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AN ECONOMETRIC MODEL OF THE
FINANCIAL SECTOR OF THE U. S. ECONOMY.**

**The University of Michigan, Ph.D., 1969
Economics, general**

University Microfilms, Inc., Ann Arbor, Michigan

**AN ECONOMETRIC MODEL OF THE FINANCIAL
SECTOR OF THE U. S. ECONOMY**

by

Gregory Vern Jump

**A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1969**

Doctoral Committee:

**Professor Daniel B. Suits, Chairman
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ABSTRACT

AN ECONOMETRIC MODEL OF THE FINANCIAL SECTOR OF THE U. S. ECONOMY

by

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Financial variables have, for the most part, been excluded from large-scale econometric models of the U.S. economy. The University of Michigan Econometric Model is no exception. It has, up until now, not contained a sector representing financial markets. In this study an econometric model of the financial sector of the U.S. economy is developed. The financial model is designed to serve as the financial sector of the University of Michigan Model.

The equations of the financial model are developed on an annual basis and estimated using data from the post-war period. They describe the workings of three major markets within the financial system of the economy. The first of these is the residential mortgage market. A set of equations is developed which describe how the quantity of mortgage credit supplied by each of the four principal financial intermediaries--life insurance companies, savings and loan associations, mutual savings banks, and commercial banks--is altered by changes in their inflows of savings funds. Other equations are

then developed to show how a change in the total supply of mortgage credit affects residential construction expenditures.

The second major financial market contained in the model is the market for time and savings deposits. Equations representing, respectively, the demands for time and savings deposits at each type of financial intermediary and the interest rates paid on those deposits are derived and estimated. Particular emphasis is given to incorporating into these equations the structural changes in the market for time and savings deposits that occurred with the introduction of small denomination CD's by commercial banks in 1965. Small denomination CD's have greatly increased the ability of commercial banks to compete for savings funds with other financial intermediaries. As a consequence the elasticity of demand for all types of deposits with respect to the interest rates paid on deposits has increased sharply since 1965.

The third major financial market in the model is the market for U.S. Government and corporate bonds. Equations are developed which represent the market yields on 90-day Treasury bills, long-term U.S. bonds, and corporate bonds, respectively. It is primarily through changes in these yields that the impacts of monetary policy are transmitted to other parts of the economy. The equations representing the yields are structured in such a

way that a change in monetary policy first causes a change in the 90-day Treasury bill yield and is then passed on to the others.

In the final part of the study the predictive accuracy of the financial model is tested by using it to simulate the period 1963-1966. A discussion of techniques appropriate for using the financial model as a device for forecasting financial behavior in the future is presented. Also in this part of the study the financial model is combined with the University of Michigan Econometric Model of the U.S. economy. The combined models are used to derive estimates of the impact multipliers associated with the various tools of monetary policy. On the basis of these estimates it is concluded that the quantitative tools of monetary policy--open market operations, changes in reserve requirements, and the discount mechanism--are rather ineffective means of stabilizing the economy in the short run.

ACKNOWLEDGEMENTS

I am very much indebted to the Chairman of my Thesis Committee, Daniel Suits, for his painstaking efforts in criticizing successive drafts of this paper. I am also grateful for the criticism given and the patience exhibited by the other members of my Thesis Committee: Harold Shapiro, Robert Holbrook, and Thomas Gies. The comments of Barry Bosworth and other members of the Research Seminar in Quantitative Economics were also very helpful. I would like to thank Sylvia Robbins for typing the final draft of the paper.

I wish to express my thanks to the Ford Foundation for providing financial support during the 1967-68 academic year, when much of the work was being completed.

Finally, I would like to thank my wife, Jamie, for her patience in suffering through the long preparation of the paper.

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CHAPTER I

INTRODUCTION

The purpose of this study is to develop an econometric model of the financial sector of the United States economy. The financial model is to be used for purposes of economic forecasting and policy analysis in conjunction with the larger econometric model (hereafter called the RSQE model), developed by the Research Seminar in Quantitative Economics at the University of Michigan.¹ The RSQE model consists of a system of equations representing the short-run determination of income, employment, and price levels; but does not include a financial sector. In developing a financial model, our primary objective will be to derive a set of equations that can be combined with and complement the RSQE model. The analysis will focus on those financial markets which play the largest role in determining short-run movements in income, and will deal only sparingly with financial markets whose short-run impacts on the real sector of

¹The RSQE model is a continuing project of the Research Seminar in Quantitative Economics at the University of Michigan, and is directed by Professor Daniel B. Suits.

the economy are slight or ambiguous. Limiting the scope of the study in this way helps to keep the task in manageable proportions and also serves to focus the analysis on that part of the financial sector which is of greatest interest to economists and policy-makers.

The study proceeds in two parts. In the first part the equations comprising the financial model are derived and estimated. To be compatible with the RSQE model these equations are developed on an annual basis. In the second part of the study, the financial model is combined with the RSQE model and implications regarding the effectiveness of monetary policy as a means of stabilizing the economy are examined. A discussion of techniques appropriate for economic forecasting with the combined financial and RSQE models is also presented in this part of the study.

In terms of content, the equations of the financial model describe the determination of the following variables: (1) the quantity of mortgage credit supplied by each of the four principal financial intermediaries -- life insurance companies, savings and loan associations, mutual savings banks, and commercial banks; (2) the supply and demand for time and savings deposits of each of these financial intermediaries; and (3) market yields on corporate bonds, long and short-term U. S. Government securities, and large denomination time certificates

of deposit (henceforth CD's). As is evident from this list of variables, the equations describing the residential mortgage market comprise a substantial portion of the financial model. Indeed, a detailed description of the flows of mortgage funds -- disaggregated by source of lender -- is attempted. We feel that such detail is warranted on two grounds: first, the residential mortgage market is a primary channel through which disturbances in the financial sector are transmitted -- via residential construction expenditures -- to the real sector of the economy. A detailed analysis of the mortgage market is, therefore, a pursuit which is likely to yield a relatively high payoff in terms of a better understanding of the role financial markets play in the short-run determination of income. Secondly, the mortgage market operates under the existence of a wide variety of institutional barriers, such as legally imposed maximum interest rates on certain types of mortgages and the lack of an effective secondary market. Under such circumstances we do not feel it is possible to construct a less elaborate model of the mortgage market without sacrificing important information as regards the workings of that market.

In addition to the mortgage market, another feature that distinguishes this study from earlier empirical studies of the financial sector is our treatment of the

factors determining the level and distribution of time and savings and deposits among the different financial intermediaries. Our analysis of these factors is much more detailed than anything thus far attempted on an aggregate basis. To the extent that earlier studies have dealt with time and savings deposits at all, they have done so with a view to the fact that the level or sum total of such deposits at all financial intermediaries is one component of the total supply of loanable funds in the economy. Fluctuations in the level of time and savings deposits are deemed important in earlier studies only insofar as they give rise to corresponding fluctuations in the supply of loanable funds originating at financial intermediaries. A decline in the overall level of time and savings deposits, it is argued, reduces the supply of loanable funds and is likely to lead to a decline in those real sector expenditures which are financed through borrowing. On this point we concur with our predecessors and the total of loanable funds supplied by financial intermediaries emerges as a key variable in our model. At the same time, however, it is argued throughout the study that it is not enough to know simply the overall level of time and savings deposits. In order to fully understand the real sector implications of variations in the level of time and savings deposits, it is also necessary to know how those deposits are dis-

tributed among the different financial intermediaries. The reason for this is quite simple: loanable funds are not perfectly allocated through financial markets -- or, to put it another way, for reasons of habit, custom, or law, different types of financial intermediaries "specialize" in financing different types of expenditures. Savings and loan associations, for example, "specialize" in financing residential construction expenditures (through mortgage loans), whereas commercial banks "specialize" in financing business investment expenditures (through commercial and industrial loans). Thus the distribution of a given level of time and savings deposits is likely to be an important short-run determinant of the composition of output. For this reason a substantial portion of the study is devoted to the task of developing equations that will enable us to predict the quantity of time and savings deposits at each of the four principal financial intermediaries.

Statistical Methods

At this point a few comments regarding the statistical methods used in the study are in order. Most of the equations in the financial model are estimated via ordinary least squares regressions using, as has been previously indicated, annual data. For most equations the data period begins with the early 1950's and ex-

tends through 1966. However, the first observation varies from equation to equation, depending upon the availability of data.

Each of the data series used in the study is reproduced in Appendix II along with relevant sources and descriptions.

In estimating several of the equations, particularly in the mortgage sector, we depart from the use of ordinary least squares in favor of a modified two-stage estimation procedure. This procedure involves replacing an independent variable in a regression equation with an estimate generated from a first-stage (ordinary least squares) regression. The procedure differs from familiar two-stage least squares only insofar as the independent variables appearing in the first-stage regression are not restricted to exogenous variables appearing in the original equation. Instead, the first stage independent variables are chosen from among all variables exogenous to the financial model. This modified two-stage procedure was used only in estimating equations for which the likelihood of simultaneous equations bias was judged to be especially high.

CHAPTER II

THE RESIDENTIAL MORTGAGE MARKET

In this chapter we derive and estimate the set of equations that constitute the residential mortgage sector of the financial model. Unlike other financial markets dealt with in the study, we shall find that it is necessary to go beyond the purely financial aspects of the mortgage market in this instance, and investigate the mechanism by which disturbances in that market are transmitted into the real sector of the economy. Equations representing housing starts and expenditures are also developed. This temporary excursion outside the boundaries of the financial sector may be justified on the basis of our rather unorthodox approach to the workings of the mortgage market. All of this will be made clear in the discussion that follows.

A. The Relationship Between the Mortgage and Housing Markets

The residential mortgage market has always been of special interest to students of financial economics. The reason for this is that residential construction expenditures are largely financed through mortgage

loans; hence the mortgage market provides a potentially strong link between the financial and real sectors of the U. S. economy. It is, furthermore, a potential that has been often realized. Residential construction expenditures are the one component of GNP that have been consistently observed to respond to changes in financial conditions. Expenditures have characteristically risen during periods of expansionary monetary policies and declined during periods of contractionary policies. Even in the absence of policy extremes, housing expenditures have generally moved in a direction opposite the movement in interest rates.

Most students of the housing market attribute its sensitivity to financial conditions to variations in the supply of mortgage credit. Mortgage credit is supplied by financial intermediaries, and monetary policy is thought to affect the housing market through its influence on the mortgage lending activities of these intermediaries. While there has always been general agreement that restrictive monetary policies reduce the volume of mortgage credit extended by financial intermediaries and expansionary policies increase it, there has never been agreement over the mechanism involved. There are some, like Guttentag and Alberts, who maintain that the response of mortgage credit to changes in financial conditions reflect the behavior

of borrowers -- home builders and buyers.¹ Proponents of this view argue that demand for mortgage credit is highly elastic with respect to the costs of obtaining credit. Thus any change in credit costs brought about by monetary policy actions generates large movements in actual extensions of mortgage credit as many borrowers enter or leave the market. Others, such as Warren Smith, have argued that fluctuations in mortgage credit arise because the intermediary lenders are prevented from making loans during periods of generally high interest rates by the existence of legal maximum interest rates payable on mortgages insured by the FHA or guaranteed by the VA.²

Attempts to distinguish between the arguments empirically have been hampered by the host of problems associated with measurement of mortgage credit terms. Credit terms are not easily determined since they vary not only with interest rates but also with loan maturities and loan-to-value ratios. Furthermore, credit

¹J. M. Guttentag, "The Short Cycle in Residential Construction," American Economic Review, June 1961, pp. 275-298; W. W. Alberts, "Business Cycles, Residential Construction Cycles, and the Mortgage Market," Journal of Political Economy, June 1962, pp. 263-281.

²Warren L. Smith, "The Impact of Monetary Policy on Residential Construction, 1948-1958," Study of Mortgage Credit, U. S. Senate Committee on Banking and Currency, Subcommittee on Housing, 85th Congress, 2nd Session, Washington, 1958.

rationing exists in the mortgage market; many prospective borrowers are refused loans because they are considered to be "poor credit risks." Since credit rationing is at least as effective an allocative device as interest rates and loan-to-value ratios, it must also be included in a measure of credit terms. The question of how to measure mortgage credit terms so that the measure includes all of these factors has never been successfully answered.

In the midst of the controversy over the mechanism through which the mortgage market affects the housing market, the work of G. R. Sparks stands as unique.³ Sparks was able to circumvent the problems of measuring mortgage credit terms by looking directly at their determinants. However they may be measured, mortgage credit terms include all factors that adjust to equate the supply and demand for mortgage credit. Instead of trying to establish a relationship between housing expenditures and some ad hoc measure of credit terms, Sparks was able to establish an empirical relationship between housing expenditures and all elements affecting the supply and demand for mortgage credit other than credit terms. His approach can probably be best under-

³G. R. Sparks, "The Role of Financial Intermediaries in Residential Building Cycles," in Determinants of Investment Behavior, National Bureau of Economic Research (New York: Columbia University Press, 1967), pp. 301-331.

stood by considering the following simplified four equation model of the housing and mortgage markets:

(2-1) $HS = X - a_1 Cr$, housing starts (HS) - the physical measure of housing activity - depends on mortgage credit terms (Cr) and a number of other factors, such as household formation and the ratio of rental prices to construction costs, whose net influence is denoted by the symbol X.

(2-2) $MD = b_1 X - b_2 Cr$, the demand for mortgage credit¹ (MD) is a derived demand from housing starts and depends on the same factors.

(2-3) $MS = J + c_1 Cr$, the supply of mortgage credit (MS) is a function of mortgage credit terms and a number of other factors such as inflows of savings deposits at the various financial intermediaries, whose net influence is denoted by the symbol J.

(2-4) $Cr = \frac{1}{c_1 + b_2} (b_1 X - J)$, mortgage credit terms adjust to equate supply and demand for mortgage credit.

