit-low," the amount of cash assets the bank holds, the coupon rate on securities, the earnings rate on loans (net of default risk), and the cost of borrowing from the Federal Reserve Bank. Porter is reluctant to derive implications of his model for monetary policy other than to say that his model does not indicate that increases in the coupon rate on securities will increase loans sufficiently to give support to the "availability doctrine."

For anyone interested in empirical work, Porter's model presents serious problems. It does not take account of lags in response; in fact, it does not take account of past or present levels of most variables. All rates of return and risks are future rates and risks and are thus not observable. To make the theory operational an explicit expectations hypothesis would have to be included to specify how the bank predicts these future values. A mechanism relating observed to optimum levels of assets would also be needed.

Orr and Mellon[19] present a portfolio model (although they claim it is not a portfolio model) which is similar to Porter's. They

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[19] D. Orr and W.G. Mellon, "Stochastic Reserve Losses and Expansion of Bank Credit," American Economic Review, Vol. 51 (September 1961), pp. 614-623.

consider only the choice between cash and loans, and thus their model is in this sense a special case of Porter's model. They consider reserve losses (deposits withdrawals) as exogonous and stochastic. If the banks reserves fall below the level required by the Federal Reserve Bank, the bank suffers a flat fee penalty plus a rate per dollar of reserve deficiency. Expected profit is thus the rate of interest on loans times the level of loans, minus the expected loss due to a reserve deficiency.

For the special case of reserve losses being normally distributed,[20] with mean linearly dependent upon the level of new deposits created during the period and variance independent of deposit liabilities, they solve for the optimal level of new deposits during the period. New deposits are implicitly assumed equal to the level of loans. The optimal level of new loans (deposits) is a function of the interest rate on loans, excess reserves at the beginning of the period, the legal reserve ratio, and the penalty rates for reserve deficiencies.

Orr and Mellon's principal conclusion is that the explicit introduction of uncertainty in the form of stochastic reserve losses will imply an expansion of credit which is less than the traditional money and banking textbook's example of a monopoly bank. The result is not surprising.

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[20]Porter, op. cit., assumes that the "deposit low" has a "triangular distribution". The assumption that the number of reserve changes is a Poisson variable is made by Eleanor M. Birch and John M. Heineke, "Stochastic Reserve Losses," The American Economist, Vol. 11 (Spring, 1967), p. 23.

Kane and Malkiel[21] concentrate upon the change in market value of securities, deposit variability, the resultant portfolio adjustment, and its implications for the availability doctrine. They contend that consideration of long run profits, mainly the predicted deposit relationship with the bank's customers,[22] would lead to different conclusions than the usual analysis. In particular, in boom periods banks will grant more loans than the "availability doctrine" literature suggests. Also, if credit rationing[23] does exist, it is carried out on the basis of the total customer relationship, and not merely on the basis of risk of default.[24] The main contribution of the Kane and Malkiel approach is that the authors explicitly concentrate upon long run profits and the customer relationship. Essentially, this means that in the long run the bank can influence the level and stability of its deposits. This is a

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21E.J. Kane and B.G. Malkiel, "Bank Portfolio Allocation, Deposit Variability, and the Availability Doctrine," Quarterly Journal of Economics, Vol. 79 (February, 1965), pp. 113-134.

22This is a concept similar to Hodgeman's "customer relationship." See: D.R. Hodgeman, "The Deposit Relationship and Commercial Bank Investment Behavior," Review of Economics and Statistics, Vol. 43 (August, 1961), pp. 257-68.

23Credit rationing is a term used to describe a situation in which the demand for loanable funds exceeds the supply, and because of inflexibilities in interest rates or legal and/or institutional constraints, rationing is done on the basis of non-interest rate considerations.

24Kane and Malkiel, op. cit., pp. 133-34.

departure from most literature on bank portfolio choice in which it is assumed that future deposit levels are exogenous.[25]

One further type of model should be discussed briefly. This is the linear programming model. Perhaps the most frequently cited programming model is by Chambers and Charnes.[26] The stated intent is to study bank portfolio behavior over time and to examine the implications of Federal Reserve policy actions. Chambers and Charnes make the following assumptions:

1) Bankers know for various times in the future (presumably for relevant times in the future) their levels of:
    a) demand and time deposits
    b) rates of interest
    c) the bank's net worth.
2) Bankers seek to maximize profits.
3) Bankers have a choice among various earning assets and a choice of maturities.
4) Bankers are subject to two restrictions:
    a) the required reserve ratio must be met
    b) a "balanced portfolio" must be maintained.

A "balanced portfolio" is defined in terms of measures used by bank examiners and regulators. The problem is to choose the most profitable portfolio plan that satisfies the bank examiners.

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[25]See Porter, op. cit., and Orr and Mellon, op. cit.

[26]David Chambers and Abraham Charnes, "Inter-Temporal Analysis and Optimization of Bank Portfolios," Management Science, Vol. 7 (June, 1961), pp. 393-410.

Chambers and Charnes state:

> "The criteria of the examiners reflect their judgement of what kinds of portfolios are reasonably safe, given the uncertainties which bankers face; and it seems likely that a bank which satisfies these requirements will be in a good position to meet the contingencies of fluctuation in its deposits and changes in market rates of interest, without running much risk of large losses."[27]

It is not clear what uncertainties the bank faces, given that the "various" periods of time for which bankers have knowledge of the future are the periods of time relevant to the bank's planning horizon. If bankers know future levels of demand and time deposits and rates of interest, it is unlikely that the bank should suffer losses due to "contingencies of fluctuation in its deposits and changes in market rates of interest."

Chambers and Charnes go on to specify the problem as one of choice of investment in six kinds of assets over a five period horizon. The bank will maximize profit over the period subject to restrictions imposed by regulatory agencies and bank examiners. The restrictions are inequality constraints on various asset classes.

Using data on deposits and net worth for banks of the Chicago Federal Reserve District, and arbitrary rates of net profit on assets, Chambers and Charnes construct a numerical example. The solution of the numerical example reveals that their bank would not be willing to pay more than 1.75 per cent interest on demand deposits, would have a marginal rate of return on capital of .1091, and would borrow reserves at any rate below 2.7 per cent. The authors fail to state the implications of the above results for monetary policy.

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[27] Ibid., p. 394.

2.2.2 Empirical Models

The above mentioned models share at least one common characteristic: their authors did not present empirical estimates or tests of hypotheses derived from their models. Hence, they have been classified as theoretical models. Models which have been estimated or tested will be called "empirical models." It should be noted that the so called empirical models vary greatly in their use of theory. Some empirical models are derived from elaborate theory, while others are apparently created in a vacuum.[28]

Most models involve the regression of the level or proportion of various asset categories on an interest rate variable, a predicted deposit level proxy, a total portfolio or wealth variable, and on various lagged values and changes in these variables. Also, most models are estimated from aggregate time series data.[29]

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[28]For an example of this range, compare the relatively rigorous theoretical work of William Russell, "An Investigation of Commercial Bank's Aggregate Portfolio Adjustment," International Economic Review, Vol. 10 (October, 1969), pp. 266-290; and the work of Donald Hester and James Pierce, "Cross-Section Analysis and Bank Dynamics," Journal of Political Economy, Vol. 76 (July/August, 1968), pp. 755-776.

[29]See Russell, op. cit.; F. Brechling and G. Clayton, "Commercial Bank's Portfolio Behavior," The Economic Journal, Vol. 65 (June, 1965), pp. 290-316; and James L. Pierce, "An Emperical Model of Commercial Bank Portfolio Management," in Donald D. Hester and James Tobin, eds., Studies of Portfolio Behavior, New York: Wiley, 1967, pp. 171-90.

There have, however, been attempts to use micro-bank, disaggregated data[30] and to estimate cross-section models of individual bank behavior. Three of the more significant and interesting empirical studies will be discussed.

Hester and Pierce[31] advocate the use of cross section analysis to supplement the more usual time series analysis and to avoid the problem of few observations and "the curse of macro-econometrics. . . that nearly all specifications fit well."[32] There is the implication in the work of Hester and Pierce, that an empirical model to be tested with cross-section data must be derived from a theoretical model which is different from one to be tested using time series. To be sure, if one is using cross-section data for a particular period of time, interest rates can be assumed to be constant for all banks and could be eliminated from the regression equation. Likewise for time series, the level of capital stock may change only slightly and may be eliminated from the regression equation. However, it does not seem that this implies a need for a separate theoretical model for time series and cross section studies. If one is constructing a model of bank portfolio adjustment it should take into account variables that change over time as well as across sections. Hester and Pierce hint at this approach when they suggest that it may be desirable "to marry cross-section and time-series estimates of

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[30]The most notable attempt at micro-bank behavior analysis is the study of individual bank reserves by W. R. Bryan and W.T. Carleton, "Short-run Adjustments of an Individual Bank," Econometrica, Vol. 35 (April, 1967), pp. 321-347.

[31]Hester and Pierce, op. cit.

[32]Ibid., p. 756.

structural parameters."[33] Unfortunately, Hester and Pierce present a model in which the level of particular asset categories depends upon the sequence "of previous deposit levels."[34] If one believes that a bank's portfolio behavior depends upon relative costs and expected returns of various assets, then yields on assets must be included explicitly in ones theory.

In another article by Pierce,[35] based on time series data, expected interest rates are included in the regression equation. The reduced form of the model expresses the level of reserves, loans, and investments as linear functions of present and lagged values of time and demand deposits, expected rates of return, standard errors of rates of return forecasts, past and present levels of capital stock, and past and present levels of national income. An autoregressive scheme is used to forecast future rates of return.

The three equations (for reserves, loans, and investments) are estimated using first differences on monthly aggregate bank data covering the period from January 1960, through September 1964. Pierce states:

> "There is an insufficient number of observations to allow one to draw any convincing conclusions from the results. The reduced form character of the equations and the poor quality of the data make interpretation of the results difficult.

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[33] Ibid., p. 757.

[34] Ibid., p. 761. Also see the comment by Karl Brunner, "Comment: The Contribution of Macro and Micro Studies to Policy Making," Journal of Political Economy, Vol. 76 (July/August, 1968), pp. 777-785.

[35] Pierce, op. cit.

> While the existence of serially correlated residuals precludes tests of significance, some general comments can be ventured."[36]

Increases in present levels of deposits influenced reserves the most strongly. The results of estimates for expected changes in interest rates had the expected sign for reserves (negative), but the wrong sign for loans and investments. No clear pattern of lagged response was evident.

More recently, a similar model was estimated by William Russell.[37] Russell estimated equations for cash, short-term investments, long-term investments, and loans as functions of lagged dependent variables, an interest rate variable, and expected changes in deposits. The interest rate variable is the difference between the rate on the given asset and an opportunity cost rate. As a proxy for expected deposit changes, Russell used the actual change in deposits.

The lagged dependent variable "explains" much of the variation, leading one to the conclusion that banks are unlikely to change their portfolios drastically in short periods of time. The coefficients on the interest rates have the expected sign in all cases. Loans and cash are the most responsive to changes in interest rates. The coefficients of the expected deposit changes proxy have the expected signs. An increase in expected deposits leads to a decrease in the share of cash and to an increase in the share of earning assets in the portfolio.

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[36] _Ibid_., p. 185.

[37] Russell, _op_. _cit_.

Russell uses his model to predict portfolio shares during World War II. The model performed well, and gave further evidence that interest rates are important in portfolio decisions.

2.2.3 The Loan Portfolio

Work on the loan portfolio has concentrated on the problem of credit rationing and the availability doctrine. While this problem is not the main concern of this dissertation, it is related to it. The works cited in this section are concerned mainly with micro-bank aspects of the effectiveness of monetary policy. Will banks restrict credit by non-price means, so that a tight money policy will be effective, even in the absence of increasing interest rates or in the absence of response of investment to changes in interest rates? We are interested in the following question: Given that total credit is restricted, how will various loan categories be affected?

Although the works cited do not deal with this question, the models developed are of interest, and are important contributions to the theory and empirical evidence of bank loan portfolio behavior. Two major contributions will be summarized and discussed.

The theory and empirical test of the banks loan offer function or supply of loanable funds is developed in a paper by Donald Hester.[38] The paper abstracts from the "larger" portfolio decisions, and concentrates upon the terms at which banks will lend to various loan applicants. It is thus concerned with the determinants of the loan portfolio composition. The loan offer function ". . .is a generalized

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[38]Donald D. Hester, "An Empirical Examination of a Commercial Bank Loan Offer Function," Yale Economic Essays, Vol. 2 (Spring, 1962) pp. 3-57.

supply function for loans in the sense that, instead of merely having the amount of loans determined by a set of exogenous variables, it has a set of loan terms including the amount of loans determined by the set of exogenous variables."[39]

Discussion of terms of loans is limited to the four principal terms: "the rate of interest, the size of the loan, the maturity of the loan, and whether or not the loan is secured."[40] It is assumed that, ceteris parabus, banks prefer higher rates of interest, relatively short maturity loans, moderate size loans, and secured loans. "Borrowers attempt to get more favorable terms by seeking low rates of interest, no security, and frequently larger amounts and longer maturities."[41]

Hester then presents an analysis of borrower characteristics and an analysis of bank characteristics. Borrower characteristics include "the present and past size of his current assets, liquid assets, working capital, current ratio, inventories, total assets, outstanding debt, net worth, profit, sales, and deposit balances; the age of his inventories, plant, and equipment; the stability of demand for his product; and certain qualitative information..."[42]

Bank characteristics include "a banks deposit level and stability, equity, and growth in deposits; the proportion of a bank's portfolio in loans and the distribution of its loans among industries;

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[39] Ibid., p. 3.

[40] Ibid., p. 5.

[41] Ibid., p. 6

[42] Ibid., p. 8.

the maturity structure of its security holdings, the aggressiveness and specialization of a banks lending offices; the interest rates on competing assets; the legal restrictions on its actions; the demand for bank loans; and the structure of its competition."[43]

The characteristics of borrowers and banks are considered to be exogenous.

Hester interprets various formulations of the credit availability doctrine in the context of the loan offer function. He concentrates on the version of the credit rationing or availability doctrine which states that the loan market is not cleared by the loan interest rate alone if interest rates on competing assets (bonds) increase. The market is cleared by credit rationing, which presumably means" 1) that a higher percentage of loan applications are rejected and 2) that of those loans which are granted to borrowers . . ., the amounts are smaller, the maturities are shorter, and the security requirements are greater."[44] Using the concept of the loan offer function, and the concept of the partial loan offer function,[45] Hester concludes that the only evidence of credit rationing due to higher bond rates is that banks seem less willing to make longer maturity term loans. However, a comparison of terms of lending for commercial and industrial loans in 1955 and 1957 suggests that there was no credit rationing.

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[43] Ibid., p. 10.

[44] Ibid., p. 14.

[45] A partial loan offer function relates each of the terms of lending separately to the characteristics of banks and borrowers. Therefore, multiple regression techniques can be used. Canonical correlation techniques are used to estimate the loan offer function, which relates the set of lending terms to the sets of bank and borrower characteristics.

The analysis and empirical work was confined to commercial and industrial loans and term loans. Therefore, nothing is concluded about the relationship between commercial and industrial loans and various other loan categories. Within the commercial and industrial loan category, the characteristics of the borrower and of the bank were found to affect significantly the terms of lending. Also, it was found that banks do trade off between terms of lending. Specifically, longer maturity is associated with higher interest rates.

The question of credit rationing is considered in a recent article by Jaffee and Modigliani (J-M),[46] who consider the questions: "1) Is it rational for commercial banks to ration credit by means other than price? 2) can credit rationing be measured?"[47]

J-M define credit rationing "as a situation in which the demand for commercial loans exceeds the supply of these loans at the commercial loan rate quoted by the banks. Equilibrium rationing is defined as credit rationing which occurs when the loan rate is set at its long-run equilibrium level. Dynamic rationing is defined as credit rationing which may occur in the short-run when the loan rate has not been fully adjusted to the long-run optimal level."[48]

J-M derive the bank's first order profit maximizing conditions with respect to loans to the ith customer, and consider the rationality of credit rationing under various market conditions. If

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[46]Dwight M. Jaffee and Franco Modigliani, "A Theory and Test of Credit Rationing," American Economic Review, Vol. 59 (December, 1969), pp. 850-72.

[47]*Ibid.*, p. 850.

[48]*Ibid.*, p. 851.

the banker is a perfectly discriminating monopolist, he would not ration credit by methods other than price. If he is forced to charge all customers a uniform rate, it may be profitable to ration credit to some customers. Also, if the bank can separate its customers into a number of different classes, charging each class a different rate, it may be profitable to ration credit within some classes. This situation seems to fit the institutional and legal setting within which banks operate.