Sparks' approach is to eliminate credit terms and concentrate on the role of all other factors operating in the mortgage market. He substitutes equation (2-4) for Cr into equation (2-1) for housing starts and obtains a reduced-form expression for housing starts as a function of only the elements of X and J.

$$(2-5) \quad HS = \left(1 - \frac{a_1 b_1}{c_1 + b_2}\right) X + \frac{a_1}{c_1 + b_2} J.$$

After spelling out the arguments of X and J, this equation could be estimated by regression. However, Sparks proceeds by examining the elements in J on a disaggregate basis, looking in detail at the mortgage loan be-

havior of each of the four principal financial intermediaries -- life insurance companies, savings and loan associations, mutual savings banks, and commercial banks. Disaggregation increases the number of supply variables included in J so that equation (2-5) cannot be estimated directly from a small number of observations. Instead, Sparks estimates a separate supply equation for each of the financial intermediaries and constructs an estimate of J , using coefficients from these equations to combine all of his supply variables into a single term. With this estimate, $\hat{J}$, he is able to estimate an equation for housing starts that approximates equation (2-5).

Sparks' procedure is roundabout because he disaggregates the supply side of the market. However, there are enough advantages to disaggregation to make it worthwhile. Most important is the realization that credit terms are only one small factor influencing the mortgage activity of financial intermediaries. The different financial intermediaries are a diverse lot, and factors which give rise to disturbances in mortgage lending by one or more do not necessarily affect the others. As a case in point, consider the role of savings and loan associations versus that of commercial banks in the mortgage market. Savings and loan associations were originally chartered as institutions whose primary function was to supply mortgage credit to local markets.

Even today they are permitted to invest in very little other than mortgages. When savings and loan associations acquire additional funds in the form of savings deposit inflows, they have little choice but to channel these funds into mortgages -- at terms which borrowers will accept.

Commercial banks, on the other hand, pursue their lending operations with an eye toward servicing businessmen and their short-term loan requirements. For most commercial banks mortgages are a small and secondary investment outlet, and one which might be neglected if business loans demands run high. Obviously the mortgage lending activities of these two financial intermediaries respond to quite different market forces. A period of restrictive monetary policy, for example, will almost surely cause commercial banks to forego mortgage loans in favor of high yielding business loans, but it will cause savings and loan associations to curtail their mortgage operations only if the restrictive policy results in an outflow of savings and loan shares.

A dramatic illustration of the need for disaggregation in the supply of mortgage credit is provided by the large 1966 decline in housing expenditures that occurred primarily because depositors at savings and loan associations withdrew large quantities of savings deposits and shifted them into time deposits at commer-

cial banks. Commercial banks were able to induce depositors to make these shifts by offering a new deposit instrument, the small denomination CD, which paid interest rates competitive with non-bank savings deposits.⁴ Since commercial banks make fewer mortgage loans per dollar of savings deposit than do savings and loan associations, a substantial decline in the supply of mortgage credit ensued. It is just this sort of occurrence that makes disaggregation of the supply of mortgage credit a prerequisite to understanding the housing and mortgage markets.

In the remainder of this chapter we propose to use Sparks' study as a basis for developing a set of equations that relate housing starts and expenditures to the quantity of mortgage credit supplied by each of the four principal financial intermediaries and the Federal National Mortgage Association. Our approach will closely parallel that of Sparks. In terms of the preceding inter-related model of the housing and mortgage markets, our procedure is as follows. In Section B we derive and estimate equations representing respectively the quantity of mortgage credit supplied by life insurance companies, savings and loan associations, mutual savings banks, and commercial

⁴Banks first began to issue large quantities of CD's in denominations small enough to be purchased by the average individual in late 1965. Before that time most CD's were issued in denominations of $\geq$ \$100,000.

banks. The role of mortgage credit terms in determining these supply components is estimated through the use of a proxy variable. These equations are then aggregated, along with credit supplied by the Federal National Mortgage Association, into one expression -- analogous to equation (2-3) -- in which the net influence of all supply factors other than the proxy measure of credit terms is combined into one variable, $\hat{J}$. In Section C this variable, $\hat{J}$, is used as an independent variable along with demographic factors to estimate an equation for housing starts -- analogous to equation (2-5).

The major point at which our approach differs from that of Sparks is in our use of a proxy measure for credit terms in the estimation of the supply equations. Sparks completely ignores the role of credit terms in determining the supplies and uses no such proxy. While we agree with him that the primary objective is to establish empirical estimates of all supply factors other than credit terms, to completely ignore the influence of credit terms -- even though it is likely to be small -- is to invite biases in the estimates of the other coefficients. Our use of a proxy measure represents an attempt to eliminate such biases.

As a proxy measure we have selected the secondary market yield on FHA-insured mortgages. This yield comes as close to measuring mortgage credit terms as any single

variable can. It is calculated from data derived from transactions in the rather small secondary market that exists for FHA-insured mortgages. Calculations are based on secondary market prices of mortgages with fixed maturities and loan-to-value ratios. To the extent that changes in contract interest rates, maturities, or loan-to-value ratios in the primary market affect the secondary market, these show up as variations in the secondary market yield. Hence, the secondary market yield reflects more than one of the credit characteristics of mortgage loans. It is, however, not a perfect measure of all credit terms because it cannot reflect changes in credit rationing. In addition it applies only to FHA-insured mortgages and may not, therefore, be representative of the whole market.

B. The Supply of Mortgage Credit

In estimating equations to represent the sources of mortgage credit, the quantity of mortgage credit supplied by each of the financial intermediaries is measured by the net change in the respective residential mortgage holdings and denoted by the symbols MS_i ; where $i = LI$ refers to life insurance companies, $i = SL$ to savings and loan associations, $i = MS$ to mutual savings banks, and $i = CB$ to commercial banks. Following the format of Sparks, the supply equations share a common specification of the form:

$$(2-6) \quad MS_i = S_i \Delta M_i^* + (1 - S_i) MS_{i-1}, \text{ for } i \in (LI, SL, MS, CB)$$

The equation may be seen to be a first-difference version of the familiar partial adjustment mechanism, where M_i^* is the stock of residential mortgages "desired" by the i th financial intermediary and S_i is the annual rate at which discrepancies between "desired" and actual holdings are eliminated. Each of the four kinds of financial intermediary is distinguished by the factors which determine M^* .

For the i th intermediary "desired" mortgage holdings are assumed to depend on: (1) SD_i -- the level of its savings deposit liabilities, (2) r_M -- the secondary market yield on FHA-insured mortgages, (3) r_j -- the yield on the most important investment alternative to mortgages, and (4) X_i -- any institutional factors that directly influence its mortgage lending. Substituting these factors for M_i^* in Equation (2-6) and expressing the results as a linear approximation yields the general form of the equations used in the regressions.

$$(2-7) \quad MS_i = A_{0i} + A_{1i} \Delta SD_i + A_{2i} \Delta r_M + A_{3i} \Delta r_j \\ + A_{4i} \Delta X_i + (1 - S_i) MS_{i-1}$$

The regression results are presented in turn for each financial intermediary.

Life Insurance Companies

The regression results for mortgage credit supplied

by life insurance companies are presented as equation (2-8) below. The regression was performed on annual observations over the period 1953-66. A liberal interpretation of the term "savings deposit liabilities" was used in constructing the variable SD_{LI} . It consists of the total of policy reserves at life insurance companies plus accumulated dividends less policy loans.⁵

Corporate bonds are by far the most important investment alternative to mortgages for life insurance companies, and the corporate bond yield (r_B) was entered in the regression. It is the practice of life insurance companies to make investment commitments into the future, both with regard to corporate bonds and mortgages. This practice introduces lags into the response of insurance companies to changes in interest yields. Accordingly, we have allowed for such lags in the regression equation. After some experimentation, best results were obtained using the mortgage yield current and lagged one period, and the corporate bond yield current and lagged one and two periods. To preserve degrees of freedom, the coefficients on the Δr_{B-i} were constrained to lie along a second degree polynomial in i by use of the technique

⁵ This is the same definition used by Sparks. Policy loans are deducted from the sum of reserves and accumulated dividends because insurance companies tend to regard them as the investment form of highest priority.

developed by Shirley Almon.⁶

$$(2-8) \text{MS}_{\text{LI}} = -.077 + .518 \Delta \text{SD}_{\text{LI}} + 1.211 \Delta r_m + 1.306 \Delta r_{m-1} \\ (.102) \quad (.305) \quad (.471) \\ -5.205 \sum_{i=0}^2 w_i \Delta r_{B-i} + .285 \text{MS}_{\text{LI}-1} \\ (.133)$$

$$w_0 = .214$$

$$\text{d.f.} = 7$$

$$w_1 = .429$$

$$R^2 = .98$$

$$w_2 = .357$$

$$\text{S.E.} = \$.13 \text{ Bil.}$$

The equation was estimated using the modified two-stage technique described in Chapter I.⁷ The figures in parentheses beneath the regression coefficients are standard errors. As is evidenced by the regression results, the estimated equation fits the observed movements in mortgage credit extensions by life insurance companies quite well. At \$.13 billion, the standard error of estimate is low in spite of the limited number of degrees of freedom. In addition, all coefficients are more than twice their respective standard errors.

⁶ Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," Econometrica, January 1965, pp. 178-196.

⁷ What was done specifically was to replace Δr in the regression with an estimate Δr_m , generated by regressing Δr on variables exogenous^m to the mortgage sector. The exogenous variables were the net change in mortgage holdings of the Federal national mortgage association (ΔFNMA), the net change in long term advances outstanding at Federal Home Loan Banks (ΔFHLB), and the change in net household formation (ΔHF). This same estimate Δr_m was also used to replace Δr in regression equations for mortgage lending by mutual savings banks and commercial banks.

The coefficient on the savings deposit variable implies that slightly over one-half of new inflows of savings funds are used by life insurance companies to make mortgage loans within the same year. The equilibrium response of mortgage loans to a change in savings deposits is only a little larger at .72 $\left[=.518/(1-.285) \right]$, indicating that the bulk of the adjustment process occurs within the space of a year.

The interest rate coefficients are more difficult to evaluate, particularly the one on the mortgage yield, since that yield is only a proxy measure of credit terms. However it is interesting to note that life insurance companies appear to be much more responsive to changes in corporate and yields than to changes in mortgage yields. The sum of the coefficients on changes in the corporate bond yield is -5.205, whereas the corresponding sum for mortgage yields is only 2.517. The discrepancy between these sums is attributable to the fact that insurance companies have, in the past, tended to reduce mortgage lending in the face of equal increases in bond and mortgage yields.

Savings and Loan Associations

Savings and loan associations are the largest suppliers of residential mortgage credit and they currently supply just under one-half of the total. In view of the fact that they are permitted to invest in very little

other than mortgages, all interest rates were omitted from the regression equation. The regression results are shown as equation (2-9).

The variable Δ FHLB measures changes in long-term advances to savings and loan associations by Federal Home Loan Banks. Its coefficient was constrained to be identical to that of changes in savings and loan shares. Long-term advances are interest bearing loans with maturities in the range of 1 - 10 years.⁸ They were devised by the Federal Home Loan Bank Board as a means of increasing funds to areas in which demands for mortgage credit exceed the capacity of local savings and loan associations to supply it through normal inflows of savings shares. The long-term advances program has never been large (it reached a peak in 1965 when total advances outstanding of \$2.9 billion were recorded) but it was, ironically enough, a major factor contributing to the decline in extensions of mortgage credit by savings and loan associations in 1966. The FHLB Board decided to discontinue the program in early 1966; borrowing associations were forced to repay \$1.0 billion in advances during that year and another \$1.5 billion dur-

⁸ Long-term advances are not to be confused with the more common short-term advances also provided to savings and loan associations by Federal Home Loan Banks. Short-term advances are made to associations faced with savings share withdrawals and are not used to finance new mortgage loans.

ing 1967. Since savings and loan associations were faced with large-scale deposit withdrawals at the same time, a declining rate of mortgage lending was forced even lower.

$$(2-9) \quad MS_{SL} = -.131 + .872 \Delta (SD_{SL} + FHLB) + .141 MS_{SL-1} \\ (.089) \quad (.089)$$

$$df = 11$$

$$R^2 = .96$$

$$S.E. = \$.56 \text{ Bil.}$$

data period: 1953-66

The small (and insignificant) coefficient on the lagged dependent variable implies that savings and loan associations adjust rapidly to discrepancies between actual and desired mortgage holdings. While this coefficient is insignificant, it does yield a plausible value for the equilibrium mortgage-deposit ratio when combined with the coefficient on savings and loan shares. That equilibrium value is 1.02, which compares favorably with observed values between .93 and 1.00 over the period 1953-1966. The standard error of estimate, at \$.56 billion, is considerably larger than that obtained for life insurance companies, but this is to be expected in view of the fact that savings and loan associations supply roughly four times the amount of residential mortgage financing that insurance companies do.

Mutual Savings Banks

The regression results for mortgage credit supplied by mutual savings banks are presented as equation

(2-10) below. In addition to mortgages, mutual savings banks hold small amounts of U. S. Government securities and corporate bonds. In recent years the latter have been the more important substitute for mortgages and we have, therefore, entered the corporate bond yield into the regression.

$$(2-10) \text{MS}_{\text{MS}} = .571 + \frac{.312}{(.206)} \Delta \text{SD}_{\text{MS}} - \frac{1.278}{(.464)} \Delta r_B + \frac{.541}{(.225)} \text{MS}_{\text{MS}-1}$$

$$df = 10$$

$$R^2 = .91$$

$$S.E. = \$.25 \text{ Bil}$$

data period: 1953-66

The mortgage yield failed to enter the regression with a positive coefficient and was subsequently dropped in obtaining the final results. This failure typified our experiences with statistical relationships involving mutual savings banks throughout the study. The problems of insignificant coefficients and coefficients with signs contrary to a priori expectations arose not only here but also in the estimation of equations appearing in the next chapter. Yet in other respects, such as predictive ability, the regression results are reasonably good -- as they are in the case of (2-10). Perhaps the cause of these statistical problems is that mutual savings banks have dramatically altered their investment policies over the past decade and a half. Between 1950 and 1966, the share

of mortgages in total assets at mutual savings banks has increased from 35.8% to 77.4%. The intervening years seem to have been ones of disequilibrium.

Commercial Banks

The regression results for commercial banks are presented as Equation (2-11). The source of funds from which mortgage loans are drawn is measured as the difference between household time and savings deposits (SD_{CB}) and reserves required on them (RR_{CB}). Non-household time deposits were excluded because they consist mostly of large denomination ($\geq \$100,000$) CD's, which represent volatile short-term liabilities to commercial banks and are not likely to be used by banks as a source of financing long-term illiquid mortgage loans. The separation of time and savings deposits into household and non-household components is as close as we can come to separating large denomination CD's from other types of time and savings deposits with existing data sources.

The yield on long-term U. S. bonds (r_L) appears in the regression as a measure of the returns commercial banks might earn on other long-term investments. While long-term U. S. bonds are certainly not the only alternative to mortgages, their yields should at least be representative of the choices open to commercial banks. In fitting the regression, the coefficient on Δr_L was constrained to be of equal magnitude but opposite sign

to that on Δr_m because of colinearity between the two variables.

The variable GOV₋₁ is the stock of the U. S. Government securities held by commercial banks at the beginning of the year. It serves as a measure of commercial banks' liquidity positions and is included in the equation as an attempt to relate changes in banks' acquisitions of mortgages to changes in liquidity. As was noted earlier, commercial banks pursue lending operations with an eye toward servicing business loan demands. When business loan demands increase faster than bank reserves, commercial banks often reduce their holdings of liquid securities -- mostly U. S. Government securities -- in order to accomodate these loan demands. In periods following such sell-offs of securities, commercial banks usually attempt to restore liquidity by reducing their holdings of less liquid assets such as mortgages. During slack periods, when commercial banks find themselves with a surplus of loanable funds, the whole process works in reverse -- first to increase holdings of U. S. Government securities and then, with somewhat of a lag, to increase mortgage loans. The lagged first-difference of commercial banks' holdings of U. S. Government securities was inserted into the equation in an effort to capture liquidity adjustments of this sort.

$$(2-11) \text{ MS}_{\text{CB}} = .322 + \frac{.172}{(.050)} \Delta (\text{SD}_{\text{CB}} - \text{RR}_{\text{CB}}) + \frac{.273}{(.845)} \Delta (r_{\text{M}} - r_{\text{L}}) \\ + \frac{.083}{(.036)} \Delta \text{GOV}_{-1} + \frac{.222}{(.175)} \text{MS}_{\text{CB}_{-1}}$$

$$\text{df} = 9$$

$$R^2 = .81$$

$$\text{S.E.} = \$.46 \text{ Bil.}$$

data period: 1953-66

The regression results are reasonably good. The coefficient on the savings deposit variable is highly significant, although those on the constrained interest yields and the lagged dependent variable are not. These results suggest that commercial banks adjust mortgage holdings fairly rapidly in response to changes in savings deposits without much regard to interest rates. The positive (and significant) coefficient on ΔGOV_{-1} , is consistent with our hypothesis that commercial bank liquidity adjustments reach their mortgage holdings with a one period lag.

The Total Supply of Mortgage Credit

The equations developed above may be combined with changes in the residential mortgage holdings of the Federal National Mortgage Association ("Fanny Mae") to yield an estimate of the total of mortgage credit supplied by financial intermediary and U.S. Government sources.

$$(2-13) \hat{\text{MS}}_{\text{TOTAL}} = \hat{J} + (1.211 + .273) \Delta r_{\text{m}}$$

The coefficients 1.211 and .273 are estimates of the

coefficients on the proxy measure of mortgage credit terms from equations (2-8) and (2-11) for life insurance companies and commercial banks, respectively. These were the only two estimated equations that the variable Δr_m entered. $\hat{J}$ denotes our empirical estimate of the net influence of all factors affecting the supply of mortgage credit other than the proxy measure of mortgage credit terms. Specifically $\hat{J}$ is defined as

$$\begin{aligned} \hat{J} = & \text{FNMA} \\ & + \left[-.077 + .518 \Delta SD_{LI} + 1.306 \Delta r_{m-1} - 5.205 \sum_{i=0}^2 w_i \Delta r_{B-i} \right. \\ & \quad \left. + .285 MS_{LI-1} \right] \\ & + \left[-.131 + .872 \Delta (SD_{SL} + FHLB) + .141 MS_{SL-1} \right] \\ & + \left[.571 + .312 \Delta SD_{MS} - 1.278 \Delta r_B + .541 MS_{MS-1} \right] \\ & + \left[.322 + .172 \Delta (SD_{CB} - RR_{CB}) - .273 \Delta r_L + .083 \Delta GOV_{-1} \right. \\ & \quad \left. + .222 MS_{CB-1} \right] \end{aligned}$$

The bracketed terms may be recognized as equations (2-8) - (2-11) exclusive of terms involving r_m . The symbol FNMA denotes changes in the residential mortgage holdings of "Fanny Mae," which are exogenously determined.

C. Housing Starts and Expenditures

Having defined $\hat{J}$ as the net impact on the supply of mortgage credit of all factors exclusive of mortgage credit terms in a way that is unique to the study, it now remains to demonstrate how this variable affects

the housing market. Fortunately, this is not difficult to do since we have already described, with the aid of equations (2-1) - (2-5), the reasoning through which Sparks was able to relate factors affecting the supply of mortgage credit to housing starts. Following that same line of reasoning, we have derived the following equation for annual changes in housing starts:

$$(2-14) \Delta HS = .118 + .363 \Delta HF - .311 (HS-HF)_{-1} \\ \quad \quad \quad (.182) \quad \quad \quad (.211) \\ + 1.066 \Delta (R/P_{RC}) + .037 \Delta (\hat{J}/P_{RC}) \\ \quad \quad \quad (1.509) \quad \quad \quad (.015)$$

$$df = 9$$

$$R^2 = .76$$

$$S.E. = .08 \text{ Mil.}$$

data period: 1953-66

The variables are defined as follows: HS is private nonfarm housing starts, measured in millions of units; HF is net household formation, measured in millions; R is the rent component of the Consumer Price Index, 1957 - 59 = 1.000; and P_{RC} is the implicit deflator for residential structures, 1958 = 1.000. The variables other than $\hat{J}$ in the equation represent measures of the underlying profitability of housing construction and lead to an inventory-like behavior in the response of housing starts. These are discussed in detail by Sparks and in an earlier work by Maisel.⁹ Note that $\hat{J}$ appears in the

⁹ Sparks, op. cit., pp. 304-07; S. J. Maisel, "A Theory of Fluctuations in Residential Construction Starts," American Economic Review, June, 1963, pp. 359-83.

equation deflated by the implicit deflator for residential structures. This was deemed advisable since housing starts are measured in physical units, whereas $\hat{J}$ is measured in billions of dollars. The number of housing units that can be financed by a given dollar volume of mortgage credit declines with rising construction costs, and deflation serves to translate $\hat{J}$ into an index of credit availability consistent with measuring the dependent variable in physical units.

Implications of the equation are not immediately obvious, and are probably best illustrated by way of an example. Let us suppose that factors affecting mortgage credit supplied by one or more of the financial intermediaries became more favorable, and an increase of \$1 billion in the total supply of mortgage credit results through the $\hat{J}$ component. The effect this will have on housing starts will depend on the level of construction costs; the lower are construction costs, the larger will be the increase in housing starts. At 1966 values of construction costs ($P_{RC} = 1.209$), the \$1 billion in mortgage funds would amount to a \$.83 billion increase in $\hat{J}/P_{RC}$. This would stimulate an estimated increase of 30,700 housing starts.

At this point we have developed a set of equations that allow us to translate variations in factors affecting mortgage lending by financial intermediaries into

movements in the total supply of mortgage credit and, ultimately, into changes in housing starts. The next logical step is to develop an equation which will translate changes in housing starts into housing expenditures. Here again we face a task that is not difficult. Housing expenditures as reported in the National Income and Product Accounts are compiled by simply "pricing out" monthly totals of housing starts, i.e.:

$$HE_t = V \left[\sum_{i=0}^n W_i HS_{t-i} \right],$$

Where HE is expenditures, V the average value of a completed housing unit, and n the number of months from the start of construction to completion. The W_i represent the proportion of construction put in place in the i^{th} month and $\sum_{i=0}^n W_i = 1.0$.

For our purposes an annual approximation to this "pricing out" formula may be obtained by regressing annual changes in housing expenditures on current and lagged changes in housing starts.

$$(2-15) \Delta \overline{HE} = .290 + \frac{11.908}{(1.432)} \Delta HS + \frac{3.321}{(1.597)} \Delta HS_{-1}$$

$$df = 14$$

$$R^2 = .87$$

$$S.E. = \$.83 \text{ bil}$$

data period: 1950-66

$\overline{HE}$ is housing expenditures measured in billions of dollars at 1958 prices. Measuring the dependent

variable in 1958, or "constant," prices eliminates the problem of changes in the average value per start. It also is the form of the variable that will be required when we integrate the results of this study with the RSQE model in a later chapter.¹⁰ Note that the sum of the housing starts coefficients may be interpreted as the average value of a completed housing unit in 1958 prices -- about \$15,000 per unit. Thus the equation may be interpreted as saying that every additional housing unit started will cause constant dollar housing expenditures to increase by about \$15,000. The increase, however, will take place over two calendar years because of construction lags.

If we now return to our earlier example, we can extend the estimated effects of the hypothetical \$1 billion increase in the supply of mortgage credit to include the effects on housing expenditures. Corresponding to the estimated increase in housing starts of 30,700 units would be an increase in constant dollar housing expenditures of approximately \$.46 billion, some \$.36 billion of which would occur in the same calendar year and the remainder in the next. At first this dollar magnitude might appear to be small in re-

¹⁰The equations representing the various components of aggregate demand in the RSQE model are all expressed in constant dollars.

sponse to a \$1 billion increase in the factors underlying the supply of mortgage credit. We remind the reader, however, that our index of mortgage credit, $\hat{J}$, is an estimate of what would happen to the supply of mortgage credit only if mortgage credit terms remain unchanged. Since changes in $\hat{J}$ are likely to lead to (partially) offsetting changes in credit terms, it is not proper to identify dollar magnitudes of changes in $\hat{J}$ (or more properly, changes in $\hat{J}/P_{RC}$) with dollar magnitudes of changes in $\overline{HE}$.

Further implications of these equations will be examined in Chapter V, after the remaining equations of the financial model have been developed and integrated with the RSQE model.

D. The Mortgage Yield

Before concluding the chapter there is still one loose end to be tied. While we have no further use for the secondary market yield on FHA-insured mortgages as regards the housing and mortgage markets (i.e., it was used only as a proxy measure of mortgage credit terms in order to reduce biases in the estimation of other coefficients and does not, itself, enter into the definition of $\hat{J}$), it does appear elsewhere in the financial model. Therefore an equation representing it is also required.

Like the credit terms for which it is a proxy, the secondary market yield on FHA-insured mortgages is determined by the elements of supply and demand for mortgage credit. We have already spent considerable time examining the elements of supply and have aggregated these into the variable $\hat{J}$. In addition, since the demand for mortgage credit is derived from the financing requirements of housing construction, we have already come into contact with the major demand factors in the form of the variables ΔHF , $(HS - HF)_{-1}$, and $\Delta R/P_{RC}$ which appear as arguments in the housing starts equation. A workable approximation to the determination of secondary market yields on FHA-insured mortgages may be obtained by regressing Δr_m on the same factors appearing as independent variables in equation (2-14) for housing starts. We have performed such a regression over the period 1953-66 with the following results:

$$(2-16) \Delta r_m = .117 + .189 \Delta HF - .075 (HS - HF)_{-1} + 2.220 \Delta (R/P_{RC}) \\
\begin{matrix} (.144) & (.165) & (1.275) \end{matrix}$$

$$- .068 \Delta (\hat{J}/P_{RC}) + .832 \Delta \bar{r}_{FHA} \\
\begin{matrix} (.017) & (.144) \end{matrix}$$

$$df = 8$$

$$R^2 = .96$$

$$S.E. = .07 \text{ percent}$$

data period: 1955-66

The variable $\bar{r}_{FHA}$ is the annual average of the legal maximum interest rate payable on mortgages in-

sured by the FHA. It was included in the regression to allow for any possible restrictive effects the existence of such arbitrary ceilings might have. The secondary market yield, itself, is not subject to the ceiling but may move with changes in the ceiling insofar as such changes affect mortgage activity in the secondary market. As evidenced by the very large and significant coefficient obtained by the variable, changes in ceiling rates appear to have extremely large impacts (almost one-for-one) on secondary market yields.¹¹

The overall regression equation is highly satisfactory. Its fit is good and its standard error of estimate, at seven basis points, is quite low. The supply factors embodied in $\hat{J}$ enter with a strong and highly significant coefficient, and while none of the demand variables obtains a significant (at the five-percent level) coefficient, their coefficients do imply that factors increasing the demand for housing starts put upward pressure on mortgage yields.

¹¹The reader is cautioned against interpreting the large impact of changes in the FHA ceiling interest rate as an indication that the existence of such ceilings provide an effective constraint to the supply of mortgage credit. Such a conclusion is unwarranted. While our results here do imply that a change in $\bar{r}_{FHA}$ will lead to a large change in r_M , our results in Section B also suggest that a change in r_M has little effect on the mortgage lending of financial intermediaries.

CHAPTER III

THE MARKET FOR HOUSEHOLD SAVINGS DEPOSITS

In this chapter we develop equations representing, respectively, the determination of interest rates paid on savings deposits and the demands for those deposits. The specific types of savings deposits considered are: (1) savings and loan shares, (2) mutual savings bank deposits, (3) household time and savings deposits at commercial banks, and (4) the special construct for life insurance companies which is measured as the total of policy reserves plus accumulated dividends less policy loans. It will be noted that these are the same variables as appeared in the mortgage lending equations of the previous chapter. The list is limited to the savings deposit claims of the household sector in this chapter in order to facilitate the analysis. However this does not create any serious omissions because of the fact that all savings and loan shares, mutual savings bank deposits, and claims on life insurance companies (as we have defined them) are held by households. Non-household sectors do hold a substantial volume of time deposits at commercial banks, but these will be dealt with in a later chapter.