Given that it appears that credit rationing is in some cases probable, J-M attempt to "measure" credit rationing. Theoretically credit rationing should be measured by the *ex ante* excess demand for loans. Since this is not observable, some observable proxy is needed. The model developed by J-M suggests that dynamic credit rationing will be accompanied by an increase in the share of risk free loans in the loan portfolio. Thus a proxy for credit rationing is the proportion of risk free loans in the total loan portfolio.

J-M regress their proxy on the commercial loan rate, the treasury bill rate, the ratio of deposits to treasury bills, two dummy variables (representing changes in the certificate of deposit market), and the share of the loan portfolio in total assets.

Apparently the most interesting (and expected) results are the indications that credit rationing is negatively related to the commercial loan rate and positively related to the rate on treasury bills, an opportunity cost rate.

Also, J-M find that "credit rationing" was very high in the second and third quarters of 1966, the period of the credit crunch.[49] That is, J-M find that especially in this tight money period, the proportion of risk free loans in the total loan portfolio is increased.

Certain problems with this proxy should be noted. First of all, even though this proxy is positively related to the true level of dynamic credit rationing, the question of strength of the relationship remains. Does an increase in the ratio of risk free loans to total loans imply an increase in credit rationing significant enough to support the availability doctrine?

Even more important than this question is the following: where does the increase in the proportion of risk free loans come from? The proxy J-M propose is

$$H = \frac{L_1}{L_1+L_2}$$

where L_1 denotes loans granted to risk free customers

L_2 denotes loans granted to all other customers.

H could increase from an increase in the total loan portfolio, with the increase in L_1 greater than the increase in L_2. H could increase due to a fall in L_2 and equal increase in L_1. Or, H could increase with a fall in L_1+L_2, but with L_1 falling proportionally less. The incidence of the observed "rationing" will obviously depend upon the cause of the increase in H.

Consider, for example, a case in which the demand for funds by prime customers increases and the demand for funds by other

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[49]J-M actually used quarterly time series data for 1952 to 1965 in their regressions, omitting the year 1966 so they could attempt to predict credit rationing for that year.

customers remains constant.[50] If banks increase their loan portfolios to accommodate these prime customers, while maintaining other loan levels, no actual rationing will take place. Yet the proxy H will increase, indicating increased rationing.

It seems that an alternative approach would be to examine the allocations of funds to various loan categories, given a total asset or total loan constraint. This may yield some evidence about the cause of changes in H.

2.3 Incidence of Policy

In this section the two principal contributions to the issue of policy incidence will be discussed. The two approaches are quite different but both approaches have some problems.

Bach and Huizenga (B-H) investigated the differential impact of tight money policies in what has come to be regarded as the classic work in this area.[51] The authors recognize the problem of distinguishing discriminatory effects from "ordinary" market effects, and approach the problem by dividing banks into three groups: "tight, medium, and loose, depending on the degree of tightness induced in them by the over-all tightness of money...Then the lending and investing behavior of these three groups of banks [is] compared over the period,[52] with the presumption that the tight quartile would reflect the differential impact of tight money on the supply side, when compared with the loose

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[50]J.M. discuss this possibility and dismiss it as an "error in measurement."

[51]G.L. Bach and C.J. Huizenga, "The Differential Effects of Tight Money," American Economic Review, Vol. 51 (March, 1961), pp. 52-80.

[52]B-H compare banks reporting in October 1965 and October 1957.

quartile which apparently felt little if any pressure of tightness."[53]

The data indicate that from 1955 to 1957 loans to large business increased relative to loans to small business. However, B-H find that the increase was substantially the same for loose banks as for tight banks and, thus, by the process of elimination, attribute the increase in large-business loans to the demand side of the market, i.e., demand for loanable funds by large firms increased relative to demand by small firms. In other words, the tightness did not cause the "discrimination". The data are consistent with this hypothesis. However, in a comment on the article, Tussing suggests another hypothesis which is also consistent with the data. "All the authors have clearly shown is that if discrimination did exist during the period under review, it existed equally in tight and loose banks."[54] That is, B-H neglect the possibility that a tight money policy may have a general effect on both tight and loose banks, and that both a tight bank and a loose bank may discriminate in the same way.

While the central concern of the study is discrimination against small borrowers, evidence is observed concerning changes among loan categories. B-H observe: "tight banks increased real estate loans much less than did loose banks. But still more, they squeezed security and agricultural loans heavily to obtain funds for

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[53]*Op. cit.*, p. 53. As a measure of tightness B-H used:

$$\frac{\text{excess reserves} - \text{borrowing} + \text{government bills and certificates}}{\text{deposits}}$$

[54]A. Dale Tuising, "The Differential Effects of Tight Money: Comment," American Economic Review, Vol. 53 (September, 1963), pp. 740-45.

market expansion in other loan categories.[55] It seems that this indicates the possibility of discrimination against real estate, security, and agricultural loans. However, B-H suggest that this discrimination may well have been on the basis of traditional banking standards and customer relationship.

It should be noted that the above conclusion of B-H rest upon casual empiricism or at best descriptive statistics. Changes in levels and proportions of loans were compared for two points in time, October 5, 1955 and October 16, 1957. No statistical test of hypotheses were presented.

The second major contribution in this field was made by Leonall Andersen.[56] Andersen starts with the assumption that the 1959 level of GNP is to be expanded by one per cent. This can be accomplished by one of three measures (used separately): increase in the money supply, increase in government expenditures, or decrease in taxes. It is assumed that monetary policy affects the economy through interest rate changes, government expenditures affect the economy through changes in disposable income and direct demand, and tax changes affect the economy through changes in disposable income.

A supply and demand model is developed and estimates of elasticities of equilibrium output with respect to income and the interest rate are obtained for ten selected industries. With the

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[55]Bach and Huizenga, op. cit., p. 61.

[56]Leonall C. Andersen, "The Incidence of Monetary and Fiscal Measures on the Structure of Output," Review of Economics and Statistics, Vol. 46 (August, 1964), pp. 260-68.

assumption of a marginal propensity to consume of .9, a marginal tax rate of 1/3, and an interest elasticity of spending of -.20, Andersen calculates the policy actions (used separately) that would be necessary to raise 1959 GNP by one percent. The incidence of each measure is then calculated for each of the ten industries.

The main conclusions are: "The monetary measure results in the greatest shift of resources toward investment goods, residential construction, and autos. A tax decrease results in the greatest shift of resources toward consumer goods. Government expenditures result in a shift toward the federal government sector."[57]

Two major problems with the study should be noted: 1) the question of rigidities and asymmetric response to policy measures, and 2) the problems of an indicator of monetary policy.

Andersen presents point estimates of various elasticities and macro-economic coefficients, and calculates effects of three expansionary policy actions. But, what would be the effect of contractionary measures? Can we assume for example that sectors stimulated the most by expansionary monetary policy will be dampened the most by contractionary monetary policy? Andersen's approach suggests that this would indeed be true. It does not allow for the possibility of institutional constraints which would cause an asymmetric response to policy actions. Specifically, the banking and financial intermediary systems are a "missing link" which may very well respond differently in transmitting a tight money policy than in transmitting

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[57]*Ibid.*, p. 268.

an expansionary money policy to various sectors.[58] Thus, the above approach cannot be used to determine the existence of a discriminating effect of a tight money policy or to identify the source of discrimination.

Perhaps even more fundamental is the use of "the interest rate" as the means by which monetary policy is transmitted and as an indicator of monetary policy.

Limiting the transmissions of monetary policy to the interest rate mechanism ignores the possibility of influences through "wealth-effects" and non-price credit rationing (the availability doctrine). For empirical purposes this limitation may be justified, due to the difficulty of estimating wealth effects and especially credit rationing. However, any conclusions reached must be qualified by the above limitations.

The "indicator problem" has received attention recently in the literature and will not be discussed in detail here.[59] The essential problem is that "the interest rate" is influenced by forces other than monetary policy actions (i.e., market forces, changes in general economic activity, changes in fiscal operations, changes in expectations, etc.) and thus may not indicate correctly the magnitude or direction of a monetary policy action.

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[58] See Hodgeman, _op_. _cit_.

[59] See Thomas R. Saving, "Monetary Policy Targets and Indicators," _Journal of Political Economy_, Vol. 75 (August, 1967), pp. 16-26.

Specifically, high interest rates may reflect increased demand for loanable funds and not a tight money policy. In fact, if the money stock (or the monetary base) is used as an indicator of monetary policy, it is obvious that it is possible to have an expansionary monetary policy accompanied by increasing interest rate. In fact, evidence suggests that high interest rates historically have not indicated monetary restraint.[60]

Since interest expense is such a large proportion of total housing costs, the residential housing sector does respond more than most industries to changes in interest rates. If high interest rates are used as an indicator of tight money, it appears as if housing is being discriminated against. However, if the money stock is used as an indicator, it appears that housing expenditures do not suffer excessively during periods of relatively slow monetary growth.[61]

2.4 Summary

The conclusion of the studies cited in this section are incomplete and in some cases contradictory. If discrimination does exist, its source has not been identified.

The purpose of the next chapter will be to develop a testable hypothesis concerning the existence of discrimination in the behavior of individual commercial banks.

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[60]See "Money, Interest Rates, Prices, and Output", Federal Reserve Bank of St. Louis - Review, Vol. 44 (November, 1962), pp. 2-6.

[61]Norman N. Bowsher and Lionel Kalish, "Does Slower Monetary Expansion Discriminate Against Housing?," Federal Reserve Bank of St. Louis - Review, Vol. 50 (June, 1968), pp. 5-17.

CHAPTER 3

THEORETICAL MODEL

The purpose of this chapter is to develop a theory of bank behavior that will allow concentration upon the bank's adjustment of its loan portfolio to changes in certain predetermined variables.

3.1 The Balance Sheet

3.1.1 Assets

A bank may hold the following assets:

R_p: Primary reserves (cash, Federal Reserve deposits, and deposits at other commercial banks)

R_s: Secondary reserves (Investments)

L: Loans

where $R_p + R_s + L \equiv$ Total Assets = TA

The loan category can be further subdivided into categories, L_i, where $\sum_{i=1}^{N} L_i = L$. The usual classification divides loans into categories based on the purpose for which funds are borrowed, e.g., commercial and industrial loans, real estate loans, consumer loans, and others.

3.1.2 Sources of Funds

On the right hand side of the balance sheet are the following sources of funds:

D: Demand deposits

T: Time deposits

B: Borrowings (from the Federal Reserve System and from other commercial banks)

C: Capital stock

where D + T + B + C = Total Sources = TS

3.1.3 Balance Sheet Identity

The balance sheet identity requires that total assets equal total sources.

$$TA \equiv TS$$

3.1.4 Assumptions about Assets

It is assumed that the primary reserves category is homogeneous, without risk of default or capital loss, and provides no direct earnings.

Secondary reserves (investments) have a fixed coupon rate, are salable in established markets, and are free from default risk, but are subject to risk of a change in capital value. We are not interested in the investment portfolio *per se*, and we will assume that the investment portfolio is internally homogeneous.

The loan portfolio is composed of N loan categories. We will assume that all loans are subject to default risk. Also, we will assume that loans are homogeneous within each category and that a particular rate of interest is associated with each loan category. The homogeneity assumption is not as restrictive as it may at first seem, since the problem of differences in loan characteristics within a loan category could be handled through terms of lending other than the rate of interest. For example, if we were considering two mortgage loans, one of which was viewed by the bank as "more risky" than the other, there exists some set of conditions imposed on the risky loan which would make it equally as attractive to the bank as the less risky loan at the same rate of interest. The conditions may take the form of differing repayment schedules, countersigning, or other types of insurance or security.[1]

3.1.5 Assumptions about Sources of Funds

For the short run period being considered here, it is assumed that the bank's level of capital stock is fixed, and thus is not a source of additional funds.

Borrowings provide a source of additional funds for the bank and are assumed to be endogeneously determined. Regulatory authorities discourage prolonged and extensive borrowing from the Federal Reserve System. However, in recent years the growth of the certificate of deposit market has provided banks with the opportunity to borrow large amounts of funds from other banks.

Levels of time deposits may be influenced by the rate of interest the bank pays on these deposits. The bank's ability to influence the level of time deposits is inhibited to some extent by the maximum legal limit on this interest rate (Regulation Q). However, the rate is flexible in the downward direction, and therefore, the bank can act to decrease levels of time deposits by lowering the rate paid. Even with the rate at its legal maximum, the bank may increase the level of its time deposits through non-price competition such as

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[1]For a discussion of the concept of terms of lending, see Donald D. Hester, "An Empirical Examination of a Commercial Bank Loan Offer Function," Yale Economic Essays, Vol. 2 (Spring, 1962), pp. 3-57. For a summary of Hester's article, see Chapter 2 of this dissertation.

increased advertising and free gifts to customers opening new time deposit accounts. Banks can also require a 30 day notice for withdrawal of time deposits and thus control the timing of withdrawals. However, this option is seldom used, and, in fact, time deposits are subject to day to day random fluctuations.

Since banks are prohibited from paying interest on demand deposits, they cannot attract more deposits by paying higher interest rates. They may attract more demand deposits by offering other benefits, i.e., lower service charges, better consulting advice, no minimum balance requirements, etc. However, the fate of the deposit once created is not subject to direct control by the bank. The bank may limit the outflow of this deposit to some extent by a "compensating balance requirement," a minimum below which the customers deposit may not go. However, the extent to which demand deposits leave the bank and are redeposited will also depend upon the geographical location of the bank, the closeness and number of its competitors, the service it offers relative to other banks, and other market factors.[2] In addition to the above factors, we will assume that the level of deposits is subject to random fluctuations.[3] Thus, the level of demand deposits at a particular point in time is a function of the bank's desired level of deposits, market factors, and a random component. The market factors are assumed constant in the short run.

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[2]Boris P. Pesek and Thomas R. Saving, The Foundation of Money and Banking, New York: Macmillan, 1968, p. 152.

[3]See Chapter 2 of this dissertation, Footnote 20, p. 14.

It will be assumed that the bank has immediate access to the federal funds market and can offset any random fluctuation in demand and time deposits by borrowing or lending in the market. Thus the bank can determine the level of its total source of funds, and from the balance sheet identity, it determines its level of total assets. The bank may not desire to offset completely day to day fluctuations in deposits, and may allow total assets to fluctuate within an "acceptable" range.

It should be noted that the bank's decision about the level of its total assets is made within the context of numerous constraints. Obviously, a small county bank cannot become the world's largest bank merely by borrowing on the federal funds market. The amount the bank can borrow depends upon the market's evaluation of the credit worthiness of the bank and on the bank's ability to pay the going rate of interest on funds. We are assuming only that the bank can borrow sufficient funds to offset day to day fluctuations in demand and time deposits.

The size of the bank is also constrained by capital adequacy requirements of the regulatory agencies. Since we assume that capital stock is fixed in the short run, we have obviously placed an upper bound on bank size in the short run.

In the long run, the size of the bank will depend upon the bank's ability to attract deposits and to increase its capital stock (either through new issues of stock, merger type transactions, or retained earnings).

We will assume that the size of the bank is a function of the bank's long run growth policies and the above constraints. These long run growth policies and constraints remain constant in the short run.

Therefore, in the short run, the level of total assets can be taken as predetermined, and the relevant decision involves allocation of these funds among competing uses.[4]

3.1.6 Additional Assumptions

Operating and overhead expenses such as building expenses, clerical and administrative costs, and taxes will not be considered. It is assumed that these costs do not enter the short run decision process of the bank's management. Also, the function of the bank as a consultant, check clearing agency, and source of information will be ignored.

3.2 The Model

The model developed in this chapter employs the theory of multidimensional utility maximization or lexicographic vector ordering.[5]

We can specify the following preference function for the management of an individual bank:

$$1) \quad U = U(L_q, \Pi)$$

Where

L_q = Liquidity

Π = expected profit

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[4]The usual assumption of portfolio analysis is that the total size of the portfolio is determined exogeneously. See Chapter 2 of this dissertation, p. 23. We have shown how the bank in fact influences the size of its total portfolio, and have employed the weaker and somewhat more palatable assumption that decisions regarding the size of the portfolio are made prior to the allocation decision.

[5]C. E. Ferguson, "The Theory of Multidimensional Utility Analysis in Relation to Multiple-Goal Business Behavior: A Synthesis," Southern Economic Journal, Vol. 32 (October, 1965), pp. 169-175.