Our interest in developing a set of equations to represent the supply and demand for savings deposits stems from the fact that these deposits are a major source of loanable funds for financial intermediaries. Of the four kinds of intermediary, only commercial banks obtain large quantities of funds from other sources. Thus fluctuations in the level or distribution of savings deposits could have potentially profound effects on the level and composition of real output.

From the end of World War II through the early 1960's there were few disturbances in the savings deposit market. Deposit inflows were relatively stable over this period and there is no evidence to suggest that shifts in savings deposits from one type of financial intermediary to another occurred on large scale. This stability, however, ended in late 1965 when commercial banks began to issue small denomination CD's. In small CD's commercial banks found an instrument that enabled them to offer high interest rates to the small saver and thereby compete effectively with non-bank financial intermediaries. Large quantities of savings deposits were shifted from non-bank intermediaries to commercial banks in 1966. In light of banks new-found ability to compete for savings funds, the prospect is that deposit shifting will take place on a much larger scale in the future than it has

in the past.

The advent of small denomination CD's threatens the stability of the savings deposit market in yet another way. As a consequence of the increased competition among financial intermediaries induced by these deposit instruments, interest rates paid on all kinds of savings deposits have been forced up relative to the yields obtainable on marketable securities. Security holders are likely to find all kinds of savings deposits increasingly attractive investments during periods when market yields are generally depressed. Thus cyclical swings in the overall level of savings deposits (as opposed to shifts in the distribution of a given level of deposits) may also become more pronounced in the future.

Through the equations developed below we shall attempt to provide empirical estimates of the extent to which savings deposit holdings have become more volatile since the advent of the small denomination CD. The chapter proceeds in two sections. In Section A the equations representing the determination of interest rates paid on savings deposits are derived and estimated. Although life insurance companies do pay "interest" to depositors (i.e., policy holders), in some sense through periodic dividends, they are excluded from this section. In Section B we develop the equations representing the demand for savings deposits by the

household sector.

A. Interest Rates Paid on Savings Deposits

Those financial intermediaries that issue interest-bearing deposits earn profits from the differential between interest received on investments and interest paid to depositors. The individual firm has little control over the rate of interest it earns on investments and must rely on adjusting the deposit rate as a means of influencing its level of profits. Our formulations of the deposit rate equations will be based on the hypothesis that financial intermediaries attempt to set deposit rates in such a way as to maximize profits. This hypothesis must be modified slightly in the case of commercial banks, who may be prevented from paying a profit maximizing rate by the existence of legal maximum interest rates payable on time and savings deposits under Regulation Q. However, as we shall see, the restraints imposed by these interest rate ceilings may be fairly easily incorporated into the commercial bank deposit rate equation.

Since late 1966, savings and loan associations have also been subject to legal interest rate ceilings -- in this case imposed by the Federal Home Loan Bank Board.¹

¹ Congress granted authority to fix ceiling rates payable on savings and loan associations to the Federal Home Loan Bank Board in September, 1966.

These ceilings play no part in our analysis, because of the fact that our data period extends only through 1966. Yet this is not to say that such ceilings may not be important constraints on savings and loan activity in the future. They must be kept in mind if the results of this study are to be used to analyze or predict financial behavior in the future.

To illuminate the factors determining the profit-maximizing deposit rate for an individual financial firm, consider the following simplified expression for the firm's profits (π):

$$(3-1) \quad \pi = r_E SD - r_{SD} SD,$$

where SD is the firm's savings deposit liabilities, r_{SD} is its deposit rate, and r_E is the rate of interest it earns from investing savings deposits funds in earning assets. In deciding on the optimal deposit rate the firm must take account of the likely response of depositors to changes in the rate. Increasing r_{SD} , for example, will probably attract new depositors, but it will also mean that the new higher rate will have to be paid to old depositors as well.²

The profit-maximizing rate (r_{SD}^*) is found by setting $\partial \pi / \partial r_{SD} = 0$. This yields:

²There are some exceptions, changes in deposit rates do not affect interest rates paid on CD's that have already been issued. This property is one reason financial intermediaries have been so anxious to issue CD's and similar deposit instruments.

$$(3-2) \quad r_{SD}^* = r_E - SD / (\partial SD / \partial r_{SD}) = r_E - r_{SD} / \eta,$$

where η is the elasticity of demand for the firm's deposits (more properly, η is the elasticity of demand for the firm's deposits as the firm perceives it).

The expression yields the result that the higher the elasticity of demand, the closer will be r_{SD}^* to the rate received on earning assets.

In order to operationalize Equation (3-2) it is necessary to derive an expression for η in terms of observable economic variables. Let us represent the demand for the firm's savings deposits with the following expression:

$$(3-3) \quad SD = (A_0 + A_1 r_{SD} - \sum_{i=2}^n A_i r_i) W,$$

where the r_i denote interest rates paid on savings deposits and securities that compete with the firm for funds and W denotes the total wealth holdings of potential depositors. The form of the expression is consistent with the deposit demand equations to be developed in Section B of this chapter. Calculating η from the expression shows it to be a function of the interest rates offered by competitors.

$$(3-4) \quad \eta = \frac{A_1 r_{SD} W}{SD} = \frac{A_1 r_{SD}}{A_0 + A_1 r_{SD} - \sum_{i=2}^n A_i r_i}$$

Substituting Equation (3-4) for η into Equation (3-2) and rearranging terms yields

$$(3-5) \quad r_{SD}^* = 1/2 (r_E - A_0/A_1 + 1/A_1 \sum_{i=2}^n A_i r_i).$$

This shows the profit-maximizing deposit rate for an individual financial firm to be a linear function of r_E and r_i , for $i = 2, 3, \dots, n$.

It now remains to relate this expression for r_{SD}^* to interest rates actually paid on savings deposits. Observation tells us that even when financial intermediaries are not restricted by legal interest rate ceilings they do not adjust deposit rates very frequently. Frequent changes in deposit rates increase accounting costs and create uncertainty among depositors, consequently most intermediaries make only periodic rate adjustments. Behavior of this sort may be approximated by a partial adjustment mechanism of the form

$$\begin{aligned} (3-6) \quad \Delta r_{SD} &= \gamma (r_{SD}^* - r_{SD-1}) \\ &= \gamma/2 (r_E - A_0/A_1 + 1/A_1 \sum_{i=2}^n A_i r_i) - \gamma r_{SD-1} \end{aligned}$$

The regression equations for interest rates paid on savings and loan shares and mutual savings bank deposits are specified in the manner of Equation (3-6). The equation for interest rates paid on savings deposits at commercial banks contains a modification to take account of Regulation Q. It is important to point out that, whereas Equation (3-6) was derived from considering the behavior of an individual firm, the regression equations modeled after it are to be estimated from

aggregate deposit rate data. Hopefully the firms within each class of financial intermediary follow similar behavior so that micro-specifications are appropriate to represent the aggregates. Our only defense against aggregation errors is to make the specifications as flexible as possible; consequently we have not applied the constraint implicit in Equation (3-6) -- that the coefficient on r_E be equal to minus one-half that on r_{SD-1} -- in performing the regressions.³ Instead the variables representing r_E and r_{SD-1} were permitted to enter each regression with free coefficients.

Before presenting the empirical results, a comment concerning the data series for interest rates paid on household savings deposits at commercial banks is in order. The series used here and elsewhere in the study is a constructed one. Details of how it was constructed are given in Appendix II. The series consists of the rate paid on pass-book savings accounts through 1964, the rate paid on small denomination CD's in 1966, and a weighted average of the two for 1965. Small denomina-

³We also did not feel that the quality of aggregate deposit rate data is high enough to warrant a priori constraints. Aggregate deposit rate data are calculated on an ex-post basis. That is, rates are calculated by dividing average deposit balances into annual total of interest paid to depositors. Since deposits are often withdrawn before they can accumulate interest, rates calculated on an ex-post basis will nearly always turn out to be less than rates actually offered to depositors.

tion CD's first became a factor in late 1965. Since our data period extends only through 1966, it was impossible to give separate treatment to rates paid on passbook savings accounts and rates paid on small denomination CD's. Instead we have attempted to combine the two rates into one data series. There is always some error introduced when two phenomena are represented with a single variable. In this case the errors are likely to be small. More and more banks are issuing small denomination CD's with the provision that, should the depositor wish to withdraw his funds before his CD matures, he would be able to do so, and still receive the passbook rate of interest on his average deposit balance over the holding period. A CD issued in this way is difficult to distinguish from a passbook savings account.

Interest Rates Paid on Savings and Loan Shares

The regression results for the interest rate paid on savings and loan shares are shown in Equation (3-7) below. The interest rate earned by savings and loan associations on investments is represented in the equation by the secondary market yield on FHA-insured mortgages (r_M). The interest rate paid on household savings deposits at commercial banks (r_{CB}) appears in the equation as a measure of the interest rate paid by savings

and loan associations' chief competitor.⁴ We did not include the interest rate paid by mutual savings banks in the regression on the grounds that there are few areas of the country serviced both by savings and loan associations and mutual savings. Competition for savings funds between financial intermediaries is primarily on a local basis.

$$(3-7) \Delta r_{SL} = .132 + \frac{.164}{(.053)} r_M + \frac{.153}{(.076)} r_{CB} - \frac{.367}{(.117)} r_{SL-1}$$

$$df = 9$$

$$R^2 = .75$$

$$S.E. = .06 \text{ percent}$$

data period: 1954-66

The regression results are reasonably good. All coefficients are more than twice their respective standard errors and the standard error of estimate is only .06 percent (i.e., six basis points). Two aspects of the results are worth comment. First, it is interesting to note that the coefficient on r_M is roughly minus one-half times that on r_{SL-1} , which is consistent with

⁴An individual savings and loan association is, of course, likely to compete for savings funds with other S&L's as well as with other types of financial intermediaries located in the same geographic area. But it is impossible to take account of intra-industry competition when using aggregate data. This should not be considered a shortcoming of the study, however, since we are interested only in developing a model that will be able to predict shifts of savings funds between different kinds of financial intermediaries; that is, inter-industry movements of funds.

constraint implicit in Equation (3-6).

Secondly, the coefficient on r_{SL-1} is small (in absolute value) and implies that savings and loan associations are slow to adjust deposit rates to changes in market conditions. This slow speed of adjustment is not surprising in light of the fact that the mortgage-dominated portfolios of savings and loan associations turn over quite slowly. Under these circumstances only a small proportion of any change in market mortgage yields shows up as a change in current portfolio earnings. Thus, in order to avoid large swings in profits, savings and loan associations appear to adjust deposit rates at a correspondingly slow pace.

Interest Rates Paid on Mutual Savings Bank Deposits

The regression results for mutual savings banks are shown in Equation (3-8). Like savings and loan associations, mutual savings banks face their stiffest competition from commercial banks, and the commercial bank rate (r_{CB}) appears in the regression equation with a significant coefficient. We were unable to get a measure of the rate of interest earned on investments by mutual savings banks to enter the equation with a positive coefficient. Both the mortgage yield and the corporate bond yield were tried, both obtained small negative coefficients, and both were subsequently dropped from the specification.

$$(3-8) \Delta r_{MS} = .813 + \frac{.374}{(.093)} r_{CB} - \frac{.503}{(.137)} r_{MS-1}$$

$$df = 10$$

$$R^2 = .64$$

$$S.E. = .06 \text{ percent}$$

The failure of either the mortgage or corporate bond yield to enter the regression equation may be related to the fact, pointed out earlier, that mutual savings banks were shifting the composition of their portfolios to accomodate a higher proportion of mortgages over the data period. However it is difficult to see how this could result in negative coefficients for the two variables.

In any event, the predictive ability of the equation is good, even though the equation does not contain a measure of yields earned by mutual savings banks on investments. The standard error of estimate is only six basis points, which is the same as was obtained in the equation for savings and loan rates. In addition, the coefficients on the commercial bank rate and the lagged savings bank rate seem to be of reasonable magnitudes. Comparison with the corresponding coefficients in the savings and loan equation shows both coefficients to be larger (in absolute value) in the case of mutual savings banks. This is reasonable in light of the fact that the more rapid turnover of mutual savings banks portfolios puts them in a better

position to adjust deposit rates quickly in response to changes in market conditions.

Interest Rates Paid on Commercial
Bank Savings Deposits

The derivation of an equation to represent the determination of savings deposit rates, paid by commercial banks is complicated by the fact that commercial banks are subject to interest rate ceilings under Regulation Q. The existence of regulatory ceilings would, of course, be no problem if the ceiling rates were always set higher than the interest rates commercial banks would like to pay. But such has not been the case. Regulation Q ceilings appear to have kept interest rates paid by commercial banks below the levels that would have been reached in the absence of such regulatory ceilings throughout most of the post-war period. The evidence to this effect is that changes in the regulatory ceilings have been followed in every case by abnormally large changes in interest rates actually paid by commercial banks. Regulation Q ceilings applicable to household savings deposits have been raised four times since the end of World War II; in January 1957, in January 1962, in November

1964, and in December 1965.⁵ Each of these increases was followed by a larger than normal increase in deposit rates. Regulation Q ceilings have been lowered only once; that occurring in two stages in the summer of 1966. A number of banks were forced to lower deposit rates as a result of that action.

Regulation Q ceilings must be explicitly represented in the regression equation. To do so, we have adopted the following functional form for the regression:

$$(3-9) \Delta r_{CB} = \gamma \left[(\bar{r}_{CB} - b \bar{r}_{CB} / r_{CB}^*) - r_{CB_{-1}} \right],$$

where $\bar{r}_{CB}$ denotes the Regulation Q ceiling rate and r_{CB}^* , as before, denotes the profit maximizing rate commercial banks would like to pay in the absence of Regulation Q. The functional form was first developed by Rasche and Shapiro and has several properties which make it a useful approximation to the way in which Regulation Q effects commercial banks' behavior in the aggregate.⁶ The equation is non-linear in r_{CB}^* in such a way that

⁵We remind the reader that the interest rate paid on household savings deposits (r_{CB}) is measured in this study by a single series which combines the passbook rate with the rate paid on small denomination CD's. For all intents and purposes r_{CB} may be considered to be the larger of the passbook rate or the small CD rate. By analogy, the Regulation Q ceiling rate ($\bar{r}_{CB}$) is measured as the higher of the passbook ceiling or the small CD ceiling.

⁶R. Rasche and H. Shapiro, "The Supply and Demand for Savings Deposits," Unpublished paper done in conjunction with the M.I.T.-F.R.B. Project, 1967.

$\bar{r}_{CB}$ becomes an asymptote above which r_{CB} cannot rise. A second desirable property of the equation is that it allows a change in the ceiling rate to have its greatest impact when r_{CB}^* is high relative to the ceiling. This is sensible because changes in the ceiling rate will affect the greatest number of banks when there are already many who wish to pay an interest rate higher than the old ceiling. A third desirable property is that the equation permits more of an increase in r_{CB}^* to be passed on in the form of higher interest rates paid to depositors when r_{CB}^* is low relative to $\bar{r}_{CB}$ than when it is high relative to $\bar{r}_{CB}$.

For all of these desirable properties we must, however, pay a price. The functional form poses a problem for estimation because the variable r_{CB}^* enters as a reciprocal. If we attempt to represent r_{CB}^* in the manner dictated by Equation (3-5) above, we will be unable to estimate the equation because it will be non-linear in its coefficients.⁷ However, as long as r_{CB}^* is represen-

⁷Substituting Equation (3-5) for r_{CB}^* into Equation (3-9) yields

$$\Delta r_{CB} = \gamma \left\{ \bar{r}_{CB} - b \bar{r}_{CB} / \left[\frac{1}{2} (r_E - A_0/A_1 + 1/A_1 \sum_{i=2}^n A_i r_i) \right] - r_{CB-1} \right\}$$

The equation is non-linear in r_E and the r_i and, hence, the coefficients A_i cannot be estimated through linear regression techniques. However, if r_{CB}^* is proxied by only one variable; e.g., $r_{CB}^* = Ar_L$, then the regression becomes

$$\Delta r_{CB} = \gamma \left[\bar{r}_{CB} - b/A (\bar{r}_{CB}/r_L) \right] - \gamma r_{CB-1}$$

The coefficients γ and b/A are estimable because the equation is linear in $\bar{r}_{CB}/r_L$.

ted by no more than one variable, the equation is estimatable. The price that must be paid then is the loss in predictive ability that results because only one variable may be used as a measure of the market forces which lead commercial banks to set interest rates paid on savings deposits. We have decided to use the yield on long-term U.S. Bonds (r_L) as this one variable proxy for r_{CB}^* , through the reasoning that this yield best approximates the sort of returns commercial banks earn on investing savings deposit funds. The regression results appear as Equation (3-10).

$$(3-10) \Delta r_{CB} = .201 + \frac{.743}{(.183)} \bar{r}_{CB} - \frac{1.463}{(.623)} \bar{r}_{CB}/r_L - \frac{.498}{(.138)} r_{CB-1}$$

$$df = 9$$

$$R^2 = .71$$

$$S.E. = .11 \text{ percent}$$

data period: 1954-1966

Best results were obtained when neither the constraint that the intercept be zero nor the constraint that the long run coefficient on $\bar{r}_{CB}$ be unity were applied. Relaxing these constraints appears, at first glance, to have given the estimated equation the implausible ability to predict values for r_{CB} that exceed the Regulation Q ceiling. The coefficient estimates yield an asymptote at a value of

$.404 + 1.492 \bar{r}_{CB} (= \frac{1}{.498} [.201 + .743 \bar{r}_{CB}])$, which exceeds $\bar{r}_{CB}$ by a considerable margin. However, the results should not be judged on the basis of the

asymptote, for this is the value of r_{CB} the equation would predict only if the yield on long term U.S. bonds were to rise without limit. For values of r_L within a reasonable range the equation predicts equilibrium values for r_{CB} that are quite plausible and lie below the Regulation Q ceiling. This is demonstrated by the calculations presented in Table 3-1 which show the equilibrium value of r_{CB} associated with various levels of $\bar{r}_{CB}$. It is apparent from these calculations that the equation would predict a value for the deposit rate which would exceed the Regulation Q ceiling only if the yield on long term U.S. bonds were to remain in the neighborhood of 6.00 percent or higher for an indefinite period.⁸ Historically the long term bond yield has fluctuated largely within the rather narrow range of 3.00 - 5.00 percent.

More important for our purposes are the short-run implications of the equation. The results suggest that changes in Regulation Q have a strong effect on interest rates commercial banks pay on savings deposits.

⁸ It is possible for the equation to predict a value for r_{CB} that exceeds $\bar{r}_{CB}$ at values of r_L less than 6.00 percent because the equation has an equilibrium intercept of .404. However, this is not a practical possibility as long as r_{CB} is maintained at or near its present level of 5.00 percent. In any event, the problem of predicting $r_{CB} > \bar{r}_{CB}$ can be eliminated entirely in computer simulations with the financial model by simply instructing the computer program to set $r_{CB} = \bar{r}_{CB}$ whenever the equation predicts r_{CB} to exceed the regulatory ceiling.

This is perhaps best illustrated by way of an example. If Regulation Q ceilings applicable to household-type savings deposits at commercial banks had been raised from 5.00 to 5.50 percent at the beginning of 1967, our equation implies that actual savings deposit interest rates would have been raised by an average of 0.23 percent (=23 basis points) during that year. Had such an event actually occurred, the shifts of savings deposits from savings and loan associations and mutual savings banks to commercial banks that took place in 1966 would probably have been repeated. In light of commercial banks' newly acquired ability to compete in the market for households' savings, the management of Regulation Q ceilings will be a key factor shaping the financial structure of the U. S. economy in the future.

Table 3-1

if r_L is constant at	r_{CB} will approach .404+
2.00.....	.022 $\bar{r}_{CB}$
3.00.....	.512 $\bar{r}_{CB}$
4.00.....	.757 $\bar{r}_{CB}$
5.00.....	.904 $\bar{r}_{CB}$
6.00.....	1.002 $\bar{r}_{CB}$
7.00.....	1.072 $\bar{r}_{CB}$

B. Demand for Savings Deposits

The equations representing demands for savings deposits all develop from a common framework. Annual changes in savings deposits are viewed as short-run adjustments by households attempting to bring deposit holdings more closely in line with some equilibrium or "desired" holdings. The "desired" holdings of any particular type of savings deposit (SD^*) are approximated by a relationship which is homogeneous in households' wealth (W):

$$(3-11) \quad SD_i^* = f_i(r_i, r_j, r_k) W, \text{ for } i \in [LI, SL, MS, CB] .$$

In addition to wealth, "desired" holdings are determined by factors embodied in the function f . Chief among these are the deposit rate offered on the type of deposit in question and interest rates paid on competing investments. Both f and its arguments vary with the different kinds of savings deposits and will be examined in detail below. Suffice it to say that variations in these non-wealth factors alter households' preferences for some types of savings deposits relative to other forms of holding wealth. An increase in the interest rate paid on savings and loan shares, for example, will lead households to "desire" more savings and loan shares and less of some other assets.

The wealth variable measures the total size of

the household sector's portfolio of assets. Note that it enters the equation for SD_i^* only as a scale factor and does not affect the composition of the portfolio. A doubling of wealth will double the "desired" holdings of all assets, so long as it is not accompanied by a change in the values of the non-wealth factors.

Actual deposit holdings seldom coincide with SD^* . "Desired" deposit holdings are constantly changing, and transactions costs associated with portfolio adjustments introduce lags in the response of households.⁹ We have attempted to approximate the adjustment process in the following manner:

$$(3-12) \quad \Delta \left(\frac{SD_i}{W} \right) = \gamma_i \left[\frac{SD_i^*}{W} - \left(\frac{SD_i}{W} \right)_{-1} \right], \text{ for } i \in [LI, SL, MS, CB]$$

The approximation takes the form of the familiar partial adjustment mechanism, except that it is the ratio of deposits to wealth, rather than the stock of deposits, that is adjusted. We have adopted this rather unusual specification because it allows us to differentiate between adjustments made in responses to changes in wealth and non-wealth factors. This is best seen when the equa-

⁹We refer here to both monetary and implicit transaction costs. Monetary costs include such things as interest lost when savings deposits are withdrawn before they have been held long enough to accumulate any. Implicit costs are the time and trouble involved in re-allocating portfolios. The latter are the more important cause of lags in adjustments of savings deposits. Many depositors are small savers, for whom the interest gains derived from maintaining "desired" balances are overwhelmed by the time and trouble of doing so.

tion is rewritten in levels after substituting Equation (3-11) for SD_i^* .

$$(3-13) \quad SD_i = \gamma_i \left[f_i(r_i, r_j, r_k) - \left(\frac{SD_i}{W} \right) \right] W \\ + \left[SD_{i-1} \quad \frac{W}{W_{-1}} \right]$$

The first term in brackets may be identified with shifts in portfolio composition. A positive value for this term indicates that the share of the total portfolio held in the form of SD_i is increasing. A negative value indicates that SD_i is decreasing as a proportion of the total portfolio. The sum total of this first term over all assets in the portfolio of the household sector must be zero over any time period because the total portfolio is equal to W . However, this is a consideration which we may ignore in the remainder of this chapter since we are dealing only with savings deposits and not all of the assets demanded by the household sector.

The second term in Equation (3-13) may be identified with changes in the size of the total portfolio. It shows the amount of any change in SD_i due to a change in wealth, or portfolio size. In the absence of any shifts in the composition of the portfolio, the percentage change in SD_i will be the same as the percentage change in W .

Before proceeding to the individual regression equations, a comment concerning the measurement of W is in order. We were never able to find a satisfactory measure for this variable. What is labeled as W in the regression equations that follow is simply a weighted average of current and lagged values of GNP, measured in billions of dollars at current prices. The precise relationship is

$$(3-14) \quad W = .382 \sum_{i=0}^4 (.67)^i \text{GNP}_{-i},$$

where the weights approximate Friedman's permanent income weights shortened to a five year horizon. Our sole reason for adopting this measure is that it was used with moderate success by De Leeuw in an earlier empirical study of the demand for savings deposits.¹⁰

The Demand for Savings Deposits at Life Insurance Companies

The reader is reminded that what we have called savings deposits at life insurance companies is a special construct consisting of policy reserves plus accumulated dividends less policy loans. The construct measures the net claims on life insurance companies of the household sector. It is obvious that the motives

¹⁰Frank De Leeuw, "A Model of Financial Behavior," in The Brookings Quarterly Econometric Model of the United States, James Duesenberry, et al (ed.), (Rand McNally and Company; Chicago, 1965).

for holding these claims differ from the motives for holding interest-bearing savings deposits. The principal motive for purchasing a life insurance policy is to obtain the insurance protection it offers. However many types of insurance policies embody contractual savings plans, and it is reasonable to expect that these savings plans become more or less attractive to purchasers as the interest rates offered on alternative forms of savings rise and fall. Thus at least a portion of household's claims on life insurance companies can be legitimately said to be a form of savings deposit.

We have specified the "desired" relationship for savings deposits at life insurance companies to be the following:

$$(3-15) \quad SD_{LI}^* = (A_0 - A_1 r_{CB} - A_2 r_{TB}) W,$$

where r_{CB} is, as before, the interest rate paid on household type savings deposits at commercial banks and r_{TB} is the market yield on 90-day Treasury bills. The two interest rates serve as measures of the rates of return available on investment alternatives to the contractual savings component of SD_{LI} . The insurance protection motive for investing in life insurance policies is implicitly embodied in the component $A_0 W$; that is, we are implicitly saying that the demand for life insurance protection is proportional to the wealth of the household sector.

Substituting Equation (3-15) into Equation (3-12) and taking first-differences yields the form of the demand equation used in the regression analysis.

$$(3-16) \quad \Delta \left(\frac{SD_{LI}}{W} \right) = -A_1 \Delta r_{CB} - A_2 \Delta r_{TB} + (1 - \gamma) \Delta \left(\frac{SD_{LI}}{W} \right)_{-1}$$

Note that first-differencing has eliminated the coefficient A_0 , making it impossible to directly test our implicit hypothesis concerning the demand for life insurance protection. A low S.E. in the resulting regression would, however, indirectly confirm our hypothesis.

The regression results are presented as Equation (3-17). In order to better interpret the predictive ability of the regression, an additional descriptive statistic has been included with the results. This is the mean absolute error (MAE) made in predicting dollar values of SD_{LI} from the equation over the data period. The MAE is a more meaningful statistic than the standard error of estimate in this case, when our object is to develop an equation capable of predicting SD_{LI} in levels.

$$(3-17) \quad \Delta \left(\frac{SD_{LI}}{W} \right) = .0013 - .0056 \Delta r_{CB} - .0017 \Delta r_{TB} + .5902 \Delta \left(\frac{SD_{LI}}{W} \right)_{-1}$$

$(.0026) \quad (.0006)$

$$df = 9$$

$$R^2 = .70$$

$$S.E. = .0016$$

$$MAE \text{ of } SD_{LI} = \$.50 \text{ Bil.}$$

data period: 1954-66

In terms of R^2 and MAE the regression results are satisfactory. In addition all coefficients are more than twice their standard errors. The interest rate coefficients are surprisingly large, especially the one on the commercial bank deposit rate. At current values of W (= \$628 billion in 1965), the coefficient on Δr_{CB} implies that a one percentage point rise in the interest rate paid on household type savings deposits at commercial banks would cause savings deposits at life insurance companies to fall by \$3.4 billion within one year.