3.2.1 Liquidity

Liquidity is a characteristic of some assets. The definition of liquidity involves mainly "the ease and speed with which assets can be sold."[6] James Pierce gives the following interpretation to the concept of liquidity. "At any given time, t, an asset has a maximum expected price, which may be designated P_t^*. P_t^* is the highest price the owners of the asset expects to obtain by liquidating one unit of the asset if he is allowed all useful preparation prior to its disposal."[7]

However, if the owner is forced to sell the asset more quickly, he must sell it at an actual price P_t, where P_t is less than P_t^*. Thus the ratio of the actual price to the maximum potential price is a measure of the liquidity of a unit of the asset in question. The liquidity ratio P_t/P_t^* will depend upon the length of time from the decision to sell until the time of the actual sale.

The relationship between i, the length of time from the decision to sell until the time of sale, and $\frac{P_{t+i}}{P_t^*}$ can be illustrated graphically.

[6]James L. Pierce, "Commercial Bank Liquidity," Federal Reserve Bulletin, Vol. 52 (August, 1966), p. 1093.

[7]Ibid., p. 1094.

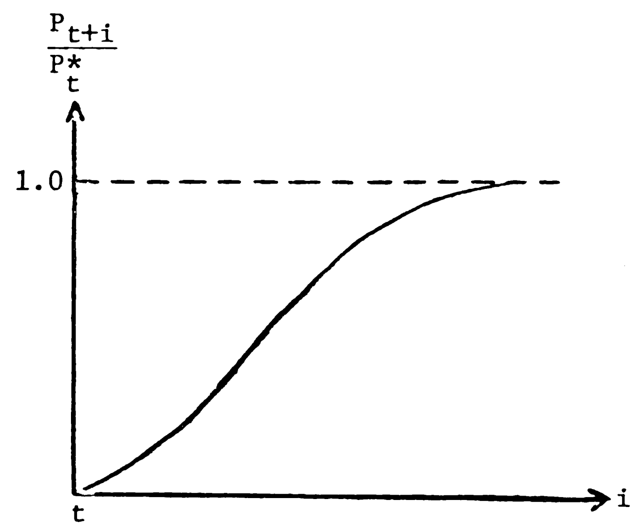

Figure 1.--Asset Liquidity

The form of the relationship between i and $\frac{P_{t+i}}{P^*_t}$ for a particular asset depends largely upon the market in which the asset is traded. Cash, of course, can be sold at time (i=0) for P^*_t, and thus is perfectly liquid. For cash, the ratio $\frac{P_{t+i}}{P^*_t} = 1$, for all i.

Well established and relatively deep markets exist for treasury bills. Thus, treasury bills may be sold quickly at slightly less than P^*_t. $\frac{P_{t+i}}{P^*_t}$ then rises very rapidly to unity. Treasury bills may be termed highly liquid.[8]

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[8] *Ibid.*, p. 1094.

Most types of loans are not traded in secondary markets. We will assume that for loans $\frac{P_{t+i}}{P_t^*} = 0$, for some i, $0<i<m$, and $\frac{P_{t+i}}{P_t^*} > 0$ for $i \geq m$. However, we will assume that the m th period occurs at a time in the future beyond the bank's liquidity planning time horizon. Therefore, the bank will not rely on the loan portfolio for a source of liquidity. Liquidity is provided by primary and secondary reserves. Primary and secondary reserves will be labeled "liquid assets."

$$R_p + R_s \equiv LA$$

where LA is liquid assets.

A liquidity index for the entire asset portfolio can be constructed for any fixed time horizon i. Each asset's liquidity ratio is weighted by the share of the asset in the total portfolio.[9] Thus, given the size of the total asset portfolio, the characteristics of the market for each asset, and the time horizon, the actual level of liquidity of the bank at time period t, L_{qt}, is a function of the level of primary and secondary reserves.

$$L_{qt} = \frac{R_{Pt}}{TA} + \frac{R_{St}}{TA} \cdot \frac{P_{S,t+i}}{P_{St}^*}$$

where $\frac{P_{s,t+i}}{P_{st}^*}$ is the liquidity ratio for secondary reserves.

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[9] *Ibid.*, p. 1095.

It is assumed that at time period t the bank has some desired level of liquidity, L^*_{qt}. The traditional or institutional approach to bank behavior asserts that bankers have subjective liquidity standards. These standards are based upon historical experience (especially deposit variability), the institutional setting, and various rules of thumb. According to this view, banks give liquidity considerations first priority, and attempt to maintain the desired level at all times. The desired level of liquidity is assumed constant in the short run.[10]

We will assume that the bank assigns first priority to liquidity, but that the desired or satisfactory level of liquidity is not necessarily fixed, even in the short run.

Specifically, let L^*_{qt} be the desired level of liquidity in time period t. It will be assumed that the banks attitude toward risk and the degree of risk of illiquidity it wishes to assume is expressed in the following function.

2) $L^*_{qt} = L^*_q (R_{rt}, r_{bt}, V, I)$

where

R_{rt} is the Federal reserve system required reserve ratio in time period t

r_{bt} is the rate of interest on borrowed reserves in time period t

V is a proxy for deposit variability

I is a proxy for the institutional and legal setting.

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[10] Roland I. Robinson, The Management of Bank Funds, 2nd ed., New York: Mc Graw-Hill, 1962. See especially pages 13-18 for a summary of this view.

This desired level of liquidity will imply some desired levels of primary and secondary reserves. The question is whether these levels are unique. Obviously, the same level of liquidity could be provided by different combinations of primary and secondary reserves, and thus by different sized liquid asset portfolios. However, primary and secondary reserves are not perfect substitutes for each other, and thus the bank is not indifferent to their relative proportions in the liquid asset portfolio. We will assume that once the bank has determined its desired level of liquidity, it determines a unique ratio of primary to secondary reserves on the basis of least cost criteria.

To adjust the actual level of liquidity to the desired level, the bank must adjust the actual level of primary reserves to the desired level of primary reserves, and adjust the actual level of secondary reserves to the desired level of secondary reserves. It is assumed that the adjustment need not take place instantaneously, but only after some time lag. That is, the adjustment of the gap between desired and actual levels is only partially completed in time period t. The essential point is that once the level of liquid assets in time t has been determined by this adjustment mechanism, the size of the loan portfolio in time t has been determined. This follows from the identity, $TA \equiv LA + L$.

The assumption of first priority being assigned to liquidity and second priority being assigned to profit (to be defined later) can be expressed using the lexicographic ordering scheme. Specifically,

3) $$\frac{\partial U}{\partial L_q} \Big|_{L_q < L_q^*} > 0$$

4) $$\frac{\partial U}{\partial L_q} \Big|_{L_q \geq L_q^*} = 0$$

The rules of ordering choices can be explained with the use of the following graph.

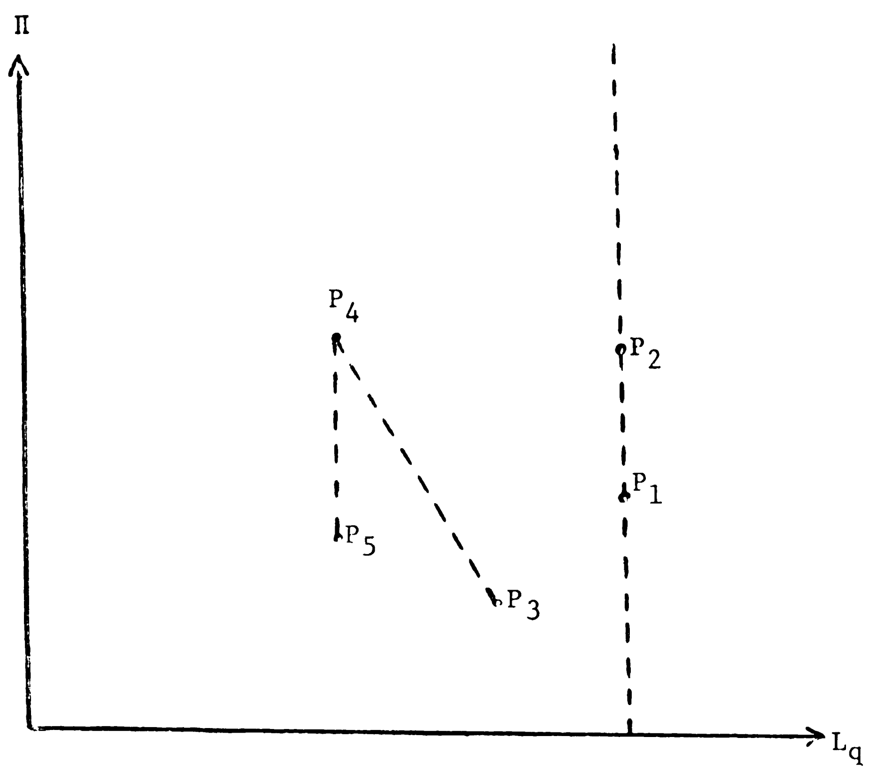

Figure 2.--Lexicographic Vector Ordering

Suppose the bank has attained the satisfactory level of liquidity, L_q^* . It is then considering a choice of two vectors, $P_1 = (L_q^* , \Pi_1)$ and $P_2 = (L_q^* , \Pi_2)$, where $\Pi_2 > \Pi_1$. Since the dominant elements are equal, the choice will be made on the basis of the subordinate element, profit. Since, $\Pi_2 > \Pi_1$ the bank will prefer the vector P_2.

Suppose that in some period the satisfactory level of liquidity has not been achieved. Then the bank would choose the point closest to the vertical line at L_q^*. If the choice were between P_3 and P_4, P_3 would be chosen because it provides greater liquidity. If the choice were between P_5 and P_4, P_4 would be selected, since the same liquidity is provided by both, but P_4 has a higher level of expected profit. The choice rule then is as follows: When any two alternatives are compared, first examine the dominant element, liquidity.

i) If $L_q \geq L_q^*$ in both alternatives, choose the alternative with the higher expected profit.

ii) If $L_q < L_q^*$ for at least one of the alternatives, and $L_{q1} \neq L_{q2}$, choose the alternative with the higher L_q.

iii) If $L_q < L_q^*$ for both alternatives, and $L_{q1} = L_{q2}$, choose the alternative with the higher expected profit.[11]

Thus, if the satisfactory level of liquidity or the highest attainable level of liquidity has been reached, the bank will seek the vector that provides the greatest expected profit, at that level

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[11] Ferguson, op. cit.

of liquidity. Since the size of the loan portfolio is determined, this implies that the bank will maximize expected profit with respect to its various loan categories, subject to a total loan constraint.

3.2.2 Expected profit

It is assumed that the rate of interest on each loan category is determined exogenously, i.e., that an individual bank is a price-taker in the loan market, and that each loan category is subject to some probability of default.

The expected profit from any loan category will depend upon the rate of return and upon the risk of default. We will assume away the possibility of deliberate and/or fraudulent default. Then the probability of default for any customer depends upon his expected economic condition. If the customer is solvent he will not default on a loan. If the customer becomes insolvent, the bank will foreclose and claim a share of the customers assets. The resources to which the bank holds claim in the event of default will depend upon the legal organization of the customer, and the particular terms of the loan contract. If the loan is a business loan, the customer may put forth some share of his business as collateral, or only the capital and income from the particular project for which the loan was made. If the loan is a mortgage loan, the bank may have claim only to the particular parcel of real estate for which the loan was granted.

We will assume that the bank views the relevant future economic condition of its loan customers as a random variable. Thus the aggregate economic condition of the customers in a particular loan category is also a random variable. Let the random variable X represent this future economic condition, i.e., X represents the bank's loan customer's future net worth. We then assume that the bank's subjective evaluation of the future net worth of customers in loan category i can be summarized by the probability density function $f_i(X)$. It is also assumed that the bank views X as being bounded. The net worth of customers in loan category i will fall between a minimum m_i and a maximum M_i.

Therefore,

5) $$f_i(X) > 0 \qquad \text{if } m_i \leq X \leq M_i$$
$$f_i(X) = 0 \qquad \text{if } X < m_i \text{ or } X > M_i$$

Since the risk of default applies to both the principal and interest, the relevant "profit" function the bank wishes to maximize in time t is the expected total loan repayment, i.e., principal plus interest.[12]

Let Π_i be expected profit from loan category i. (i=1,...,N) then,

6) $$\Pi_i = R_iL_i \int_{R_iL_i}^{M_i} f_i(X)\,dX + \int_{m_i}^{R_iL_i} X\, f_i(X)\,dX - R_oL_i$$

where,

L_i is the dollar value of the i th loan category

---

[12] The expected profit function used here involves an extension of a model used previously for commercial and industrial loans. See Marshall Freimer and Myron J. Gordon, "Why Bankers Ration Credit," Quarterly Journal of Economies, Vol. 69 (August, 1965), pp. 397-416; and, D.M. Jaffee and F. Modigliani, "A Theory and Test of Credit Rationing," the American Economic Review, Vol. 59 (December, 1969), pp. 850-72.

$R_i = 1+r_i$

r_i is the interest rate on the i th loan category

$R_o = 1+r_o$

r_o is an opportunity cost interest rate. It is the marginal rate the bank could earn in its next best alternative, and is thus a proxy for the marginal cost of investing in the i th loan category.

$f_i(X)$ is the density function of X

X represents the economic condition of the banks loan customers

m_i is the minimum possible economic condition of customers in the i th loan category

M_i is the maximum possible economic condition of customers in the i th loan category.

The first term in expression 6) is the total contractual repayment times the probability of the customers in loan category i being in economic condition which allows total repayment. The second term in 6) is the repayment in the event of at least partial default. R_oL_i is the repayment the bank could have had with certainty in its next best alternative investment.

By adding and subtracting

$$R_iL_i \int_{m_i}^{R_iL_i} f_i(X)\,dX$$

from expression 6), we obtain;

7) $$\Pi_i = R_iL_i - R_iL_i\,F_i(R_iL_i) + \int_{m_i}^{R_iL_i} X\,f_i(X)dX - R_oL_i$$

where $F_i(u) = \int_{m_i}^{u} f_i(X)dX$ is the cumulative distribution of the probability density function $f_i(X)$. Integrating by parts yields:

8) $$\Pi_i = R_iL_i - R_iL_i\ F_i(R_iL_i) + R_iL_i\ F_i(R_iL_i) - \int_{m_i}^{R_iL_i} F_i(X)dX - R_oL_i$$

$$= (R_i - R_o)\ L_i - \int_{m_i}^{R_iL_i} F_i(x)\ dX$$

Total expected profit is then the sum of the profit for each loan category.

9) $$\Pi = \sum_i \Pi_i = \sum_i (R_i - R_o)\ L_i - \sum_i \int_{m_i}^{R_iL_i} F_i(X)dX \quad (i= 1, \ldots N)$$

Since the bank has already determined the size of the total loan portfolio for the time period under consideration, the problem now is to maximize expected profit subject to the total loan portfolio constraint. To do this, form the Lagrange expression:

10) $$H = \sum_i (R_i - R_o)\ L_i - \sum_i \int_{m_i}^{R_iL_i} F_i(X)dX - \lambda\ (\sum_i L_i - L)$$

where λ is the undetermined Lagrange multiplier.

The first order conditions require that the first partial derivatives of H equal zero.

11) $$\frac{\partial H}{\partial L_i} = R_i[1-F_i(R_iL_i)] - R_o - \lambda = 0$$

$$\frac{\partial H}{\partial \lambda} = \sum_i L_i - L = 0$$

Note that $F(R_iL_i)$ is the probability of default on any loan category i. The first order conditions imply that the bank will allocate funds among loan categories until the repayment on the marginal dollar times the probability of repayment is equal for all loan categories.

For this to be a maximum, the second order conditions require that the relevant bordered Hessian determinants must alternate in sign, starting with plus.

Denote the second partials of H by H_{ij}.

Then,

12)
$$H_{ii} = -R_i^2 \; f_i(R_iL_i) < 0$$
$$H_{ij} = 0 \qquad i \neq j$$

The first partials of the constraint are all equal to unity.

$$\begin{vmatrix} H_{11} & 0 & 1 \\ 0 & H_{22} & 1 \\ 1 & 1 & 0 \end{vmatrix} = -H_{22} - H_{11} > 0$$

$$\begin{vmatrix} H_{11} & 0 & 0 & 1 \\ 0 & H_{22} & 0 & 1 \\ 0 & 0 & H_{33} & 1 \\ 1 & 1 & 1 & 0 \end{vmatrix} = -H_{22}H_{33} - H_{11}H_{33} - H_{11}H_{22} < 0$$

and

$$\begin{vmatrix} H_{11} & 0 & 0 & 0 & 1 \\ 0 & H_{22} & 0 & 0 & 1 \\ 0 & 0 & H_{33} & 0 & 1 \\ 0 & 0 & 0 & H_{44} & 1 \\ 1 & 1 & 1 & 1 & 0 \end{vmatrix} = -H_{22}H_{33}H_{44} - H_{11}H_{33}H_{44}$$
$$- H_{11}H_{22}H44 - H_{11}H_{22}H_{33} > 0$$

The bordered Hessian determinants do alternate in sign, starting with plus.

3.2.3 Derived demand equations

Solving the system 11) implicitly for L^*_{it}, the desired level of loan category i in time period t, yields

13) $$L^*_{it} = L^*_i \left(r_{it}, \quad \{r_{jt}\}, \quad F_i(P_iL_i), \{F_j(R_jL_j)\}, \quad r_{ot}, L_t\right)$$

where $\{r_{jt}\}$ is the set of interest rates for $j \neq i$.

$\{F_j(R_jL_j)\}$ is the set of probabilities of default in loan category j, $j \neq i$.

To formulate this in terms of observable economic variables, some further assumptions must be made. Specifically, some assumption must be made about the nature of the probability of default. Up to this point, we have assumed that the probability of default is determined subjectively by the individual banker, and that it is not observable. To deal with this problem, we will assume that the market has evaluated the risk of default and that adjustment for it has been made as an additive term in the interest rate. That is, the observed interest rate contains a pure credit element and an additive adjustment for default risk.[13] We will also assume that the relevant opportunity cost rate for the i th loan category is given by r_{jt}. ($j = 1, \ldots, N, j \neq i$)

---

[13] For a discussion of this assumption, see Richard C. Porter, "A Model of Bank Portfolio Selection," in Donald D. Hester and James Tobin, eds., Financial Markets and Economic Activity, New York: Wiley, 1967, pp. 12-54.

Linearizing the resulting equations, one obtains:

14) $$L^*_{it} = \beta_{i1}r_{it} + \beta_{i2}r_{2t} + \dots + \beta_{iN}r_{Nt} + \beta_{iN+1}L_t$$

It should be noted that L^*_{it} represents the desired level of loan category i, and could be considered the demand for loans of category i. This departs from the usual banking terminology which considers banks as suppliers of loans and bank customers as demanders of loans. Banks are said to demand bonds and supply loans. We will depart from this obviously inconsistent terminology. Loans are assets that banks desire to hold in their portfolios, and thus banks demand these assets. In fact, the demand for these assets is similar to the demand for factors of production in the ordinary theory of the firm. They are desired because they produce profits which in turn produce utility. The demand for loans is thus a derived demand. We should note that in the process of demanding loans, the bank supplies funds (sometimes called loanable funds). This is probably where much of the confusion in terminology arises.

3.2.4 Asymmetric behavior

We must now specify what a tight money situation is for an individual bank and develop a test of the hypothesis that banks discriminate against various categories of borrowers in periods of tight money.

A tight money policy is a policy which restricts the expansion of credit and the money supply. To be effective, a monetary policy must restrict the expansion of bank credit. Thus, a tight money situation for an individual bank implies that the size of the loan portfolio is decreasing.[14] However, not all situations in which the size of the total loan portfolio is decreasing are caused by tight money. A decrease in the total loan portfolio may be caused by a fall in the supply of loans (the demand for loanable funds). Since we have assumed that the individual bank is a price-taker in the loan market, the supply of loans is determined by "the rate of interest." Therefore, an increase in the rate of interest leads to an increase in the supply of loans to the bank, and a decrease in the rate of interest leads to a decrease in the supply of loans to the bank.

A tight money situation for an individual bank is a situation in which the supply of loans is nondecreasing and the size of the total loan portfolio is decreasing. If an average rate of interest, r_{at}, is used as a proxy for "the rate of interest," an individual bank is in a tight situation if

$r_{at} \geq r_{at-1}$ and $L_t < L_{t-1}$

The bank is in a non-tight situation if

$r_{at} < r_{at-1}$ or $L_t \geq L_{t-1}$

---

[14]An alternative definition of a tight money policy is a monetary policy that slows the rate of expansion of credit and the money supply rather than decreasing the level of credit and money. For an individual bank, this would imply that the rate of increase in the total loan portfolio is decreasing. The use of this approach is considered in Chapter 5 of this dissertation.

If a bank discriminates against some loan categories during a tight money period, this implies that the bank behaves differently during tight money periods than during non-tight periods. This asymmetric behavior can be represented by the introduction of two binary variables, Z_t and W_t. We now have:

$$L^*_{it} = \beta_{i1} r_{1t} + \ldots + \beta_{iN} r_{Nt} + \beta_{iN+1} W_t L_t + \beta_{iN+2} Z_t L_t$$

where $W_t = 1$ if $r_{at} < r_{at-1}$ or $L_t \leq L_{t-1}$

$= 0$ otherwise

$Z_t = 1$ if $r_{at} \geq r_{at-1}$ and $L_t < L_{t-1}$

$= 0$ otherwise

However, since $W_t = 1 - Z_t$, for all t, we can substitute for W_t.

15) $$L^*_{it} = \beta_{i1} r_{1t} + \ldots + \beta_{iN} r_{Nt} + \beta_{iN+1} L_t + \beta^*_{iN+2} Z_t L_t$$

where $\beta^*_{iN+2} = (\beta_{iN+2} - \beta_{iN+1})$

Our theory does not suggest that β_{iN+2} should differ from β_{iN+1}. Our null hypothesis is that $\beta^*_{iN+2} = 0$. If we know that β^*_{iN+2} is not significantly different from zero, we cannot reject the null hypothesis. Specifically, we will be interested in β^*_{iN+2} for the mortgage loan category. A value of β^*_{iN+2} for mortgage loans significantly greater than zero would imply that the bank adjusts mortgage loans more severely during tight periods than during non-tight periods.

3.2.5 Stock Adjustment Mechanism

We have the following N equations for desired loans:

$$
16)\quad
\begin{aligned}
L^*_{1t} &= \beta_{11} r_{1t} + \beta_{12} r_{2t} + \dots + \beta_{1N} r_{Nt} + \beta_{1,N+1} L_t + \beta^*_{1,N-2} Z_t L_t \\
L^*_{2t} &= \beta_{21} r_{1t} + \beta_{22} r_{2t} + \dots + \beta_{2N} r_{Nt} + \beta_{2,N+1} L_t + \beta^*_{2,N+2} Z_t L_t \\
&\;\;\vdots \\
L^*_{Nt} &= \beta_{N1} r_{1t} + \beta_{N2} r_{2t} + \dots + \beta_{NN} r_{Nt} + \beta_{N,N+1} L_t + \beta^*_{N,N+2} Z_t L_t
\end{aligned}
$$

We also assume that the bank has rational desires, i.e., that

$$
17)\quad \sum_{i=1}^{N} L^*_{it} = L_t
$$

We do not wish to assume that the model is always in equilibrium. Specifically, we must relate the actual level of each loan category to the desired level. It is assumed that the bank adjusts actual to desired levels according to the following adjustment equations.[15]

$$
\begin{aligned}
L_{1t} - L_{1,t-1} &= \alpha_{11}[L^*_{1t} - L_{1,t-1}] + \dots + \alpha_{1N}[L^*_{Nt} - L_{N,t-1}] + \varepsilon_1 \\
L_{2t} - L_{2,t-1} &= \alpha_{21}[L^*_{1t} - L_{1,t-1}] + \dots + \alpha_{2N}[L^*_{Nt} - L_{N,t-1}] + \varepsilon_2 \\
&\;\;\vdots \\
L_{Nt} - L_{N,t-1} &= \alpha_{N1}[L^*_{1t} - L_{1,t-1}] + \dots + \alpha_{NN}[L^*_{Nt} - L_{N,t-1}] + \varepsilon_N
\end{aligned}
$$

where $\sum_{i=1}^{N} L_{it} = L_t$

and ε_i, $i = 1,\dots,N$ are stochastic disturbance terms.

---

[15] This is the adjustment process suggested by William C. Brainard and James Tobin, "Pitfalls in Financial Model Building," American Economic Review, Vol. 58 (May, 1968), pp. 99-122.

The assumptions about the disturbance terms and procedures for estimating the above system will be discussed in the following chapter.

CHAPTER 4

EMPIRICAL PROCEDURES

The task of this chapter is to consider various problems of estimation. Because the main interest of the dissertation is with the determinants of business loans and mortgage loans, and because of data limitations, the set of equations (16), (17) and (18) from the previous chapter will be considered for the special case of N = 3, where

L_1 = business loans

L_2 = real estate loans

L_3 = other loans

We then have the following system of equations:

19) $L^*_{1t} = \beta_{11}\, r_{1t} + \beta_{12}\, r_{2t} + \beta_{13}\, r_{3t} + \beta_{14}\, L_t + \beta_{15}\, Z_t\, L_t$

20) $L^*_{2t} = \beta_{21}\, r_{1t} + \beta_{22}\, r_{2t} + \beta_{23}\, r_{3t} + \beta_{24}\, L_t + \beta_{25}\, Z_t\, L_t$

21) $L^*_{3t} = \beta_{31}\, r_{1t} + \beta_{32}\, r_{2t} + \beta_{33}\, r_{3t} + \beta_{34}\, L_t + \beta_{35}\, Z_t\, L_t$

22) $L_{1t} - L_{1t-1} = \alpha_{11}\,(L^*_{1t} - L_{1t-1}) + \alpha_{12}\,(L^*_{2t} - L_{2t-1})$

$+ \alpha_{13}\,(L^*_{3t} - L_{3t-1}) + \varepsilon_{1t}$

23) $L_{2t} - L_{2t-1} = \alpha_{21}\,(L^*_{1Z} - L_{1t-1}) + \alpha_{22}\,(L^*_{2t} - L_{2t-1})$

$+ \alpha_{23}\,(L^*_{3t} - L_{3t-1}) + \varepsilon_{2t}$

24) $L_{3t} - L_{3t-1} = \alpha_{31}\,(L^*_{1t} - L_{1t-1}) + \alpha_{2t}\,(L^*_{2t} - L_{2t-1})$

$+ \alpha_{33}\,(L^*_{3t} - L_{3t-1}) + \varepsilon_{3t}$

25) $\sum_{i}^{3} L_{it} = L$

26) $\sum_{i}^{3} L^{*}_{it} = L$

Considering L_1^*, L_2^*, L_3^*, L_1, L_2, and L_3 as endogenous variables, we have eight equations in six unknowns.[1]

4.1 Consistency of solution

Prior to estimation the question arises as to the existence of a consistent solution to this system. Arranging the equations in order 22, 23, 24, 19, 20, 21, 25, 26, and writing the system in matrix notation we have:

$$27)\quad \underset{(8\text{x}6)}{\begin{bmatrix} I_3 & -A \\ 0 & I_3 \\ 0 & r' \\ r' & 0 \end{bmatrix}} \underset{(6\text{x}1)}{\begin{bmatrix} \vec{L}_t \\ L^*_t \end{bmatrix}} + \underset{(8\text{x}1)}{\begin{bmatrix} -(\Gamma \vec{L}_{t-1} + \varepsilon_t) \\ -\beta X_t \\ -L_t \\ -L_t \end{bmatrix}} = \underset{(8\text{x}1)}{\underline{0}}$$

where

$$A = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{bmatrix} \quad \vec{L}_t = \begin{bmatrix} L_{1t} \\ L_{2t} \\ L_{3t} \end{bmatrix}, \quad L^*_t = \begin{bmatrix} L^*_{1t} \\ L^*_{2t} \\ L_{3t} \end{bmatrix}$$

---

[1]The approach taken here follows that of Mark Ladenson, Pitfalls in Financial Model Building: Some Extensions," American Economic Review, Vol. 61 (March, 1971), pp. 179-186.

$$\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix}, \quad r' = (1, 1, 1)$$

$$\Gamma = I_3 - A = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix}$$

$$X_t = \begin{bmatrix} r_{1t} \\ r_{2t} \\ r_{3t} \\ L_t \\ Z_t \; L_t \end{bmatrix} \qquad \beta = \begin{bmatrix} \beta_{11} & \cdots & \beta_{15} \\ \beta_{21} & \cdots & \beta_{25} \\ \beta_{31} & \cdots & \beta_{35} \end{bmatrix}$$

I_3 is the identity matrix of order three, and $\underline{0}$ is an (8x1) vector of zeros. The system will have a consistent solution if and only if:[2]

$$C = \begin{bmatrix} I_3 & -A \\ 0 & I_3 \\ 0 & r' \\ r' & 0 \end{bmatrix} \text{ and } [C \; b] = \begin{bmatrix} I_3 & -A & -(r\, L_{t-1} + \varepsilon_t) \\ 0 & I_3 & -\beta\, X_t \\ 0 & r' & -L_t \\ r' & 0 & -L_t \end{bmatrix}$$

have the same rank.

---

[2]Franz E. Hohn, Elementary Matrix Algebra, New York: Macmillan, 1964, p. 140.

Performing row operations we find that [C b] is equivalent to

$$\begin{bmatrix} I_3 & -A & -(\Gamma \vec{L}_{t-1} + \varepsilon_t) \\ 0 & I_3 & -\beta X_t \\ 0 & 0 & -L_t + r' \beta X_t \\ 0 & 0 & -L_t + r' (\Gamma \vec{L}_{t-1} + \varepsilon_t) + r' A \beta X_t \end{bmatrix}$$

This matrix will have the same rank as C if

1) $L_t = r' \beta X_t$

and

2) $L_t = r' (\Gamma L_{t-1} + \varepsilon_t) + r' A \beta X_t$

Condition (1) will be satisfied if

a) $r' \beta = [0, 0, 0, 1, 1]$

Condition (2) is satisfied if the above restrictions holds and

b) $r' = r'A$

c) $r' \varepsilon = 0$

The sufficient conditions for a consistent solution are:

1) The coefficients of each interest rate sum to zero across equations

2) The coefficients of total loans sum to one across equations

3) The adjustment coefficients sum to one across equations

4) The disturbance terms sum to zero across equations.

Ladenson has shown that estimates of the behavioral parameters which satisfy the above conditions may be derived from ordinary least squares estimates of the reduced form.[3]

---

[3]Ladenson op. cit., p. 185-6. Indeed, a preliminary run with OLS did embody the desired restrictions.

Substituting for L_t^* we get the reduced form.

28) $\vec{L}_t = C\,X_t + \Gamma\,\vec{L}_{t-1} + \varepsilon_t$

where $C = A\,\beta$

and $\Gamma = I_3 - A$

4.2 Disturbance term assumptions

The problem now is to find a consistent estimator of C and Γ, given the following specifications on the disturbance term.

Consider ε_{it}

where $i = 1, 2, 3$ refers to equations,

$t = 1, \ldots, 156$ refers to time in weeks.

We make the following assumptions, for all i,t:

1) ε_{it} is normally distributed

2) $E\,(\varepsilon_{it}) = 0$

3) $E\,(\varepsilon_{it}^2) = \sigma_i^2$

i.e., we are assuming that the disturbance term has constant variance for each equation.

4) $E\,(\varepsilon_{it}\ \ \varepsilon_{it-s}) = \rho_i{}^s\ \sigma_i{}^s$

Specifically, it is assumed that ε_{it} follows a first order autoregressive scheme:

$\varepsilon_{it} = \rho_i\ \varepsilon_{it-1} + u_{it}$

where $0 \leq \rho_i^2 \leq 1$

$u_{it} \sim N\,(0,\ \sigma_{iu}{}^2)$

$E(u_{it}\ u_{it-1}) = 0$

5) $E(u_{it}\ u_{jt}) = \sigma_{ij}$

Assumptions (1), (2), and (3) cause no problems for estimation. Assumption (4) and (5) require further explanation and examination.

4.2.1 Autocorrelation

A situation in which the disturbance term is autoregressive is frequently encountered when the data are in the time series form. Also, ceteris paribus, the shorter the time period the more likely it is that the effects of exogenous random disturbances will carry over into subsequent time periods. Since the model is to be estimated using weekly time series data, it is highly likely that the disturbance term is autocorrelated. There is no overriding a priori reason to assume otherwise, and thus the possibility of autocorrelation will be allowed. (Note that we have not ruled out the possibility of serial independence, but have considered the more general case.)

4.2.2 Properties of OLS

In the case of non-stochastic regressors and autocorrelation of the disturbance term, OLS estimators are unbiased and consistent, but neither efficient nor asymptotically efficient.