Demands for Interest-Bearing Savings Deposits

The three types of interest-bearing savings deposits -- savings and loan shares, mutual savings bank deposits, and household savings deposits at commercial banks -- are such similar assets that it is necessary to take great care to distinguish between those factors that affect the demand for all of them in the same manner and those factors that cause one type of deposit to be preferred to the others. In addition to paying interest, they are all virtually free of default risk and are subject to free and easy withdrawal.¹¹ These latter two characteristics are what make investors

¹¹ Savings balances at nearly all savings and loan associations are insured by the FSLIC. Those at mutual savings banks and commercial banks are insured by the FDIC.

want to hold some interest-bearing savings deposits even when their interest rates are lower than those obtainable on marketable securities. Investors are willing to sacrifice higher yields in order to obtain the safety and liquidity provided by savings deposits. The substitution of safety and liquidity for yields takes the form of a trade-off. As yields on marketable securities rise relative to those paid on savings deposits, more investors are willing to hazard the risks of the open market, and their demands for savings deposits decline. Yields on marketable securities are the primary factors that influence the demands for all interest-bearing savings deposits taken collectively.

To identify the factors which make one type of deposits more attractive than the others is more difficult. Surely differences in deposit rates offered by the different institutions are the most important among these. Funds are naturally attracted to the financial intermediaries paying the highest deposit rates. Another major factor is geography. Few depositors are willing to put their funds into financial intermediaries not located in the area in which they work and live. The fact that savings and loan associations and mutual savings banks are concentrated in different areas of the country means that there are few depositors who consider deposits issued by these two institutions to

be substitutes. For all practical purposes we can treat savings and loan shares and mutual savings bank deposits to be non-competing assets in the aggregate. This reduces the problem to the two-fold one of identifying the factors that influence a depositor's choice between deposits at commercial banks and mutual savings banks in some parts of the country, and between deposits at commercial banks or savings and loan associations in other parts. In choices of this sort, things other than deposit rates must play a role. Otherwise, how can one explain why households have continually maintained large savings deposit balances at commercial banks throughout the post-war years, in spite of large deposit rate differentials that have, until recently, favored the non-bank intermediaries? The phenomenon can only be explained by such immeasurables as convenience, preferences, and even ignorance. There must be large numbers of depositors who find it convenient to hold their savings balances at banks, or who prefer banks to non-bank intermediaries for various historical or other reasons, or who are ignorant of the alternatives.

The immeasurable factors act to reduce the extent to which choice of savings institution is affected by interest rate differentials. To illustrate, consider the individual who, having decided to invest X dollars in savings deposits, is trying to decide whether to put

it all into commercial bank deposits, to put it all into savings and loan shares, or to split it in some combination between the two. First, note that he has nothing to gain from splitting the sum between the two. There are no risks to be reduced by diversification among interest-bearing savings deposits.¹² Savings deposits bear neither the risk of default nor of capital loss. He will invest the entire X dollars in either one or the other. But in which? If our individual is typical, he already has a checking account at the commercial bank. It would be convenient for him to locate his savings account at the same place. Having a savings account at the bank would enable him to co-ordinate future checking and savings operations; to transact them at the same counter. Suppose our individual is typical in this sense. He will, therefore, choose the commercial bank deposit, providing it pays an interest rate at least as high as that offered by the savings and loan association. He will even choose the bank if it pays a slightly lower rate because it is more convenient. In order for the individual to prefer the savings and loan shares,

¹²By this we mean risks of default or capital loss. There are some other types of risks that may be reduced by diversification for some isolated individuals. For example, a depositor might find that by maintaining a savings balance at both the local commercial bank and the local savings and loan association he reduces the risk that he will be refused a loan at both places. However, such considerations are irrelevant for the average depositor.

they would have to pay him an interest rate far enough in excess of the bank's rate to overcome their inconvenience. Let us denote by $(r_{SL} - r_{CB})^0$ the (positive) interest rate differential at which the individual would be indifferent between the two types of deposits. For all $(r_{SL} - r_{CB}) < (r_{SL} - r_{CB})^0$, he prefers the commercial bank. For all $(r_{SL} - r_{CB}) > (r_{SL} - r_{CB})^0$, he prefers the savings and loan association. Variations in the rate differential do not affect his choice unless they involve movements across $(r_{SL} - r_{CB})^0$. The difference in convenience the individual attaches to the two types of savings deposits does not change the "all or nothing" nature of his decision.

For every such person faced with the choice between savings and loan shares and commercial bank deposits there is an interest differential at which he is indifferent between the two. It varies from person to person, according to preferences, habits, and personal evaluations of the relative convenience associated with the two types of savings deposits. At any point in time the distribution of $(r_{SL} - r_{CB})^0$ over the entire population of these persons might look like the curve depicted in Figure 3-1. The curve shows the number of persons indifferent between savings and loan shares and commercial bank deposits at alternative deposit rate differentials. More than half of the curve

is drawn to the right of the vertical axis to indicate that the majority of persons would prefer savings and loan shares only at a positive rate differential. The large proportion of persons concentrated near the peak of the distribution represent active investors, for whom preference and convenience are only minor considerations. Further to the right (left) on the curve are persons more firmly entrenched in their preferences for commercial banks (savings and loan associations). The inter-personal differences represented by Figure 3-1 imply that any variation in $(r_{SL} - r_{CB})$ will be enough to cause some persons to switch their preferences from one type of deposits to the other. What this means for the specification of deposit demands is best illustrated by the integral of the curve. At any given deposit rate differential, the integral from $-\infty$ is the total number of persons preferring savings and loan shares.

The integral is depicted in Figure 3-2. It is roughly an S-shaped curve steep in the center and flat at the extremes. While it is true that any increase in the deposit rate differential will increase the number of persons who prefer savings and loan associations to commercial banks, the number of depositors responding to changes in the differential is seen to vary considerably with the level of that differential. At extreme values of $(r_{SL} - r_{CB})$ few depositors respond.

Figure 3-1
DISTRIBUTION OF DEPOSITORS INDIFFERENT BETWEEN
SAVINGS AND LOAN ASSOCIATIONS AND COMMERCIAL BANKS

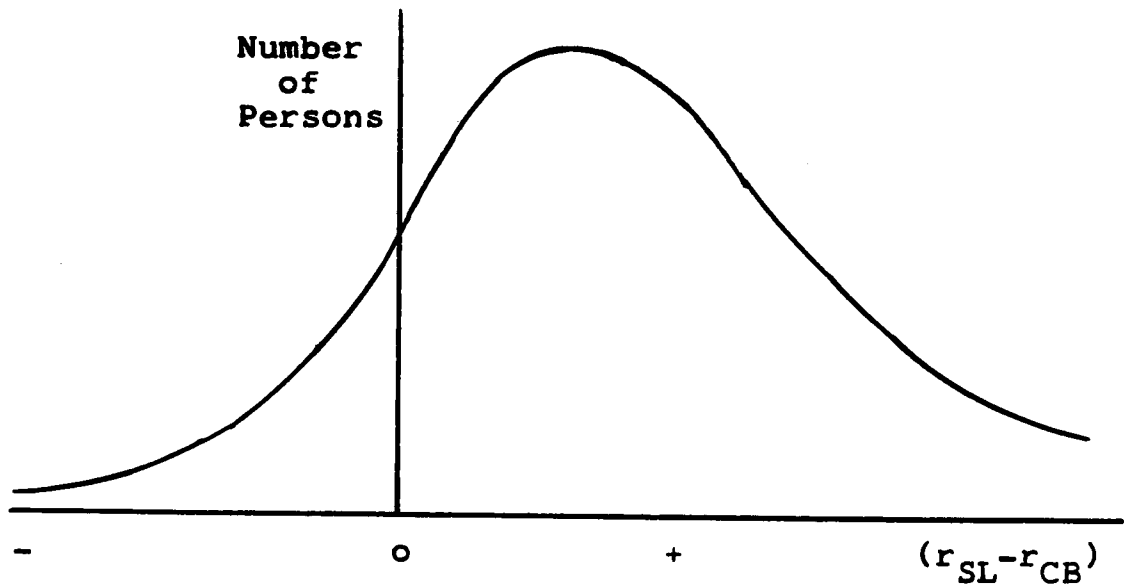
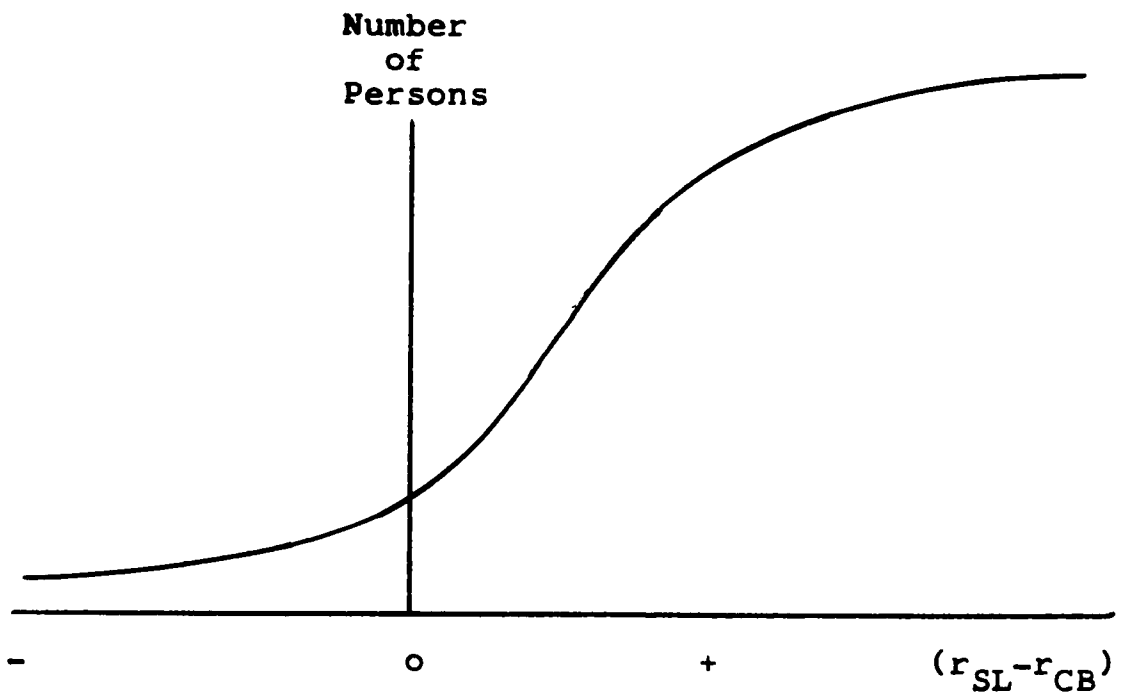


Figure 3-2
TOTAL NUMBER OF DEPOSITORS PREFERRING SAVINGS
AND LOAN ASSOCIATIONS TO COMMERCIAL BANKS



However, at small values of $(r_{SL} - r_{CB})$ -- beneath the steep portion of the curve -- the number of depositors responding to change in the differential is large. It is here, where savings and loan associations and banks are offering nearly identical deposit rates, that deposit rate competition can result in large transfers of savings funds.

Figure 3-2 is helpful in explaining actual movements in savings and loan shares over the post-war period. Throughout the early post-war years, savings and loan associations were able to maintain large deposit rate differentials over commercial banks. The upper right-hand portion of the curve depicts these years. Starting in 1957 and aided by the succession of increases in Regulation Q ceilings, banks began to reduce the differential. Between 1957 and 1964, $(r_{SL} - r_{CB})$ was reduced from 1.40% to .90%. However this resulted in few deposits being shifted from savings and loan association to commercial banks. At the end of 1964 depositors were still on the upper right-hand portion of the curve, albeit closer to the steep portion. Then in late 1965, Regulation Q ceilings were raised again. Banks began issuing small denomination CD's that paid interest rates as high as those paid on savings and loan shares. The steep portion of the curve became relevant. As a consequence of the virtual elimination of their favor-

able rate differentials, savings and loan associations began losing large quantities of deposits to commercial banks in late 1965 and early 1966. These losses moderated only after Regulation Q ceilings on small CD's were lowered in mid-1966.

There is nothing about the preceding discussion that limits its applicability to savings and loan shares. We could just as easily have focused on the choice between deposits at mutual savings banks and commercial banks, and arrived at the same conclusions. The number of depositors preferring mutual savings banks to commercial banks is affected by the deposit rate differential ($r_{MS} - r_{CB}$) in the manner of Figure 3-2. In fact, the post-war experience of mutual savings banks has been remarkably similar to that of savings and loan associations. Mutual savings banks also lost most of their favorable deposit rate differential to commercial banks in late 1965 and early 1966. With this in mind, we are now prepared to specify demand equations for the three kinds of interest-bearing savings deposits.

The Demand for Savings and Loan Shares

"Desired" holdings of savings and loan shares are expressed as

$$(3-18) \quad SD_{SL}^* = (A_0 + A_1 t - A_2 r_L + \alpha_1 r_{SL} - \alpha_2 r_{CB}) W,$$

where t denotes a time trend and the other variables are as previously defined. The trend was included in

the specification as a means of capturing any secular changes in households' preferences for savings and loan shares that may have occurred over the data period. Savings and loan associations have become increasingly popular with small savers over the post-war period and we expect the coefficient on the trend to have a positive sign.

The yield on long-term U. S. bonds appears in the expression as a measure of the yields obtainable on marketable securities. With our limited degrees of freedom no more than one variable could be entered for this purpose but since yields on marketable securities tend to rise and fall together, one should be sufficient. Actually, before settling on r_L , we experimented in regressions for SD_{SL} with yields on U. S. securities of different maturities -- 90 day bills, 9-12 month bills, and 3-5 year securities as well as long-term bonds. Regression results proved remarkably insensitive to choice of yield and the long-term yield was retained because it appears elsewhere in the model.