When a lagged dependent variable is included as a regressor and the disturbance term is autocorrelated, the situation is worse. Without loss of generality, consider the first equation:

$$L_{1t} = C_{11}\ r_{1t} + C_{12}\ r_{2t} + C_{13}\ r_{3t} + C_{14}\ Z_t\ L_t + C_{15}\ W_t\ L_t + \gamma_{11}\ L_{1t-1} + \gamma_{12}\ L_{2t-1} + \gamma_{13}\ L_{3t-1} + \varepsilon_{1t}$$

Where $\varepsilon_{1t} = \rho_1\ \varepsilon_{1t-1} + u_{1t}$

$E(L_{1t-1}\ \varepsilon_{1t}) \neq 0$, since $E\ [\varepsilon_{1t-1})\ \rho_1\ (\varepsilon_{1t-1})] = \rho_1 \sigma_1^{\ 2}$

This is a situation in which a stochastic regressor is correlated with the disturbance term. OLS estimators are not consistent,[4] i.e., even if the sample size approaches infinity, the distribution of the estimator will not collapse at the true parameter value.

4.2.3 Alternative estimation procedure

If we know the value of ρ_1 we could perform an Orcutt transformation on the data to remove autocorrelation. For example,

$$L_{1t} - \rho_1 L_{1t-1} = C_{11} (r_1 - \rho_{1t} r_{1t-1}) + \ldots + \gamma_{11} (L_{1t-1} - \rho_1 L_{1t-2})$$

$$+ \ldots + u_{1t}$$

Where u_{1t} the new disturbance term has all desired properties.

Generally one does not know the value of ρ_1 and must find a consistent estimator of it.

Two of the usual methods of estimation of ρ are not satisfactory in this case. One cannot merely transpose $\rho_1 L_{1t-1}$, to the right hand side of the equation and estimate ρ_1,[5] since L_{1t-1} already appears there, and one could only estimate $(\gamma_{11} + \rho_1)$.

Another method frequently used is to estimate $e_t = \rho\, e_{t-1} + U_t$, where e_t and e_{t-1} are OLS residuals. In this case

$$\hat{\rho} = \frac{\Sigma\, e_t\, e_{t-1}}{\Sigma\, e_{t-1}^2}$$

---

[4]Arthur S. Goldberger, Econometric Theory, New York: Wiley, 1964, pp. 272-287. Also see J. Johnston, Econometric Methods, New York: McGraw-Hill, 1960, pp. 211-221.

[5]J. Durbin, "Estimation of Parameters in Time-series Regression Models," Journal of Royal Statistical Society, Vol. 22 (1960), pp. 139-153.

However, since the e's are functions of the estimated coefficients $\hat{C}$ and $\hat{\Gamma}$, which are inconsistent, $\hat{\rho}$ will be inconsistent.

The method used will be the conditional maximum likelihood method suggested by Hildreth and Lu.[6] The method involves the following: For each equation, perform an Orcutt transformation (as shown above) for various values of ρ between -1 and 1. Estimate each transformed equation by OLS and select the value of ρ that minimizes the error sum of squares. It has been shown that this method has all desirable asymptotic properties, i.e., consistency,[7] asymptotic efficiency,[8] and asymptotic normality.[9]

4.2.4 Correlation of disturbances across equations

After the Orcutt transformation by the appropriate ρ, the remaining disturbance term u_{1t} in each equation will be non-autoregressive. However, we have made the assumption that E $(u_{it}\ u_{it}) = \sigma_{ij}$, that is, that the disturbance terms are not necessarily uncorrelated across equations. In this case (usually called seemingly unrelated

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[6]C. Hildreth and J. Y. Lu, Demand Relations with Auto-Correlated Disturbances, Technical Bulletin 276, East Lansing: Michigan State University, 1960.

[7]Ibid.

[8]E. Malinvaud, Statistical Methods of Econometrics, Chicago-Amsterdam: Rand McNally, 1966, pp. 439-441.

[9]Phoebus J. Dhrymes, "On the Treatment of Certain Recurrent Non-Linearities in Regression Analysis", Southern Economic Journal, Vol. 33 (Oct. 1966), pp. 187-96.

regressions) OLS estimation of each equation separately gives estimates that are unbiased and consistent, but not necessarily efficient.[10] Zellner suggests the use of the joint Aitken generalized estimation procedure to take advantage of the information of correlation of disturbances across equations and increase efficiency over OLS estimates. Writing the system as

$$29)\quad \vec{L}^{\tau} = X^{\tau} \begin{bmatrix} C_1 \\ r_1 \\ C_2 \\ r_2 \\ C_3 \\ r_3 \end{bmatrix} + u$$

Where

$$\vec{L}^{\tau} = \begin{bmatrix} L_1^{\tau} \\ L_2^{\tau} \\ L_3^{\tau} \end{bmatrix} \quad \text{is a (486 x 1) vector}$$

$$X = \begin{bmatrix} r_1^{\tau},\ r_2^{\tau},\ r_3^{\tau},\ L^{\tau},\ ZL^{\tau},\ L_{1t-1}^{\tau},\ L_{2t-1}^{\tau},\ L_{3t-1}^{\tau} & 0 & 0 \\ 0 & r_1^{\tau},\ r_2^{\tau},\ r_3^{\tau},\ L^{\tau},\ ZL^{\tau},\ L_{1t-1}^{\tau},\ L_{2t-1}^{\tau},\ L_{3t-1}^{\tau} & 0 \\ 0 & 0 & r_1^{\tau},\ r_2^{\tau},\ r_3^{\tau},\ ZL^{\tau},\ WL^{\tau},\ L_{1t-1}^{\tau},\ L_{2t-1}^{\tau},\ L_{3t-1}^{\tau} \end{bmatrix}$$

is (486 x 24)

The τ superscript indicates that the variable has been transformed

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[10] A. Zellner,"An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," Journal of the American Statistical Association, Vol. 57 (June, 1962), pp. 348-68.

by the appropriate value of ρ. Estimated values of ρ are presented in Appendix B.

$$\begin{bmatrix} C_1 \\ \Gamma_2 \\ C_2 \\ \Gamma_2 \\ C_3 \\ \Gamma_3 \end{bmatrix}$$

is the (24 x 1) vector of coefficients.

Where C_i is the transpose of the ith row of C and Γ_i is the transpose of the ith row of Γ.

$$E(u'u) = \Omega = \begin{bmatrix} \sigma_{11} & I_{156} & \sigma_{12} & I_{156} & \sigma_{13} & I_{156} \\ \sigma_{21} & I_{156} & \sigma_{22} & I_{156} & \sigma_{23} & I_{156} \\ \sigma_{31} & I_{156} & \sigma_{32} & I_{156} & \sigma_{33} & I_{156} \end{bmatrix}$$

$$(468 \times 468)$$

The joint Aitken generalized "estimator" is

$$30) \quad \begin{bmatrix} \hat{C}_1 \\ \hat{\Gamma}_1 \\ \hat{C}_2 \\ \hat{\Gamma}_2 \\ \hat{C}_3 \\ \hat{\Gamma}_3 \end{bmatrix} = \underset{(24 \times 24)}{(X^{\tau'} \Omega^{-1} X^{\tau})^{-1}} \quad \underset{(24 \times 1)}{(X^{\tau'} \Omega^{-1} \vec{L})}$$

$$(24 \times 1)$$

The estimated variance-covariance matrix of coefficients is given by

$$(X^{\tau'} \hat{\Omega}^{-1} X^{\tau})^{-1}$$

where $\hat{\Omega}$ is a consistent estimator of Ω.

In general we do not know the value of the elements of Ω. A consistent estimator of σ_{mp} is:[11]

31) $$\sigma_{mp} = \frac{1}{T-K_m} e_m e_p$$

Where e's are OLS residuals and in this case

$T = 156$

$K_m = 8$ (the number of regressors in the mth equation)

The e's are residuals obtained from OLS regressions after the Orcutt Transformations described in the previous section. Note that had the Orcutt transformation not been made and OLS residuals had been obtained from regressions with the original data, the above method would be inappropriate. Recall that with the original data one of the resulting restrictions implied (and given by OLS) was that the disturbance terms (residuals) sum to zero across equations. For three equations this implies, for example, that

$$e_3 = -e_1 - e_2$$

Writing $\hat{\Omega}$ as

$$\hat{\Omega} = \frac{1}{T-K_m} \begin{bmatrix} e_1'e & e_1'e & e_1'e_3 \\ e_2'e_1 & e_2'e_2 & e_2'e_3 \\ e_3'e_1 & e_3'e_2 & e_3'e_3 \end{bmatrix} \otimes I_T$$

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[11]*Ibid*.

Substituting for e_3

$$\hat{\Omega} = \frac{1}{T-K_m}\begin{bmatrix} e_1'e & e_1'e_2 & -e_1'e_1 & -e_2'e_1 \\ e_2'e_1 & e_2'e_2 & -e_1'e_2 & -e_2'e_2 \\ -e_1'e_1 & -e_2'e_1 & -e_1'e_2-e_2'e_2 & e_1'e_1 + 2\, e_1'e_2 + e_2'e_2 \end{bmatrix} \otimes I_T$$

The third row of the e matrix is a linear combination of the first and second rows. Therefore $\hat{\Omega}$ is singular.

In this situation the seemingly unrelated method is inappropriate because the three equations are not seemingly unrelated, but related by the balance sheet equation

$$L_1 + L_2 + L_3 = L$$

However, after transformation of each equation by the appropriate ρ_i, the transformed data do not conform to the above constraint and the equations do become seemingly unrelated. This is a mixed blessing in the sense that we can now use Zellner's asymptotically efficient estimation method, but we do lose the restriction discussed earlier. However, by estimation in two stages, first applying the Hildreth and Lu method and then Zellner's method, we have an estimation procedure that has all the desirable asymptotic properties. Note that one could have estimated two of the three equations by the Zellner Aitken method and derived estimates of the coefficients of the third equation from the restrictions.

4.3 Description of the data

The model is estimated from weekly data covering the period from January 1, 1965 to December 31, 1967.

The individual bank data consist of the three loan categories:

L_1 Commercial and industrial loans

L_2 real estate loans

L_3 other loans.

These data were obtained from weekly call reports of ten reporting banks in the Second Federal Reserve District. The "commercial and industrial" and "real estate" categories for each bank correspond to the respective aggregate series published in the Federal Reserve Bulletin. The "other loans" category is the sum of: loans to domestic commercial banks, loans to foreign banks, loans to other financial institutions, loans to brokers and dealers, other loans for purchase or carrying securities, agricultural loans, consumer installment loans, and all other loans.

The following three interest rates are used:

r_1 The prime commercial paper rate

r_2 The conventional first mortgage rate (including fees)

r_3 an index of other rates

The prime commercial paper rate and the conventional first mortgage rate are published in the Federal Reserve Bulletin. The prime commercial paper rate is published as a weekly series and is an average of daily offering rates of commercial paper dealers. The conventional first mortgage rate plus fees is the contract rate on conventional first mortgages plus fees and charges. "Fees and charges include loan commissions, fees, discounts, and other charges which provide added income to the lender and are paid by the borrower."[12] This

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[12]Board of Governors of the Federal Reserve System, Federal Reserve Bulletin, Vol. 55 (February, 1969), p. A33.

series is published monthly. Linear interpolation was used to construct a weekly series.

An index was constructed to serve as a proxy rate for other loans. The index is a weighted average of the federal funds rate, the rate on bankers acceptances (90 days), the going rate on call loans, the rate on certificates of deposit in New York City, and the rate on finance company paper. The weights were determined by principle component analysis. This has the property of maximizing the generalized correlation between the rates and the index, and also of minimizing any errors in variables.[13]

The above index, as well as the constructed mortgage rate series, is presented in Appendix D.

4.4 Estimates of Behavioral Parameters

At this point we wish to obtain estimates of the behavioral parameters A and B from the reduced form estimates $\hat{C}$ and $\hat{\Gamma}$.

Since $A = L_3 - \Gamma$

and $C = A\ B$

estimates of A and B are given by

$$\hat{A} = I_3 - \hat{\Gamma}$$

and

$$\hat{B} = \hat{A}^{-1}\ C$$

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[13]See Gerhard Tintner, Econometrics, New York: Wiley, 1965, p. 102-114.

To conduct the appropriate tests we also need estimates of the standard errors of the B's. These estimates are obtained using "Kleins approximation,"[14] which states:

if $\hat{\beta} = f\ (\hat{\alpha}_1, \hat{\alpha}_2, \ldots , \hat{\alpha}_K)$

Then an estimate of the asymptotic variance of $\hat{\beta}$ is given by :

$$\text{Est Var}\ (\hat{\beta}) \doteq \Sigma \frac{\partial f}{\partial \hat{\alpha}_k}^2 \ \text{Est Var}\ (\hat{\alpha}_k) + 2 \sum_{j<k}\Sigma \left(\frac{\partial f}{\partial \hat{\alpha}_j}\right) \left(\frac{\partial f}{\partial f_k}\right) \text{Est Cov}\ (\hat{\alpha}_j\ \hat{\alpha}_k)$$

The required partial derivatives are presented in Appendix A. The reduced form estimates are presented in Appendix C.

The estimates of the structural and adjustment parameters are presented in the following tables. In all tables the numbers in parentheses are the ratios of the coefficient to its standard error.

Table 1.--Structural Coefficients Bank 1

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	81,059.5 (0.3824)	-60,323.3 (-0.9030)	-20,745.9 (-2.0472)	0.1014 (0.5896)	0.0022 (0.0147)
Mortgage Loans, L_2	307,265.0 (0.1137)	-691,837.0 (-0.8442)	-418,174.0 (-0.8442)	0.6717 (1.7265)	0.0499 (0.3797)
Other Loans, L_3	-389,236.0 (0.1387)	752,082.0 (0.8790)	438,815.0 (0.2628)	0.3192 (2.2474)	-0.0432 (-0.0433)

Table 2.--Structural Coefficients Bank 2

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-50,007,700.0 (-1.3420)	11,388,900.0 (1.5737)	47,396,200.0 (0.8226)	-0.0669 (-1.4996)	0.03702 (1.6611)
Mortgage Loans, L_2	-14,954,300.0 (-1.6430)	193,333.0 (0.8990)	16,140,000.0 (1.6881)	0.0393 (3.8601)	0.0054 (0.4046)
Other Loans, L_3	54,195,700.0 (1.4149)	-10,817,900.0 (-1.5458)	53,399,900.0 (-1.1768)	0.4548 (3.2034)	-0.0344 (-0.3973)

Table 3.--Structural Coefficients Bank 3

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-15,836,500.0 (-0.5681)	19,061,800.0 (1.6478)	1,732,300.0 (0.0541)	-0.0674 (-0.2984)	-0.8138 (-1.2318)
Mortgage Loans, L_2	8,946,920.0 (0.5900)	-661,250.0 (-0.3933)	-9,710,720.0 (-5.3904)	0.4013 (2.9174)	-0.0474 (0.0753)
Other Loans, L_3	15,037,800.0 (0.0567)	-19,229,600.0 (-1.6414)	-16,461,200.0 (-0.0531)	0.6547 (1.8860)	0.7691 (1.0515)

Table 4.--Structural Coefficients Bank 4

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-2,880,270.0 (-0.4836)	1,858,250.0 (1.7146)	4,564,550.0 (0.6819)	-0.1961 (-0.5872)	-0.0356 (-0.1024)
Mortgage Loans, L_2	1,452,700.0 (0.2647)	-410,818.0 (0.5694)	-2,882,170.0 (-0.4552)	0.4966 (2.5469)	0.0187 (0.2556)
Other Loans, L_3	1,235,210.0 (1.2684)	-1,596,590.0 (-9.0722)	-1,350,150.0 (-1.3464)	0.7263 (1.1902)	0.0092 (0.0706)

Table 5.--Structural Coefficients Bank 5

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-1,249,710.0 (-0.1349)	9,700,220.0 (1.2228)	3,970,400.0 (0.474)	0.0366 (0.4637)	0.0191 (0.1164)
Mortgage Loans, L_2	-14,074,900.0 (-0.9289)	-5,770,700.0 (-1.3024)	21,819,500.0 (1.5471)	0.1768 (1.6199)	-0.0203 (-1.0587)
Other Loans, L_3	11,951,400.0 (0.9157)	-3,844,510.0 (0.9127)	21,645,900.0 (3.2731)	0.7661 (2.4934)	0.0058 (0.0352)