The coefficients, α_1 and α_2 are not constants, but vary with the differential between r_{SL} and r_{CB} . Specifically:

$$\alpha_1 = \Lambda_3 - b(r_{SL} - r_{CB})^2$$

$$\alpha_2 = \Lambda_4 - b(r_{SL} - r_{CB})^2$$

Allowing α_1 and α_2 to vary in this manner produces an S-shaped relationship (approximating that of Figure 3-2) between SD_{SL}^* and $(r_{SL} - r_{CB})$ over the range $-(A_3/3b)^{1/2} \leq (r_{SL} - r_{CB}) \leq + (A_3/3b)^{1/2}$

This can best be seen by substituting for α_1 and α_2 in Equation (3-18) and writing the result as

$$(3-19) \quad SD_{SL}^* = [A_0 + A_1 t - A_2 r_L + A_3 r_{SL} - A_4 r_{CB} - b(r_{SL} - r_{CB})^3] w$$

Taking $\partial SD_{SL}^* / \partial r_{SL}$ from this expression yields

$$(3-20) \quad \partial SD_{SL}^* / \partial r_{SL} = [A_3 - 3b(r_{SL} - r_{CB})^2] w$$

In our earlier discussion we were led to hypothesize that $\partial SD_{SL}^* / \partial r_{SL}$ should always be positive, but should diminish in magnitude as the absolute value $|r_{SL} - r_{CB}|$ increases. As can be seen from Equation (3-20), our mathematical approximation of SD_{SL}^* does yield this behavior, but only for values of $(r_{SL} - r_{CB})$ between $-(A_3/3b)^{1/2}$ and $+(A_3/3b)^{1/2}$. For values of $(r_{SL} - r_{CB})$ outside this range, the approximation is not valid because $\partial SD_{SL}^* / \partial r_{SL} < 0$.

The fact that Equation (3-19) approximates the hypothesized behavior only over a certain range of values for the differential between r_{SL} and r_{CB} raises the question of whether that specification can legitimately be used as the basis for a regression equation. The answer to this question is an empirical one. The regression equation derived from substituting Equation (3-19) into Equation (3-12) will yield estimates

of δA_3 and δb , where δ denotes the speed of adjustment coefficient. With these estimates the ratio $(\hat{\delta A_3})/3(\hat{\delta b})$, which is an estimate of $A_3/3b$, may be calculated. If none of the observed values of $(r_{SL} - r_{CB})$ fall far outside the range $[-\hat{\delta A_3}/3(\hat{\delta b}), + \hat{\delta A_3}/3(\hat{\delta b})]$, the approximation may be considered adequate.

The results of such a regression are shown as Equation (3-21) below. Taking the prescribed ratio $[.0299/3(.0046)]$ yields the result that the regression equation possesses the desired property (i.e., that

$\partial SD_{SL}^* / \partial r_{SL} > 0$ over the range $-.148\% \leq (r_{SL} - r_{CB}) \leq + 1.48\%$. Two of the values of $(r_{SL} - r_{CB})$ observed over the data period lie just outside this range; the value for 1954 (1.60%) and the value for 1955 (1.50%). All of the other observations fall well within this range. This, together with the fact that the spread between r_{SL} and r_{CB} had narrowed to .16% by 1966 and is unlikely to widen substantially in the near future, makes the regression equation appear acceptable.

In terms of standard errors and goodness of fit measures the regression results are quite good. The equation makes a mean absolute error (MAE) in predicting the dollar level of savings and loan shares over the data period of \$.64 billion. Even the largest prediction error, an over-estimate of \$1.40 billion in 1964, is small relative to the year-to-year move-

ments in savings shares that have occurred over the period.

$$(3-21) \Delta \left(\frac{SD_{SL}}{W} \right) = .0040 \underset{(.0025)}{\Delta r_L} + .0299 \underset{(.0086)}{\Delta r_{SL}} - .0270 \underset{(.0060)}{\Delta r_{CB}} \\ - .0046 \underset{(.0018)}{\Delta (r_{SL} - r_{CB})^3} + .6336 \underset{(.2726)}{\Delta \left(\frac{SD_{SL}}{W} \right)} - 1$$

$$df = 7$$

$$R^2 = .91$$

$$S.E. = .0016$$

$$MAE \text{ of } SD_{SC} = \$.64 \text{ Bil.}$$

data period: 1954-66

As anticipated, the equation shows evidence of trend increases in depositors' preferences for savings and loan shares once the past decade and one-half. This is indicated by the positive value of the intercept, which in a first-difference equation measures trend movements in the dependent variable.

A more important aspect of the regression equation is its implications for the response of savings shares to changes in interest rates. A comparison of the relative size of the coefficient on Δr_L with those on Δr_{SL} and Δr_{CB} indicates that savings shares are less responsive to changes in long-term U. S. bond yield than to changes in deposit rates. However, the cubic term must not be overlooked in evaluating the effects of changes in r_{SL} or r_{CB} . The significant (at the 5% level) negative coefficient on $\Delta (r_{SL} - r_{CB})^3$ con-

firms our hypothesis that depositors react more strongly to changes in deposit rates when savings and loan associations and commercial banks are paying similar interest rates on savings deposits than when they are not. Some idea of the magnitudes involved can be gained through the following illustration. According to the regression equation, a 1.00 percent increase in r_{SL} , with $(r_{SL}-r_{CB})$ initially equal to .89 percent (as it was in 1964), would stimulate an increase in savings and loan shares equal to .0135 W within the course of a year. The same increase in r_{SL} , with $(r_{SL}-r_{CB})$ initially equal to .16 percent (as it was in 1966), would stimulate an estimated increase in SD_{SL} of .0237 W. Using 1965 values of W (= \$628.0 Bil.) for comparison, the difference between the two estimated responses is \$6.4 billion. This is a considerable difference which shows just how sensitive the demand for savings and loan shares is to the differential between r_{SL} and r_{CB} .

The Demand for Mutual Savings Bank Deposits

The analysis which led to the specification of Equation (3-19) for the "desired" holdings of savings and loan shares is equally appropriate for mutual savings bank deposits. Consequently "desired" holdings of mutual savings bank deposits have been specified to take the form of Equation (3-19) with r_{MS} , the interest

rate paid by mutual savings banks, replacing r_{SL} . Regression results based on that formulation appear below.

$$(3-22) \quad \Delta \left(\frac{SD_{MS}}{W} \right) = .0008 - \frac{.0047}{(.0015)} \Delta r_L + \frac{.0089}{(.1188)} \Delta r_{MS} - \frac{.0073}{(.1147)} \Delta r_{CB} \\ - \frac{.0028}{(.0020)} \Delta (r_{MS} - r_{CB})^3 + \frac{.4720}{(.3256)} \Delta \left(\frac{SD_{MS}}{W} \right)_{-1}$$

$$df = 7$$

$$R^2 = .74$$

$$S.E. = .0009$$

$$MAE \text{ of } SD_{MS} = \$.38 \text{ Bil.}$$

data period: 1954-66

The problem of large standard errors on the regression coefficients that has followed our empirical efforts with relationships involving mutual savings banks is again in evidence. Yet the equation yields a mean absolute prediction error for SD_{MS} of only \$.38 billion over the data period. In this latter respect, at least, the regression results are reasonably good.

The interest rate coefficients are all lower than their respective values for savings and loan associations. This is reasonable in light of the fact that there were fewer total savings bank deposits than savings and loan shares throughout the data period. However, the coefficient on Δr_L in this case is nearly as large as it is for savings and loan shares, which suggests that savings banks are relatively more suscep-

tible to deposit fluctuations in response to changes in open market yields than are savings and loan associations. The negative coefficient on $\Delta (r_{MS} - r_{CB})^3$ indicates that the magnitude of a change in SD_{MS} in response to a change in either r_{MS} or r_{CB} is also dependent on the size of the differential between r_{MS} and r_{CB} .

The range of values for $(r_{MS} - r_{CB})$ over which the regression equation is a valid approximation to the hypothesized behavior may be calculated as

$$\left[- .0089 / 3(.0028) \quad , \quad + \quad .0089 / 3(.0028) \right].$$

This turns out to be $(-1.03\% + 1.03\%)$. The observed value for $(r_{MS} - r_{CB})$ in each of 1955, 1956, and 1957, was 1.20 percent, which does fall beyond this range. However, we again feel that this is not sufficient to render the regression equation useless for predicting the volume of mutual savings bank deposits in periods like the present, when the differential between r_{MS} and r_{CB} is quite small (.20% in 1966) and likely to remain so. The fact that the equation yields accurate predictions for SD_{MS} over the data period goes a long way towards justifying our decision to retain it.

The Demand for Household Savings Deposits at Commercial Banks

Except for the yields on marketable securities, which affect all deposit demands in the same direction,

the factors increasing households' demands for savings deposits at commercial banks are the reverse of those that increase households' demands for savings deposits at non-bank financial intermediaries. An equation "explaining" $\Delta(SD_{CB}/W)$ should, therefore include as independent variables all of the deposit rate variables appearing in either Equation (3-21) for $\Delta(SD_{SL}/W)$ or Equation (3-22) for $\Delta(SD_{MS}/W)$. Specifically this means that all of the following should appear as independent variables in the equation: Δr_{CB} , Δr_{SL} , Δr_{MS} , $\Delta(r_{SL}-r_{CB})^3$, and $\Delta(r_{MS}-r_{CB})^3$ in addition to the lagged dependent variable and an open market security yield. Obviously any attempt to estimate such an equation with only fourteen annual observations would prove futile. There are simply too many variables for so few degrees of freedom. In addition the problems of multicollinearity among the five variables involving deposit rates are simply overwhelming.

Faced with these problems, it was necessary to make several concessions in order to obtain a regression equation for $\Delta(SD_{CB}/W)$. First, the variables $\Delta(r_{SL}-r_{CB})^3$ and $\Delta(r_{MS}-r_{CB})^3$ were omitted from the regression since they are likely to be the least important in terms of explanatory power. This served to reduce the number of independent variables to manageable size. Secondly, the coefficient on Δr_{SL} was constrained to be twice as

large (in absolute value) as that on r_{MS} . This was done to reduce multicollinearity among the deposit rates. For changes in r_{SL} to have twice the impact of changes in r_{MS} seems reasonable in light of the fact that deposit liabilities of savings and loan associations have been roughly twice those of mutual savings banks since 1959.

The regression results are shown in Equation (3-23). In spite of its simplifications the regression equation produces fairly small residual errors. Its mean absolute error in predicting dollar values of SD_{CB} is only \$.61 billion, which is small when compared with the \$6 to \$7 billion average annual increase in SD_{CB} that occurred over the data period. The yield on 90-day Treasury bills (r_{TB}) appears in the equation instead of the long-term U. S. bond yield used in the equations for savings and loan shares and mutual savings bank deposits. The switch was made in this case because the bill yield gave slightly better results.

$$(3-23) \Delta \left(\frac{SD_{CB}}{W} \right) = .0001 \frac{-.0025}{(.0011)} \Delta r_{TB} + .0287 \frac{.0287}{(.0064)} \Delta r_{CB} \\ - .0082 \frac{.0082}{(.0036)} (2 \Delta r_{SL} + \Delta r_{MS}) + .6111 \frac{.6111}{(.2713)} \Delta \left(\frac{SD_{CB}}{W} \right)_{-1}$$

$$df = 7$$

$$R^2 = .79$$

$$S.E. = .0022$$

$$MAE \text{ of } SD_{CB} = \$.61 \text{ Bil.}$$

data period: 1954-65

The equation was fit to annual observations over the period 1954-65. The 1966 observation was excluded because of an unusual set of circumstances that prevailed in that year. In late 1966 household savings deposits at commercial banks registered a sharp decline. Surveys taken by the Board of Governors over this period indicate that, when classified by type of deposit, the only type of time deposits that experienced such a decline were large denomination ($\geq \$100,000$) CD's.¹³ Apparently the series for household deposits includes some unknown quantities of these instruments.¹⁴ Recall that our distinction between household and "other" deposits was motivated by a desire to separate large denomination CD's from other types of time deposits. In the absence of a continuing series classifying deposits by type, separating deposits by household and "other" is as close as we can come to making such a distinction. In most cases the distinction is workable. To the extent that households do hold some quantities of large denomination CD's, these are likely to fluctuate sharply only during and immediately following periods in which the interest rates paid on them are

¹³ See the August 1966 and April 1967 issues of the Federal Reserve Bulletin.

¹⁴ Some large denomination CD's are undoubtedly held by individuals. However, more are probably held in personal trusts or by non-profit institutions, both of which are included in the Flow of Funds' definition of the household sector.

constrained by Regulation Q ceilings. This was the case in the second half of 1966, when yields on short-term marketable securities rose above the 5½ percent ceiling on large denomination CD's. The funds that deserted large denomination CD's in late 1966 returned to them in early 1967 after market pressures had subsided.

As long as the Federal Reserve Board does not permit Regulation Q ceilings to inhibit banks' abilities to adjust large CD rates to market conditions, Equation (3-23) should provide reasonably accurate predictions. By raising the ceilings applicable to them, in conjunction with policies of general credit restraint in early 1968, the Board has demonstrated that it does not want the 1966 experience to be repeated during every period of tight money. However, if rates paid on large denomination CD's ever do become constrained by Regulation Q ceilings again, we at least have an estimate of the probable impact on household savings deposits in the form of prediction errors made by Equation (3-23) for 1966 and 1967. For 1966 the equation over-predicts by \$6.0 billion. For 1967 it under-predicts by \$5.0 billion. Henceforth, we will express the demand for household deposits at commercial banks as

$$(3-24) \quad \Delta \left(\frac{SD_{CB}}{W} \right) = .0001 - .0025 \Delta r_{TB} + .0287 \Delta r_{CB} \\ - .0082 (2 \Delta r_{SL} + \Delta r_{MS}) + .6111 \Delta \left(\frac{SD_{CB}}{W} \right)_{-1} - .0080 \Delta d_1$$

The variable d is a dummy variable defined as follows:

$$d = \begin{cases} 1, & \text{if the secondary market yield on large,} \\ & \text{negotiable CD's exceeds its ceiling} \\ 0, & \text{otherwise} \end{cases}$$

Its coefficient of .0080 is a compromise estimate based on the 1966 and 1967 prediction errors. Expressing d_1 in first-differences, gives the equation the ability to predict the return of large denomination CD funds during periods immediately following constraint by Regulation Q ceilings.

CHAPTER IV

DETERMINATION OF MARKET INTEREST RATES

In this chapter we derive and estimate the remaining equations of the financial model. Equations are developed in Sections A - C which represent the determination of yields on 90-day Treasury bills, long-term U. S. bonds, and corporate bonds, respectively. In the course of this analysis several new variables, also endogenous to the financial sector, are used as arguments. Consistency requires that these also be "explained," and a fourth section has been included for that purpose. Specifically, Section D contains equations representing: (1) the demand for hand-to-hand currency, (2) the demand for commercial bank time deposits by non-household private sectors, and (3) the determination of secondary market yields on large negotiable CD's.