Table 6.--Structural Coefficients Bank 6

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-430,117.0 (-1.1653)	-147,346.0 (-1.8450)	498,805.0 (1.4980)	0.2428 (2.4833)	-0.0114 (-0.3212)
Mortgage Loans, L_2	-90,796.4 (-2.3618)	160,208.0 (1.6076)	52,971.9 (0.1377)	0.2051 (1.7561)	-0.0098 (-3.6162)
Other Loans, L_3	530,444.0 (0.7536)	-15,086.6 (-0.0761)	-561,420.0 (-0.6826)	0.5226 (4.1982)	0.0213 (0.4577)

Table 7.--Structural Coefficients Bank 7

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	155,733.0 (0.9681)	37,948.1 (0.5951)	-236,626.0 (-1.0337)	0.2461 (1.8707)	0.0063 (0.0547)
Mortgage Loans, L_2	1,183,490.0 (1.5136)	-128,320.0 (-0.6159)	-1,562,410.0 (-2.3372)	0.5568 (2.1732)	0.0180 (0.4830)
Other Loans, L_3	-1,341,240.0 (-1.8925)	89,253.1 (0.3400)	1,802,940.0 (4.1569)	0.1928 (1.5158)	-0.0246 (-0.1906)

Table 8.--Structural Coefficients Bank 8

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	77,989,600.0 (6.1300)	-12,456.0 (-0.0170)	-77,696,700.0 (-2.6143)	0.2198 (5.0308)	-0.0013 (-0.0238)
Mortgage Loans, L_2	-32,937,300.0 (-5.0126)	-1,423,190.0 (-0.5207)	36,755,900.0 (3.0043)	0.1367 (0.8390)	0.0019 (0.3847)
Other Loans, L_3	10,452,600.0 (0.7664)	1,444,580.0 (1.1484)	-14,311,800.0 (-1.0441)	0.7904 (3.4681)	-0.0016 (-0.0083)

Table 9.--Structural Coefficients Bank 9

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-5,542,940.0 (-0.1054)	2,296,360.0 (0.2840)	11,161,800.0 (1.1828)	0.3106 (0.5500)	0.0257 (0.0454)
Mortgage Loans, L_2	-2,433,920.0 (-0.1862)	1,765,770.0 (0.7880)	4,003,140.0 (0.5985)	0.0350 (0.2411)	0.0047 (0.0873)
Other Loans, L_3	7,618,010.0 (0.0956)	-3,633,590.0 (-0.3543)	-14,820,100.0 (-0.2712)	0.7007 (3.0576)	-0.0316 (-0.0107)

Table 10.--Structural Coefficients Bank 10

	r_1	r_2	r_3	L	ZL
Business Loans, L_1	-753,986.0 (-1.1016)	82,373.0 (0.5316)	680,210.0 (0.9310)	0.5620 (5.5765)	0.0017 (0.0682)
Mortgage Loans, L_2	153,523.0 (0.1356)	256,723.0 (0.9900)	-546,436.0 (-4.1681)	0.2419 (2.8983)	0.0033 (0.1370)
Other Loans, L_3	593,336.0 (0.3035)	-353,488.0 (-0.7737)	-107,424.0 (-0.0502)	0.6488 (3.5809)	-0.0055 (-0.1950)

Table 11.--Adjustment Coefficients Bank 1

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.2670 (7.3930)	0.0180 (0.864)	0.0257 (1.424)
Mortgage Loans, L_2	0.0082 (0.362)	0.0142 (0.928)	0.0044 (0.303)
Other Loans, L_3	0.7426 (16.724)	0.9660 (34.061)	0.9694 (37.170)

Table 12.--Adjustment Coefficients Bank 2

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.2539 (9.233)	-0.5183 (-3.084)	0.0973 (4.783)
Mortgage Loans, L_2	-0.0086 (-1.887)	0.0416 (1.970)	-0.0067 (-1.572)
Other Loans, L_3	0.7755 (28.448)	1.3510 (8.728)	0.9052 (41.221)

Table 13.--Adjustment Coefficients Bank 3

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.0555 (2.618)	-0.0324 (-1.592)	0.0576 (3.982)
Mortgage Loans, L_2	0.0999 (2.258)	0.9447 (32.089)	0.0498 (2.290)
Other Loans, L_3	0.8712 (16.366)	-0.0483 (-1.222)	0.9276 (32.410)

Table 14.--Adjustment Coefficients Bank 4

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.1956 (7.405)	0.1850 (3.853)	0.0227 (1.264)
Mortgage Loans, L_2	0.0335 (2.409)	0.0608 (2.345)	-0.0006 (-0.073)
Other Loans, L_3	0.4346 (8.376)	0.4914 (5.188)	1.0469 (58.357)

Table 15.--Adjustment Coefficients Bank 5

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.2465 (9.227)	0.1348 (2.864)	0.1403 (6.129)
Mortgage Loans, L_2	0.0232 (1.658)	0.0478 (1.785)	-0.0076 (0.740)
Other Loans, L_3	0.5054 (10.904)	0.7979 (7.757)	0.9256 (39.404)

Table 16.--Adjustment Coefficients Bank 6

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.1501 (4.130)	-0.0802 (-1.510)	-0.2051 (-11.189)
Mortgage Loans, L_2	-0.0069 (-0.586)	0.04128 (2.430)	-0.0039 (-0.626)
Other Loans, L_3	0.8717 (22.747)	1.0301 (18.411)	1.0261 (4.919)

Table 17.--Adjustment Coefficients Bank 7

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	-0.4526 (10.824)	-0.0473 (-0.840)	0.0442 (4.058)
Mortgage Loans, L_2	0.0119 (0.907)	0.0180 (1.143)	-0.0005 (0.113)
Other Loans, L_3	0.5713 (14.030)	1.0164 (18.491)	0.9489 (89.182)

Table 18.--Adjustment Coefficients Bank 8

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.2835 (10.174)	0.6064 (5.261)	0.0861 (3.676)
Mortgage Loans, L_2	0.0161 (3.318)	0.0631 (3.083)	0.0005 (0.120)
Other Loans, L_3	0.0035 (0.125)	0.3562 (3.139)	0.9053 (39.123)

Table 19.--Adjustment Coefficients Bank 9

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.1833 (5.122)	-0.1158 (-1.391)	0.1193 (3.903)
Mortgage Loans, L_2	0.0022 (0.226)	0.0320 (1.676)	0.0057 (0.663)
Other Loans, L_3	0.8054 (21.088)	1.1067 (12.324)	0.8733 (27.038)

Table 20.--Adjustment Coefficients Bank 10

	L_1 (t-1)	L_2 (t-1)	L_3 (t-1)
Business Loans, L_1	0.3876 (8.012)	0.1030 (2.574)	0.1778 (5.060)
Mortgage Loans, L_2	0.0580 (1.330)	0.4082 (11.614)	0.2327 (8.230)
Other Loans, L_3	0.4858 (7.789)	0.5266 (10.237)	0.5724 (12.731)

Of the ninety interest rate coefficients, only twelve are significant at the five percent level. Of these, eleven have the expected sign. The coefficient of the other interest rate in the mortgage loan equation for bank eight has a significant wrong sign.

Of the thirty own-adjustment coefficients, twenty-six are significant at the five percent level. Of the sixty cross-adjustment coefficients, thirty-six are significant at the five percent level.

Implications of the above results are considered in Chapter 5 of this dissertation. The stability of the model is analyzed in the following section of this chapter.

4.5 Stability

We wish to determine whether the model is inherently stable or unstable. The analysis which follows reduces the system to a single "fundamental dynamic equation," which expresses one current endogenous variable in terms of its own lagged values and of values of exogenous variables, current and lagged. Corresponding to this fundamental dynamic equation is the "characteristic equation," whose roots define the dynamic properties of the system. If the absolute value of the largest root is less than unity, the system is inherently stable. Otherwise the system is inherently unstable.

Consider the estimated system written in matrix notations.

$$\vec{L}_t = \hat{C}X_t + \hat{\Gamma}\vec{L}_{t-1} + e_t$$

or

$$\vec{L}_t - \vec{L}_{t-1} = \hat{C}X_t + e_t$$

where e_t is a 3X1 vector of residuals and the other symbols are previously defined. The system can be written[15]

$$\phi\vec{L}_t = \hat{C}X_t + e_t$$

where

$$\phi = I_3 - \hat{\Gamma}E$$

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[15]A. S. Goldberger, Impact Multipliers and Dynamic Properties of the Klein - Goldberger Model, Amsterdam: North-Holland, 1970, pp. 106-109.

where E is the lag operator defined by

$$E^{i}x_t = x_{t-i} \quad \text{for any variable x.}$$

Then

$$\vec{L}_t = \phi^{-1}\hat{C}X_t + \phi^{-1}e_t$$

or $|\phi|\ \vec{L}_t = (\text{Adj } \phi)\ \hat{C}X_t + (\text{Adj } \phi)\ e_t$

where (Adj ϕ) is the adjoint of ϕ and $|\phi|$ is the determinant of ϕ.

$$|\phi| = 1 + b_1E + b_2E + b_3E^3$$

where

$$b_1 = (\hat{\gamma}_{11} + \hat{\gamma}_{22} + \hat{\gamma}_{33})$$
$$b_2 = (\hat{\gamma}_{11}\hat{\gamma}_{22} + \hat{\gamma}_{11}\hat{\gamma}_{33} + \hat{\gamma}_{22}\hat{\gamma}_{33} - \hat{\gamma}_{31}\hat{\gamma}_{13} - \hat{\gamma}_{33}\hat{\gamma}_{23} - \hat{\gamma}_{21}\hat{\gamma}_{12})$$
$$b_3 = (\hat{\gamma}_{31}\hat{\gamma}_{13}\hat{\gamma}_{22} + \hat{\gamma}_{32}\hat{\gamma}_{23}\hat{\gamma}_{11} + \hat{\gamma}_{21}\hat{\gamma}_{12}\hat{\gamma}_{32} - \hat{\gamma}_{12}\hat{\gamma}_{23}\hat{\gamma}_{31} - \hat{\gamma}_{13}\hat{\gamma}_{32}\hat{\gamma}_{21} - \hat{\gamma}_{11}\hat{\gamma}_{22}\hat{\gamma}_{33})$$

The homogeneous characteristic equation corresponding to the fundamental dynamic equation is

$$L_{1t} + b_1L_{1t-1} + b_2L_{1t-2} + b_3L_{1t-3} = 0$$

the basic soluation is

$$\lambda^3 + b_1\lambda^2 + b_3\lambda + b \ \ = 0$$

The roots of the above equation for each bank are presented in Table 21.

Table 21.--Characteristic Equation Roots

Bank 1	$\lambda_1 = -0.0001$	$\lambda_2 = 0.7594$	$\lambda_3 = 0.9901$
Bank 2	$\lambda_1 = 0.0002$	$\lambda_2 = 0.83676$	$\lambda_3 = 0.9614$
Bank 3	$\lambda_1 = 0.0376 -0.0616i$	$\lambda_2 = 0.0376 +0.0616i$	$\lambda_3 = 0.9971$
Bank 4	$\lambda_1 = -0.0585$	$\lambda_2 = 0.7799$	$\lambda_3 = 0.9754$
Bank 5	$\lambda_1 = -0.0148$	$\lambda_2 = 0.8480$	$\lambda_3 = 0.9470$
Bank 6	$\lambda_1 = 0.3020$	$\lambda_2 = 0.5276$	$\lambda_3 = 0.9530$
Bank 7	$\lambda_1 = 0.0042$	$\lambda_2 = 0.5978$	$\lambda_3 = 0.9786$
Bank 8	$\lambda_1 = 0.0930$	$\lambda_2 = 0.6821$	$\lambda_3 = 0.9730$
Bank 9	$\lambda_1 = 0.0025$	$\lambda_2 = 0.9198$	$\lambda_3 = 0.9891$
Bank 10	$\lambda_1 = 0.0144$	$\lambda_2 = 0.6870$	$\lambda_3 = 0.9304$

In all cases the largest root is less than one in absolute value. In the case of bank three, the modulus of the complex roots is less than unity. However, in all cases the largest root is very close to unity. Also, since these roots are calculated from the estimated coefficients of the model, they are themselves subject to sampling error. Therefore, while the model is technically stable, it is on the borderline of instability. This implies that the system once displaced from equilibrium, will be slow in returning to equilibrium.

CHAPTER 5

CONCLUSIONS

5.1 Results

The most interesting and important result is that no significant asymmetric response is evident. Considering the three demands for loan equations for each of the ten banks, we find that in only one case is the asymmetric response coefficient significantly different from zero.[1] Therefore, we cannot reject the null hypothesis that banks do not restrict mortgage loans more severely during tight periods than during non-tight periods.

This does not imply that banks adjust business loans and mortgage loans equally or proportionally with respect to the total loan portfolio. It does imply that if banks discriminate "unfairly" against mortgage loans when credit is being restricted, then they also discriminate "unfairly" in favor of mortgage loans when credit is being expanded. The usual claim or the "conventional wisdom" is that banks discriminate "unfairly" against mortgage loans only during tight money periods.

The implications of the above findings are discussed in a later section of this chapter.

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[1]Specifically, bank number six exhibits a significant asymmetric response in mortgage loans. However, the coefficient is negative, indicating that during tight periods, when the total loan portfolio is decreasing, the level of mortgage loans is not only maintained but increased.

One of the most striking results is the generally disappointing performance of the interest rate variables. Of the ninety interest rate coefficients, only twelve are significant at the five per cent level. Of these twelve, eleven have the expected sign. For bank eight, the coefficient of the "other interest rate" in the mortgage loan equation has a significant wrong sign.

The explanation of this poor showing may be attributed to the poor quality of the data or to high multicollinearity among the interest rates.

The R-squared deletes for all interest rates were very near the values of the total R-squared as would be expected in the case of high multicollinearity. This would tend to indicate that high multicollinearity exists.

The simple correlation matrix of interest rates is presented in Table 22.

Table 22.--Interest Rate Correlation

	r_1	r_2	r_3
r_1	1.0000		
r_2	0.6553	1.0000	
r_3	0.9874	0.5904	1.0000

The correlation between r_3 and r_1 is particularily high. The correlation between r_3 and r_2, and between r_2 and r_1 are not extremely high.

The simple correlations and R-squared deletes tend to support the high multicollinearity explanations for the poor showing of the interest rate variables. However, OLS regressions run with a single interest rate variable yielded equally poor results. This would tend to point to the poor quality of the data as a reason for the poor results.

As indicated in the previous chapter, all three interest rates are proxies for the "true" rates. Interest rates on business loans are not available, and the rate on commercial paper was used as a proxy. The mortgage rate is only available as a monthly series, and it was necessary to construct a weekly series. The rate on "other" loans is also a proxy. The fact that none of the interest rates used are the rates we would like to have may have contributed to the poor interest rate results.

Another striking result of considerable interest is the generally good showing of the adjustment and cross-adjustment coefficients. Of the thirty own-adjustment coefficients, twenty-six are significant at the five per cent level. Of the sixty cross-adjustment coefficients, thirty-six are significant at the five per cent level.

While the own-adjustment coefficients explain a large part of the variation in all loan categories, the cross adjustment terms are important in many cases. This finding is not directly relevant for the main hypothesis of this thesis, but is interesting and important for model specification. The findings lend empirical support to the theoretical case made for the inclusion of the lagged values of all endogenous variables in each equation.

Another result which has implications for model specification should be noted. The usual assumption, implicit or explicit, in macro or aggregate studies is that individual economic units are in some sense homogeneous and can be aggregated into a class of economic units or a sector, eg., the banking sector, the household sector, the government sector or the business sector. This homogeneity may go beyond the assumption of similar objective functions and constraints, and specify that the actual behavioral parameters are equal for all economic units within a particular class. Under this assumption one would expect a properly specified, disaggregated micro study to find similar behavior for each individual economic unit.

The present results do not appear to exhibit the expected similarity of behavior across banks. The behavioral coefficients as well as the adjustment coefficients vary considerably from bank to bank. For example, the coefficient of mortgage loans with respect to total loans ranges from 0.0350 for bank nine to 0.6717 for bank one. The own adjustment coefficient for mortgage loans ranges from 0.0142 for bank one to 0.9447 for bank three. The lack of statistically significant response to interest rates precludes any meaningful comparison of interest rate coefficients across banks. However, the differences in the other structural coefficients and in the adjustment coefficients do suggest different behavior and speeds of adjustment across banks.

If the observed differences are caused by some systematic relationship, that relationship should be included in the model. For example, it may be hypothesized that large banks behave differently from small banks. In fact, the scale of bank as measured by the total loan portfolio is included in the model, and, if the size of the loan portfolio is a good proxy for the size of the bank, this should account for different behavior due to different bank size. Because of the nature of the data it is impossible to incorporate other factors that might explain different behavior among the banks. The bank data are confidential balance sheet data. We do not even know the names of the commercial banks. If one knew the names, geographic locations, and histories of the individual banks, it might be possible to explain some of the diversity of behavior among them. In the absense of such information, we can merely conclude that there appears to be a difference in behavior across banks and suggest that a study of such differences is a possible area for future research.

5.2 Interpretation and Implications

The results of the analysis and empirical work in this thesis give no support to the contention that restrictive credit discriminates "unfairly" against mortgage loans. How does one reconcile this result with the "conventional wisdom" and the findings of other studies that found a discriminatory effect? First of all, many previous discussions have used "the interest rate" as an indicator of tight money.[2] Since interest expense is such a large part of the cost of

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[2]See Chapter 2 of this dissertation.

housing, one would expect the demand for mortgage funds to be highly elastic. Thus, the quantity of mortgage funds demanded would fluctuate strongly with changes in the rate of interest. This contention is not inconsistent with the above results.

However, during the period covered by this study, specifically in 1966, the level of mortgage credit declined sharply.[3] This is not inconsistent with the findings of no significant asymmetric response. It only serves to point out that it may well be that the mortgage market comes into the limelight only when credit is being restricted, and not when it is being expanded. Our analysis indicates that banks tend to adjust mortgage credit by the same magnitude whether total credit is increasing or decreasing. Whether or not banks adjust mortgage and business credit identically or proportionately is another hypothesis. If banks adjust mortgage loans more severly than business loans, whether total credit is increasing or decreasing, this will contribute to greater fluctuations in mortgage loans than in business loans. Prolonged tight money policy will have a prolonged dampening effect on mortgage lending and tend to encourage allocation of resources away from housing. The results of this study indicate that some banks appear to adjust mortgage loans more severely than business loans, and others adjust mortgage loans less severely than business loans. No clearcut patterns of response are evident.

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[3]Norman N. Bowsher and Lionel Kalish, "Does Slower Monetary Expansion Discriminate Against Housing?" Federal Reserve Bank of St. Louis - Review, Vol. 50 (June 1968), pp. 5-12.

The definition of tight money used in this study is quite a restrictive one in the sense that a necessary condition for a tight money situation is an actual contraction of loans. An alternative necessary condition is a decrease in the rate of expansion of loans. Since we found no discriminatory effect using the more restrictive definition, we may suspect that we would find no discriminatory effect using a less contractionary definition of tight money. While this does not necessarily follow, preliminary ordinary least squares reduced form regressions did support this contention. The more contractionary definition of tight money was used in the final specification and estimation of the model.

5.3 Limitations and Suggestions for Further Research

The conclusions of this study depend upon the theoretical model used. Specifically, the results are contingent upon two basic assumptions of the model: 1) that the banks make decisions according to the specified stepwise procedure, and 2) that the supplies of assets to the bank are perfectly elastic at the given rate of interest. Future research should extend the model to consider the relaxation of these assumptions.[4]

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[4]A recent study does explore the theoretical implications of imperfect elasticities of supply of various assets that banks hold. See Michael A. Klein,"Imperfect Asset Elasticity and Portfolio Theory," Federal Deposit Insurance Corporation Working Paper No. 69-6. No attempt is made to estimate the model.

The data used in this study covered only one "credit crunch" period for only ten commercial banks. It would be desirable to have data on more commercial banks and to have data over a longer period of time. It is of course possible that the conclusions reached are due to special circumstances of the time period and the banks involved. If in the future more data become available, additional research should replicate this study using data for more banks and different time periods.

Another limitation is that only the portfolio response of commercial banks is considered. Commercial banks have traditionally accounted for only thirty per cent of mortgage lending, although they have accounted for over seventy per cent of the variation in mortgage lending.[5]

The flow of funds to the mortgage market can be impeded at two stages. The flow can be stopped or slowed before it reaches financial institutions, or it can be slowed by the portfolio decisions of the financial institutions. The first case is caused by a channelling of savings away from savings and loan associations and mutual banks which traditionally make mortgage loans. Since the portfolios of these thrift institutions are largely limited to mortgage lending, the second effect is not nearly as important for them as it is for commercial banks. That is, the first obstacle applies mainly to non-commercial bank financial institutions, while the portfolio effect applies mainly to commercial banks.

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[5]Sherman Maisel, Financing Real Estate: Principles and Practices, New York: McGraw-Hill, 1965, p. 82.

In this dissertation we have considered only the portfolio policies of commercial banks. A more complete study of housing and mortgage markets should include an analysis of the flow of savings to thrift institutions. It is likely that in this area a macro-economic approach would be needed. It would be necessary to include a consideration of direct and selective government intervention in financial markets through Regulation Q, the Federal Home Loan Bank Board and the Federal National Mortgage Association (Fanny May), and government intervention in the housing market through direct government construction and housing subsidy programs.

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APPENDICES

APPENDIX A

PARTIAL DERIVATIVES

Writing $\hat{\beta} = \hat{A}^{-1} \hat{C}$ in full, we have

$$\begin{bmatrix} \hat{\beta}_{11} & \cdots & \hat{\beta}_{15} \\ \hat{\beta}_{21} & \cdots & \hat{\beta}_{25} \\ \hat{\beta}_{31} & \cdots & \hat{\beta}_{35} \end{bmatrix} = |\hat{A}|^{-1} \begin{bmatrix} \hat{a}_{11} & \hat{a}_{12} & \hat{a}_{13} \\ \hat{a}_{21} & \hat{a}_{22} & \hat{a}_{23} \\ \hat{a}_{31} & \hat{a}_{32} & \hat{a}_{33} \end{bmatrix} \begin{bmatrix} \hat{C}_{11} & \cdots & \hat{C}_{15} \\ \hat{C}_{21} & & \hat{C}_{25} \\ \hat{C}_{31} & & \hat{C}_{35} \end{bmatrix}$$

or

$$\hat{\beta}_{1_j} = |\hat{A}|^{-1} \quad [\hat{a}_{11}\ \hat{C}_{1_j} + \hat{a}_{12}\ \hat{C}_{2_j} + \hat{a}_{13}\ \hat{C}_{3_j}]$$

$$\hat{\beta}_{2_j} = |\hat{A}|^{-1} \quad [\hat{a}_{21}\ \hat{C}_{1_j} + \hat{a}_{22}\ \hat{C}_{2_j} + \hat{a}_{23}\ \hat{C}_{3_j}]$$

$$\hat{\beta}_{3_j} = |\hat{A}|^{-1} \quad [\hat{a}_{31}\ \hat{C}_{1_j} + \hat{a}_{32}\ \hat{C}_{2_j} + \hat{a}_{33}\ \hat{C}_{3_j}]$$

Where

$$|\hat{A}| = (1-\hat{\gamma}_{11})\ (1-\hat{\gamma}_{22})\ (1-\hat{\gamma}_{33}) - \hat{\gamma}_{12}\ \hat{\gamma}_{23}\ \hat{\gamma}_{31} - \hat{\gamma}_{13}\ \hat{\gamma}_{32}\ \hat{\gamma}_{21} - \hat{\gamma}_{31}\ \hat{\gamma}_{13}$$
$$(1-\hat{\gamma}_{22}) - \hat{\gamma}_{32}\ \hat{\gamma}_{23}\ (1-\hat{\gamma}_{11}) - \hat{\gamma}_{12}\ \hat{\gamma}_{21}\ (1-\hat{\gamma}_{33})$$

And

$$\hat{a}_{11} = (1-\hat{\gamma}_{22})\ (1-\hat{\gamma}_{33}) - \hat{\gamma}_{32}\ \hat{\gamma}_{23}$$

$$\hat{a}_{12} = \hat{\gamma}_{13}\ \hat{\gamma}_{32} + \hat{\gamma}_{12}\ (1-\hat{\gamma}_{33})$$

$\hat{a}_{13} = \hat{\gamma}_{13}\ (1-\hat{\gamma}_{22}) + \hat{\gamma}_{13}\ \hat{\gamma}_{23}$

$\hat{a}_{21} = \hat{\gamma}_{31}\ \hat{\gamma}_{23} + \hat{\gamma}_{21}\ (1-\hat{\gamma}_{33})$

$\hat{a}_{22} = (1-\hat{\gamma}_{11})\ (1-\hat{\gamma}_{33})\ -\hat{\gamma}_{31}\ \hat{\gamma}_{13}$

$\hat{a}_{23} = \hat{\gamma}_{21}\ \hat{\gamma}_{13} + \hat{\gamma}_{23}\ (1-\hat{\gamma}_{11})$

$\hat{a}_{31} = \hat{\gamma}_{31}\ (1-\hat{\gamma}_{22}) + \hat{\gamma}_{21}\ \hat{\gamma}_{32}$

$\hat{a}_{32} = \hat{\gamma}_{31}\ \hat{\gamma}_{12} + \hat{\gamma}_{32}\ (1-\hat{\gamma}_{11})$

$\hat{a}_{33} = (1-\hat{\gamma}_{11})\ (1-\hat{\gamma}_{22} - \hat{\gamma}_{21}\ \hat{\gamma}_{12})$

Note: $\hat{a}_{ij}$ is the element of the ith row and jth column of the adjoint matrix of $\hat{A}$.

The partial derivatives of the β's with respect to the C's and γ's are as follows:

1) $$\frac{\partial\ \hat{\beta}_{ij}}{\partial\ C_{ij}} = a_{i1}\ |A|^{-1} \qquad i = 1, 2, 3 \quad j = 1, \ldots, 5$$

2) $$\frac{\partial\ \hat{\beta}_{ij}}{\partial\ C_{2j}} = a_{i3}\ |\hat{A}|^{-1}$$

3) $$\frac{\partial\ \hat{\beta}_{ij}}{\partial\ C_{3j}} = a_{i3}\ |\hat{A}|^{-1}$$

4) $$\frac{\partial\ \hat{\beta}_{1j}}{\partial\ \gamma_{11}} = [\hat{C}_{ij}\ \hat{a}_{11}\hat{a}_{11} + \hat{C}_{2j}\ \hat{a}_{11}\ \hat{a}_{12} + \hat{C}_{3j}\ \hat{a}_{11}\ \hat{a}_{13}]\ |\hat{A}|^{-2}$$

5) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{12}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{21} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{21} + \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{21}]\ |\hat{A}|^{-2}$$

$$+ \hat{C}_{2j}\ (1-\hat{\gamma}_{33})\ |\hat{A}|^{-1} + \hat{C}_{3j}\ \hat{\gamma}_{23}\ |\hat{A}|^{-1}$$

6) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{13}} = [C_{1j}\ a_{11}\ a_{31} + C_{2j}\ a_{12}\ a_{31} + C_{3j}\ a_{13}]\ \ |A|^{-2}$$

$$+ \hat{C}_{2j}\ \hat{\gamma}_{32}\ |\hat{A}|^{-1} + \hat{C}_{3j}\ (1-\hat{\gamma}_{22})\ |\hat{A}|^{-1}$$

7) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{21}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{12} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{12} + \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{12}]\ |A|^{-2}$$

8) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{22}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{22} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{22} + \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{22}]\ |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ (\hat{\gamma}_{33}-1) - \hat{C}_{3j}\ \hat{\gamma}_{13}]\ \ |\hat{A}|^{-1}$$

9) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{23}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{32} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{32}\ \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{32}]\ \ |A|^{-1}$$

$$+ [\hat{C}_{3j}\ \hat{\gamma}_{12} - \hat{C}_{1j}\ \hat{\gamma}_{32}]\ |\hat{A}|^{-1}$$

10) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{31}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{13} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{13}\ \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{13}]\ \ |A|^{-2}$$

11) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{31}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{23} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{23} + \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{23}] \quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{2j}\ \hat{\gamma}_{13} - \hat{C}_{1j}\ \hat{\gamma}_{23}] \quad |\hat{A}|^{-1}$$

12) $$\frac{\partial \hat{\beta}_{1j}}{\partial \hat{\gamma}_{33}} = [\hat{C}_{1j}\ \hat{a}_{11}\ \hat{a}_{33} + \hat{C}_{2j}\ \hat{a}_{12}\ \hat{a}_{33} + \hat{C}_{3j}\ \hat{a}_{13}\ \hat{a}_{33}] \quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ (\hat{\gamma}_{22-1}) - \hat{C}_{2j}\ \hat{\gamma}_{12}] \quad |\hat{A}|^{-1}$$

13) $$\frac{\partial \hat{\beta}_{2j}}{\partial \gamma_{11}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{11} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{11} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{11}] \quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{2j}\ (\hat{\gamma}_{33}\ -1) - \hat{C}_{3j}\ \hat{\gamma}_{23}] \quad |\hat{A}|^{-1}$$

14) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{12}} = [\hat{C}_{1j}\ \hat{a}_{21}\hat{a}_{21} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{21} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{21}] \quad |\hat{A}|^{-2}$$

15) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{13}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{31} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{31}\ \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{31}] \quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{3j}\ \hat{\gamma}_{21} - \hat{C}_{2j}\ \hat{\gamma}_{31}] \quad |\hat{A}|^{-1}$$

16) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{21}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{12} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{12} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{12}] \quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ (1-\hat{\gamma}_{33}) + \hat{C}_{3j}\ \hat{\gamma}_{13}] \quad |A|^{-1}$$

17) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{22}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{22} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{22} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{22}] \quad |\hat{A}|^{-2}$$

18) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{23}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{32} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{32} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{A}_{32}]\ |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ \hat{\gamma}_{31} + \hat{C}_{3j}\ (1-\hat{\gamma}_{11})]\ |\hat{A}|^{-1}$$

19) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{31}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{13} + \hat{C}_{3j}\ \hat{a}_{22}\ \hat{a}_{13} + \hat{C}_{3j}\ \hat{a}_{22}\ \hat{a}_{13}]\ |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ \hat{\gamma}_{23} - \hat{C}_{2j}\ \hat{\gamma}_{13}]\ |\hat{A}|^{-1}$$

20) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\gamma}_{32}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{23} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{23} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{23}]\ |\hat{A}|^{-2}$$

21) $$\frac{\partial \hat{\beta}_{2j}}{\partial \hat{\beta}_{33}} = [\hat{C}_{1j}\ \hat{a}_{21}\ \hat{a}_{33} + \hat{C}_{2j}\ \hat{a}_{22}\ \hat{a}_{33} + \hat{C}_{3j}\ \hat{a}_{23}\ \hat{a}_{33}]\ |\hat{A}|^{-2}$$

$$+ [\hat{C}_{2j}\ (\hat{\gamma}_{11-1}) - \hat{C}_{1j}\ \hat{\gamma}_{21}]\ |\hat{A}|^{-1}$$

22) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{11}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{11} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{11} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{11}]\ |\hat{A}|^{-2}$$

+

$$+ [\hat{C}_{3j}\ (\hat{\gamma}_{22} - 1) - \hat{C}_{2j}\ \hat{\gamma}_{32}]\ |\hat{A}|^{-1}$$

23) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{12}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{21} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{21} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{21}]\ |\hat{A}|^{-2}$$

$$+ [\hat{C}_{2j}\ \hat{\gamma}_{31} - \hat{C}_{3j}\ \hat{\gamma}_{21}]\ |\hat{A}|^{-1}$$

24) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{13}} = [\hat{C}_{2j}\ \hat{a}_{31}\ \hat{a}_{31} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{31} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{31}]$$

25) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{21}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{12} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{12} + \hat{C}_{2j}\ \hat{a}_{33}\ \hat{a}_{12}]\quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ \hat{\gamma}_{32} - \hat{C}_{3j}\ \hat{\gamma}_{12}]\quad |\hat{A}|^{-1}$$

26) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{22}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{22} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{22} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{22}]\quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{3j}\ (\hat{\gamma}_{11} -1) - \hat{C}_{1j}\ \hat{\gamma}_{31}]\quad |\hat{A}|^{-2}$$

27) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{23}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{32} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{32} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{32}]\quad |\hat{A}|^{-2}$$

28) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{31}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{31} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{13} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{13}]\quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ (1-\hat{\gamma}_{22}) + \hat{C}_{2j}\ \hat{\gamma}_{12}]\quad |\hat{A}|^{-1}$$

29) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{32}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{23} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{23} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{23}]\quad |\hat{A}|^{-2}$$

$$+ [\hat{C}_{1j}\ \hat{\gamma}_{21} + \hat{C}_{2j}\ (1-\hat{\gamma}_{11})]\quad |\hat{A}|^{-2}$$

30) $$\frac{\partial \hat{\beta}_{3j}}{\partial \hat{\gamma}_{33}} = [\hat{C}_{1j}\ \hat{a}_{31}\ \hat{a}_{33} + \hat{C}_{2j}\ \hat{a}_{32}\ \hat{a}_{33} + \hat{C}_{3j}\ \hat{a}_{33}\ \hat{a}_{33}]\quad |\hat{A}|^{-2}$$

APPENDIX B

VALUES OF $\hat{\rho}$

The values of $\hat{\rho}$ used to perform the Orcutt transformation are presented in Table 23.

Table 23.--Values of $\hat{\rho}$

	$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{\rho}_3$
Bank 1	0.00	-0.20	-0.16
Bank 2	0.00	-0.27	0.00
Bank 3	0.00	-0.18	0.00
Bank 4	-0.21	0.26	0.55
Bank 5	0.00	-0.13	-0.16
Bank 6	0.00	-0.39	-0.13
Bank 7	0.00	0.14	0.00
Bank 8	0.00	0.00	0.14
Bank 9	-0.29	-0.17	-0.21
Bank 10	0.00	0.25	0.00

APPENDIX C

REDUCED FORM ESTIMATES

The Zellner-Aitken reduced form estimates for each of the ten banks are presented in Tables 24 through 33. The numbers in parentheses below each coefficient are the "τ-statistics" corresponding to that coefficient.

Table 24.--Bank 1 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	17267.9287 (0.4377)	-9334.4387 (-0.9499)	-1837.1753 (-0.0429)	0.0375 (2.1091)	0.0022 (0.3432)	0.7330 (20.2907)	-0.0180 (-0.8630)	-0.0257 (-1.4247)	0.9189
Mortgage Loans, L_2	3318.5388 (0.1246)	-7007.4940 (-1.2493)	-4174.9466 (-0.1435)	0.0004 (1.1826)	0.0004 (0.7894)	-0.0082 (-0.3623)	0.9858 (64.6084)	-0.0044 (-0.3029)	0.9973
Other Loans, L_3	-20109.5836 (-0.3965)	15802.6207 (1.3854)	5967.8939 (0.1079)	0.9458 (36.8298)	-0.0006 (-0.6354)	-0.7426 (-16.7234)	-0.9660 (-34.0596)	0.0306 (1.1735)	0.9978

Table 25.--Bank 2 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	412908.6683 (0.2081)	738641.1449 (1.5510)	-1502679.7171 (-0.7194)	0.1299 (6.0281)	0.0029 (2.2304)	0.7461 (27.1291)	0.5183 (3.0837)	-0.0973 (-4.0831)	0.9893
Mortgage Loans, L_2	-559597.2719 (-1.8650)	58696.2304 (1.0317)	622229.8439 (1.9396)	-0.0050 (-1.2895)	0.0002 (0.5704)	0.0086 (1.8854)	0.9584 (45.3667)	0.0067 (1.5704)	0.9935
Other Loans, L_3	610247.5705 (0.3188)	-699596.7525 (-1.6197)	174839.0956 (0.0864)	0.8748 (39.1056)	-0.0029 (-2.0750)	-0.7750 (-28.4225)	-1.3510 (-8.7283)	0.0948 (4.3163)	0.9591

Table 26.--Bank 3 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-465761.1143 (-1.7954)	17633.5067 (0.2518)	504442.1046 (1.7877)	0.0283 (2.5198)	-0.0025 (-2.2014)	0.9445 (44.5264)	0.0324 (1.5927)	-0.0575 (-3.9758)	0.9298
Mortgage Loans, L_2	2802.0698 (0.0067)	405214.7605 (2.4955)	42939.5482 (0.0955)	0.2456 (8.7999)	0.0015 (0.9141)	-0.1000 (-2.2582)	0.0553 (1.8777)	-0.0498 (-2.2907)	0.6776
Other Loans, L_3	449372.9993 (0.8187)	-493387.7379 (-2.5433)	-538564.8086 (-0.9111)	0.7225 (24.5212)	0.009 (0.4016)	-0.8717 (-16.3761)	0.0483 (1.2224)	0.07242 (2.5305)	0.9137

Table 27.--Bank 4 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-268824.2163	254505.7718 (3.9053)	331383.6632 (1.4022)	0.0672 (3.2252)	-0.0033 (-2.7012)	0.8044 (30.4566)	-0.1850 (-3.8524)	-0.0227 (-1.2640)	0.9732
Mortgage Loans, L_2	-9342.4212	38765.5119 (0.9993)	-20960.1659 (-0.1473)	0.0227 (3.0195)	-0.0001 (-0.1125)	-0.0335 (-2.4077)	0.9392 (36.2568)	0.0006 (0.0722)	0.8872
Other Loans, L_3	750201.4857	-1058575.6635 (-6.3364)	-840417.7484 (-2.4030)	0.9129 (-10.1847)	0.0034 (2.9934)	-0.4346 (-8.3766)	-0.4914 (-5.1881)	-0.0469 (-2.6164)	0.9312

Table 28.--Bank 5 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-529380.7777 (-0.4822)	1069404.2794 (2.5022)	881892.6633 (0.7520)	0.1414 (5.6278)	0.0028 (1.8709)	0.7535 (28.2079)	-0.1348 (-2.8642)	-0.1403 (-6.1293)	0.9852
Mortgage Loans, L_2	-719535.5991 (-1.1376)	-21922.7793 (-0.0808)	1297565.2132 (1.7432)	0.0036 (0.3659)	-0.0006 (-0.8016)	-0.0232 (-1.6577)	0.9522 (35.5853)	0.0075 (0.7389)	0.9655
Other Loans, L_3	-801532.0158 (-0.4423)	-3268898.8163 (-3.2513)	-621123.1335 (-0.3352)	0.8709 (31.7597)	-0.0012 (-0.8137)	-0.5054 (-10.9048)	-0.7979 (-7.7573)	0.0744 (3.1663)	0.8798

Table 29.--Bank 6 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-67790.5476 (-1.2793)	-34551.1790 (-1.6919)	81716.1366 (1.4643)	0.0138 (0.7350)	-0.0014 (-1.3759)	0.8499 (23.3860)	0.0802 (1.5099)	0.0205 (1.1191)	0.8971
Mortgage Loans, L_2	-2864.5170 (-0.1759)	7682.7005 (1.2270)	952.7256 (0.0556)	0.0046 (0.6672)	-0.0004 (-1.2642)	0.0069 (0.5860)	0.9587 (56.4386)	0.0039 (0.6266)	0.9863
Other Loans, L_3	77943.8747 (1.3709)	21696.2370 (1.0184)	-89119.0822 (-1.4886)	0.9854 (47.3971)	0.0019 (1.7134)	-0.8716 (-22.7454)	-1.030 (-18.4121)	-0.0261 (-1.2514)	0.9827

Table 30.--Bank 7 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-44628.4466 (-0.7545)	27125.8672 (1.7973)	46327.5209 (0.7516)	0.0955 (7.0250)	0.0009 (0.5150)	0.5475 (13.0948)	0.0473 (0.8404)	0.0441 (-4.0566)	0.8487
Mortgage Loans, L_2	23757.5184 (1.1902)	-1900.4799 (-0.4633)	-31746.6000 (-1.5182)	0.0129 (3.3451)	0.0004 (0.6223)	-0.0119 (-0.9066)	0.9820 (62.3578)	0.0004 (0.1129)	0.9881
Other Loans, L_3	19244.5424 (0.3393)	-24123.4371 (-1.6433)	-12484.0500 (-0.2112)	0.8919 (63.3060)	-0.0014 (-0.8177)	-0.5713 (-14.0298)	-1.0164 (-18.4911)	0.0511 (4.8007)	0.9782

Table 31.--Bank 8 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	3014522.6821 (1.3529)	-734283.9817 (-1.2496)	-969207.2426 (-0.3836)	0.2208 (9.5570)	0.0007 (0.6066)	0.7165 (25.7233)	-0.6064 (-5.2613)	-0.0861 (-3.6753)	0.9902
Mortgage Loans, L_2	-819170.0574 (-1.9456)	-88804.6447 (-0.8662)	1061635.3587 (2.2118)	0.0130 (3.2934)	0.0001 (0.4640)	-0.0161 (-3.3203)	0.9369 (45.7586)	-0.0005 (-0.1205)	0.9715
Other Loans, L_3	-19995066.9578 (-0.9226)	800974.8269 (1.3817)	-139971.8788 (-0.0564)	0.7652 (32.7606)	-0.0008 (-0.7080)	-0.7036 (-25.2313)	-0.3561 (-3.1389)	0.0947 (4.0914)	0.9230

Table 32.--Bank 9 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	237822.9651 (0.7985)	-295982.4809 (-2.1627)	-245243.5580 (-0.7826)	0.1088 (3.6183)	0.0006 (0.6930)	0.8167 (22.8270)	0.1158 (1.3910)	-0.1193 (-3.9024)	0.9934
Mortgage Loans, L_2	-46015.8626 (-0.6313)	40002.0110 (1.3089)	67636.0059 (0.8828)	0.0067 (0.8133)	0.0000 (0.1422)	-0.0021 (-0.2256)	0.9680 (50.6214)	-0.0057 (-0.6632)	0.9983
Other Loans, L_3	-226678.5183 (-0.7028)	283102.4505 (1.9040)	214149.3652 (0.6310)	0.8841 (27.8870)	-0.0007 (-0.7796)	-0.8054 (-21.0862)	-1.1067 (-12.3245)	0.1267 (3.9222)	0.9800

Table 33.--Bank 10 Reduced Form Estimates

	r_1	r_2	r_3	L	ZL	L_{1t-1}	L_{2t-1}	L_{3t-1}	R^2
Business Loans, L_1	-183195.7568 (-2.0973)	1641.1080 (0.0666)	192543.0528 (1.9448)	0.1841 (5.5033)	0.0002 (0.0790)	0.6124 (12.6564)	-0.1030 (-2.5709)	-0.1778 (-5.0600)	0.8420
Mortgage Loans, L_2	155238.5391 (2.0828)	28223.1250 (1.0087)	-208019.4963 (-2.5046)	0.2563 (9.5867)	0.0002 (0.1097)	-0.0580 (-1.3301)	0.5918 (16.8369)	-0.2327 (-8.2290)	0.9609
Other Loans, L_3	38896.9498 (0.3439)	-19469.4481 (-0.6184)	-13501.0892 (-0.1053)	0.5537 (12.9966)	-0.0004 (-0.1373)	-0.4857 (-7.7900)	-0.5266 (-10.2368)	0.4246 (9.4446)	0.9828

APPENDIX D

INTEREST RATE DATA

The mortgage interest rate and "other" interest rate index are presented in Table 34.

Table 34.--Interest Rate Data

Year:Week	Mortgage Rate	Other Rate
65:1	0.0637	0.0393
65:2	0.0638	0.0393
65:3	0.0638	0.0385
65:4	0.0639	0.0392
65:5	0.0639	0.0394
65:6	0.0640	0.0397
65:7	0.0640	0.0398
65:8	0.0635	0.0400
65:9	0.0630	0.0402
65:10	0.0625	0.0403
65:11	0.0621	0.0403
65:12	0.0622	0.0404
65:13	0.0623	0.0405
65:14	0.0624	0.0405
65:15	0.0625	0.0404
65:16	0.0626	0.0404
65:17	0.0627	0.0410
65:18	0.0628	0.0412
65:19	0.0630	0.0411
65:20	0.0629	0.0411
65:21	0.0628	0.0411
65:22	0.0627	0.0412

Table 34 (cont'd.)

Year:Week	Mortgage Rate	Other Rate
65:23	0.0626	0.0412
65:24	0.0625	0.0412
65:25	0.0627	0.0406
65:26	0.0629	0.0412
65:27	0.0631	0.0413
65:28	0.0632	0.0411
65:29	0.0631	0.0410
65:30	0.0630	0.0408
65:31	0.0628	0.0409
65:32	0.0627	0.0410
65:33	0.0626	0.0409
65:34	0.0627	0.0410
65:35	0.0628	0.0411
65:36	0.0630	0.0412
65:37	0.0631	0.0413
65:38	0.0631	0.0413
65:39	0.0630	0.0406
65:40	0.0629	0.0414
65:41	0.0628	0.0416
65:42	0.0629	0.0417
65:43	0.0630	0.0415
65:44	0.0632	0.0418
65:45	0.0633	0.0416
65:46	0.0634	0.0418
65:47	0.0634	0.0418
65:48	0.0635	0.0418
65:49	0.0635	0.0424
65:50	0.0636	0.0445
65:51	0.0635	0.0451
65:52	0.0634	0.0456
66:1	0.0633	0.0456
66:2	0.0632	0.0457
66:3	0.0633	0.0447
66:4	0.0634	0.0464
66:5	0.0636	0.0464
66:6	0.0638	0.0469
66:7	0.0640	0.0469
66:8	0.0642	0.0469
66:9	0.0644	0.0471
66:10	0.0645	0.0473
66:11	0.0646	0.0483
66:12	0.0649	0.0486

Table 34 (cont'd.)

Year:Week	Mortgage Rate	Other Rate
66:13	0.0652	0.0488
66:14	0.0654	0.0489
66:15	0.0656	0.0489
66:16	0.0656	0.0490
66:17	0.0657	0.0486
66:18	0.0658	0.0495
66:19	0.0659	0.0497
66:20	0.0659	0.0502
66:21	0.0661	0.0502
66:22	0.0662	0.0508
66:23	0.0663	0.0508
66:24	0.0664	0.0511
66:25	0.0668	0.0512
66:26	0.0672	0.0525
66:27	0.0676	0.0533
66:28	0.0679	0.0521
66:29	0.0683	0.0538
66:30	0.0688	0.0539
66:31	0.0692	0.0541
66:32	0.0696	0.0564
66:33	0.0701	0.0543
66:34	0.0702	0.0553
66:35	0.0703	0.0549
66:36	0.0704	0.0558
66:37	0.0705	0.0557
66:38	0.0707	0.0549
66:39	0.0709	0.0534
66:40	0.0711	0.0559
66:41	0.0712	0.0553
66:42	0.0715	0.0559
66:43	0.0719	0.0545
66:44	0.0722	0.0558
66:45	0.0725	0.0557
66:46	0.0729	0.0560
66:47	0.0730	0.0555
66:48	0.0732	0.0556
66:49	0.0733	0.0549
66:50	0.0735	0.0548
66:51	0.0740	0.0544
66:52	0.0746	0.0547
67:1	0.0752	0.0539
67:2	0.0757	0.0539

Table 34 (cont'd.)

Year:Week	Mortgage Rate	Other Rate
67:3	0.0763	0.0524
67:4	0.0760	0.0514
67:5	0.0756	0.0479
67:6	0.0753	0.0491
67:7	0.0750	0.0498
67:8	0.0749	0.0499
67:9	0.0748	0.0488
67:10	0.0747	0.0485
67:11	0.0746	0.0477
67:12	0.0743	0.0473
67:13	0.0740	0.0460
67:14	0.0738	0.0455
67:15	0.0736	0.0430
67:16	0.0733	0.0428
67:17	0.0731	0.0430
67:18	0.0728	0.0432
67:19	0.0726	0.0429
67:20	0.0724	0.0430
67:21	0.0724	0.0428
67:22	0.0723	0.0429
67:23	0.0722	0.0429
67:24	0.0722	0.0435
67:25	0.0722	0.0436
67:26	0.0722	0.0447
67:27	0.0723	0.0446
67:28	0.0723	0.0451
67:29	0.0722	0.0444
67:30	0.0721	0.0454
67:31	0.0719	0.0452
67:32	0.0718	0.0459
67:33	0.0717	0.0456
67:34	0.0717	0.0458
67:35	0.0718	0.0447
67:36	0.0719	0.0452
67:37	0.0720	0.0454
67:38	0.0720	0.0457
67:39	0.0719	0.0463
67:40	0.0718	0.0464
67:41	0.0717	0.0467
67:42	0.0716	0.0469
67:43	0.0714	0.0461
67:44	0.0712	0.0471

Table 34 (cont'd.)

Year:Week	Mortgage Rate	Other Rate
67:45	0.0710	0.0473
67:46	0.0709	0.0475
67:47	0.0713	0.0493
67:48	0.0717	0.0502
67:49	0.0721	0.0509
67:50	0.0725	0.0513
67:51	0.0725	0.0517
67:52	0.0725	0.0521

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