Before proceeding to Section A a brief explanation of our approach to the determination of interest yields may be found useful. The interest yield on any marketable security is the "price" that equates supply and demand for that security. Interest yields are, therefore, determined by the intersection of

market supply and demand curves. However in U. S. securities markets, individual supply and demand factors are not clearly distinguishable. Buyers and sellers have historically exhibited a high degree of mobility between the markets for various types of securities, and the different marketable securities are generally regarded as close substitutes. Consequently we find that the interest yield on any particular security is influenced by variations in supply and demand in other markets as well as its own. The result is the often observed tendency for all interest yields to rise and fall together.

Under such conditions it is advantageous to view the determination of interest yields on individual securities as occurring in two stages. First, elements of supply and demand for total credit interact to determine the general level of interest rates. Secondly, given this general level, investors preferences and expectations of future movements in interest rates act to determine the relative structure of interest yields. By looking at the determination of interest yields in this manner it is possible to distinguish between those factors which affect all interest yields in the same way (the first stage) and those which affect some yields but not others (the second stage).

In developing equations to represent determination

of interest yields on 90-day Treasury bills, long-term U. S. bonds, and corporate bonds, we have attempted to simulate this two-stage process. First, one interest yield is selected to serve as representative of the general level of interest rates. This yield is expressed as a function of the elements of the supply and demand for total credit. Once the role of supply and demand has been investigated in the case of this representative yield, it is not necessary to repeat the analysis for the others. Instead we can simply "explain" these others on the basis of factors which cause them to deviate from the representative yield. It is important to recognize that the choice of representative yield is arbitrary. Since it is to be explained solely on the basis of factors common to all, no one interest yield is more ideally suited to the task than the others. We have chosen the interest yield on 90-day Treasury bills to serve as the representative yield, but merely because this choice makes it easier to compare our results with those obtained by others.

A. Yields on 90-Day Treasury Bills

We have approximated the mechanism that determines the level of interest rates by an "unstructured" equation that depicts 90-day Treasury bill yields as a function of a set of variables influencing the supply and demand for commercial bank credit. It is "unstructured"

in the sense that, rather than attempt to spell out explicitly the supply of bank credit, we have represented supply factors by a set of parameters which define the potential capacity of the banking sector to extend credit. To be more precise, we have specified the logarithm of the 90-day Treasury bill yield to be a linear function of the logarithms of the following variables:

- (1) GNP - as a measure of the demand for credit
- (2) L^* , the maximum quantity of loans and investments that can be supported by a given volume of unborrowed bank reserves supplied by the Federal Reserve. L^* is defined as:

$$L^* = \left[\left(\frac{1-k_1z_1}{k_1z_1} \right) RU + \left(\frac{k_1z_1 - k_2z_2}{k_1z_1} \right) TD \right], \text{ where}$$

RU = unborrowed reserves

TD = total time deposits adjusted at all commercial banks.¹

k_1 = average legal reserve requirements on member bank demand deposits

z_1 = the proportion of total demand deposits held in member banks

k_2 = legal reserve requirements on member banks time deposits

z_2 = the proportion of total time deposits held in member banks

This specific form was derived from the following: the quantity of loans and investments supported by a given volume, RU, of unborrowed reserves is a maximum when the total of RU is absorbed by reserve require-

¹Time deposits adjusted are defined as time deposits at all commercial banks other than those due to the U.S. Government and domestic commercial banks.

ments, i.e., when $RU = k_1 z_1 DD + k_2 z_2 TD$, where DD denotes demand deposits.² Under those conditions, total loans are given by $L^* = (1 - k_1 z_1)DD + (1 - k_2 z_2)TD$. Combining the expressions for RU and L^* to eliminate DD yields the desired result.

- (3) r_d , the Federal Reserve discount rate - as a measure indicating the ability of banks to supplement reserves by borrowing from the Fed.
- (4) CURR, the public holdings of hand-to-hand currency - as a measure of the drain on bank reserves originating outside the Fed.

From the arguments presented in the introduction to the chapter, it should be apparent that this list of variables need not be restricted to supply and demand factors at commercial banks. Indeed, a logically complete list would be composed of factors influencing the supply and demand for total credit. But unfortunately we do not have enough degrees-of-freedom to include all the variables that would be required for such a specification. Consequently we have had to limit ourselves to what we believe to be most important in determining the level of interest rates. The decision to include only variables relating to commercial banks was made on the basis of the realization that: (1) commercial banks are, after all, the largest single source of credit in the U. S. economy, and (2) nearly all policy actions taken by the Federal Reserve operate through the commercial banking system. It is important that

the activities of the Federal Reserve be represented in the specification, because it does have, and sometimes exercises, the power to maintain the level of interest rates within a narrow range. Embodied in the variables in our list are the major policy instruments of the Federal Reserve -- legal reserve requirements on both time and demand deposits, the discount rate, and un-borrowed reserves, which vary with open market operations.

The empirical results are presented as Equation (4-1). The estimated equation fits the observed data quite well and yields predictions that are close to actual values. The mean absolute prediction error for r_{TB} is 16 basis points, which compares favorably with the published results of previous studies.

$$(4-1) \quad \ln r_{TB} = 9.662 + 3.606 \ln GNP - 3.934 \ln L^* \\ \quad \quad \quad (1.241) \quad \quad \quad (.992) \\ + .767 \ln r_d + 2.297 \ln CURR \\ \quad \quad \quad (.262) \quad \quad \quad (.599)$$

$$\begin{aligned} df &= 10 \\ R^2 &= .97 \\ S.E. &= .08 \end{aligned}$$

$$MAE \text{ of } r_{TB} = .16\%$$

data period: 1952-66

All coefficients are significant by the usual statistical tests and, with the exception of that on the discount rate, seem to be of reasonable magnitudes. If the coefficient on $\ln r_d$ is taken at face value, it

implies that a one percent change in the Federal Reserve discount rate will give rise to a change of about .77 percent in the yield on 90-day Treasury bills. Considering that the probable effect of a change in the discount rate is to alter banks' willingness to borrow from the Fed, an impact of this magnitude is inconsistent with the relatively small fluctuations in borrowings that are actually observed. The estimate .77 undoubtedly overstates the impact of the discount rate. The reason an estimate this high was obtained is hardly a mystery. The Federal Reserve Board often changes the discount rate in a passive manner -- adjusting it to movements in short-term interest rates, ex post. That is, changes in the discount rate are often initiated by movements in short-term interest rates rather than vice versa. When the Fed does adjust the discount rate in this manner, it is merely trying to keep the interest rate that borrowing banks must pay in line with the sort of yield banks are earning on their own loans and investments. Unfortunately these passive movements add to the correlation between movements in 90-day bill yields and the discount rate and cannot be distinguished in regression analysis; consequently the impact of r_d on r_{TB} is bound to be overestimated. There is no way to correct for this, short of eliminating the variable from the equation entirely. But to omit a variable is tantamount

to saying that it has no impact at all, and as surely as we know that the coefficient .77 is an overestimate, we know that 0.0 is an underestimate. Nonetheless we have re-estimated the equation without the discount rate to see what effect it would have on the other coefficients. The results are shown below.

$$(4-2) \quad \ln r_{TB} = -.17.434 + \underset{(.708)}{6.864} \ln GNP - \underset{(.781)}{6.224} \ln L^* \\ + \underset{(.765)}{2.374} \ln CURR$$

$$\begin{aligned} df &= 11 \\ R^2 &= .94 \\ S.E. &= .10 \end{aligned}$$

$$MAE \text{ of } r_{TB} = .19\%$$

data period: 1952-66

Elimination of the discount rate has the effect of increasing (in absolute value) all of the other coefficients except that on $\ln CURR$. Most affected are the coefficient on GNP and the intercept. There is little basis on which to choose between Equations (4-1) and (4-2). In predictive ability there is not much difference between the two, although (4-1), with the discount rate and its spurious correlation, does have a slightly lower mean absolute prediction error over the data period. With regard to the implications for the effects of specific policy instruments, their differences are a little more pronounced. For a \$1 billion increase in unborrowed reserves, Equation (4-1) would predict a

ten percent decline in 90-day bill yields, whereas (4-2) would predict a sixteen percent decline. At current values of r_{TB} , this amounts to a difference of about thirty basis points. However, since the feedback effects through time deposits and GNP are stronger for (4-2), the difference is likely to be considerably less than thirty basis points after allowing for all simultaneous relationships between the bill yield and the rest of the economy.²

The relevant question to ask in deciding which of the equations to retain is: which is likely to provide the best estimates of the coefficients on the independent variables other than the discount rate? The answer is that Equation (4-1) is likely to provide that the best estimates of these coefficients. The reason for this has to do with the fact that changes in the discount rate are often accompanied by changes in the other tools of monetary policy, which show up in the equation as variations in L^* . Thus there is a certain

²The initial decrease in 90-day Treasury bill yields caused by an increase in unborrowed reserves will contribute to an increased demand for time deposits as investors seek substitutes for marketable securities. It will also tend to increase GNP. The increase in time deposits will add to banks' lending capacity -- thereby depressing bill yields still further, whereas the increase in GNP will stimulate loan demand -- putting upward pressure on bill yields. The GNP effect is the stronger; so that the net effect of allowing for their simultaneous influences is to moderate the initial decline in bill yields.

(and probably considerable) amount of colinearity between L^* and r_d . In Equation (4-1) the estimate of the coefficient on $\ln L^*$ may not be very efficient because of this colinearity. But at the same time it has not been biased (as it has in (4-2)), since $\ln r_d$ has not been omitted from the regression. Omitting the discount rate from the regression in Equation (4-2) has the almost certain effect of producing a downward bias in coefficient on $\ln L^*$ because of the correlation between these two variables. In light of this we have decided to retain Equation (4-1).

B. Yields on Long-Term U.S. Bonds

With the role of factors determining the level of interest rates embodied in the equation for 90-day Treasury bill yields, the determination of yields on corporate and long-term U.S. bonds becomes a problem of identifying factors which influence the term structure of interest rates. As a means of "explaining" the factors that cause yields on long-term U.S. bonds to deviate from those on 90-day Treasury bills, we have decided to adopt verbatim the formulation developed by Modigliani and Sutch in their well-known study of the term structure of interest rates.³ The formulation has

³F. Modigliani and R. Sutch, "Innovations in Interest Rate Policy," American Economic Review, Papers and Proceedings, May 1966, pp. 178-97.

as its theoretical underpinnings the so-called "expectations hypothesis," which attributes differences in interest yields on securities of similar risk but differing maturities solely to differences in expected future capital gains or losses associated with their purchase.⁴ In the Modigliani and Sutch version, expected capital gains or losses are proxied by weighted averages of current and past interest yields, and the following relationship is derived:

$$(4-3) \quad r_L = \sum_{i=0}^n w_i r_{TB-i}$$

After constraining the w_i to lie along a third degree polynomial, Modigliani and Sutch fit (4-3) by regression to quarterly data extending through 1962. They found that best results were obtained with a maximum lag of sixteen quarters. In order to take advantage of four additional years of data, we have refit their equation on a quarterly basis through 1966. The results are shown as Equation (4-4) below. Not surprisingly, our coefficient estimates are quite similar to those obtained by Modigliani and Sutch. However, we found that the regression results are improved when the current quarter Treasury bill yield is allowed to

⁴For an explanation of the "expectations hypothesis" see J. R. Hicks, Value and Capital (2nd ed., New York: Oxford University Press, 1946), Chapter XI, and F. A. Lutz, "The Structure of Interest Rates," Quarterly Journal of Economics, LV, Nov., 1940, pp. 36-63, also reprinted in Readings in the Theory of Income Distribution (A.E.A.), pp. 499-529.

enter the regression with a free coefficient. The remaining coefficients were constrained to lie along a third degree polynomial with a maximum lag of fifteen quarters.

$$(4-4) \quad r_L = 2.131 + .222 r_{TB} + \sum_{i=1}^{15} w_i r_{TB-i}$$

$w_1 = .010$	$w_6 = .032$	$w_{11} = .048$
$w_2 = .001$	$w_7 = .036$	$w_{12} = .045$
$w_3 = .008$	$w_8 = .044$	$w_{13} = .039$
$w_4 = .016$	$w_9 = .048$	$w_{14} = .030$
$w_5 = .025$	$w_{10} = .049$	$w_{15} = .017$

$$df = 40$$

$$R^2 = .92$$

$$S.E. = .10$$

data period: 1957 I - 1966 IV

The sum of the coefficients on the r_{TB-i} is .649, implying that just under sixty-five percent of any fluctuations in 90-day Treasury bill yields are passed on to yields on long-term bonds over a period of sixteen quarters. However this is not a smooth process as may be seen by the coefficients in the lag distribution. After a strong current quarter impact, the effect of a change in r_{TB} drops sharply, then gradually rises to a secondary peak after ten quarters have elapsed.

In order to integrate the equation into the financial model it must be converted to an annual basis. Since one-fourth of any quarterly movement in a yield

is reflected in its annual average, conversion is simply a matter of aggregating the coefficients by non-overlapping four quarter sequences. Annually the equation becomes

$$(4-5) \quad r_L = 2.131 + .217 r_{TB} + \sum_{i=1}^4 w_i r_{TB-i}$$

$$w_1 = .064$$

$$w_2 = .165$$

$$w_3 = .166$$

$$w_4 = .037$$

Prediction errors made by the annual version over the period 1956-1966 have a mean absolute value of slightly over seven basis points.

C. Yields on Corporate Bonds

Published series for interest yields on both corporate and long-term U.S. bonds are constructed by averaging yields on issues maturing in ten or more years. As a measure of corporate yields we are using Moody's average of yields on bonds rated Aaa, Aa, A, and Baa.⁵ The average maturity of issues used in constructing this series has fluctuated mildly from time to time but has averaged in the neighborhood of twenty-four years. This is roughly the same as the average maturity of

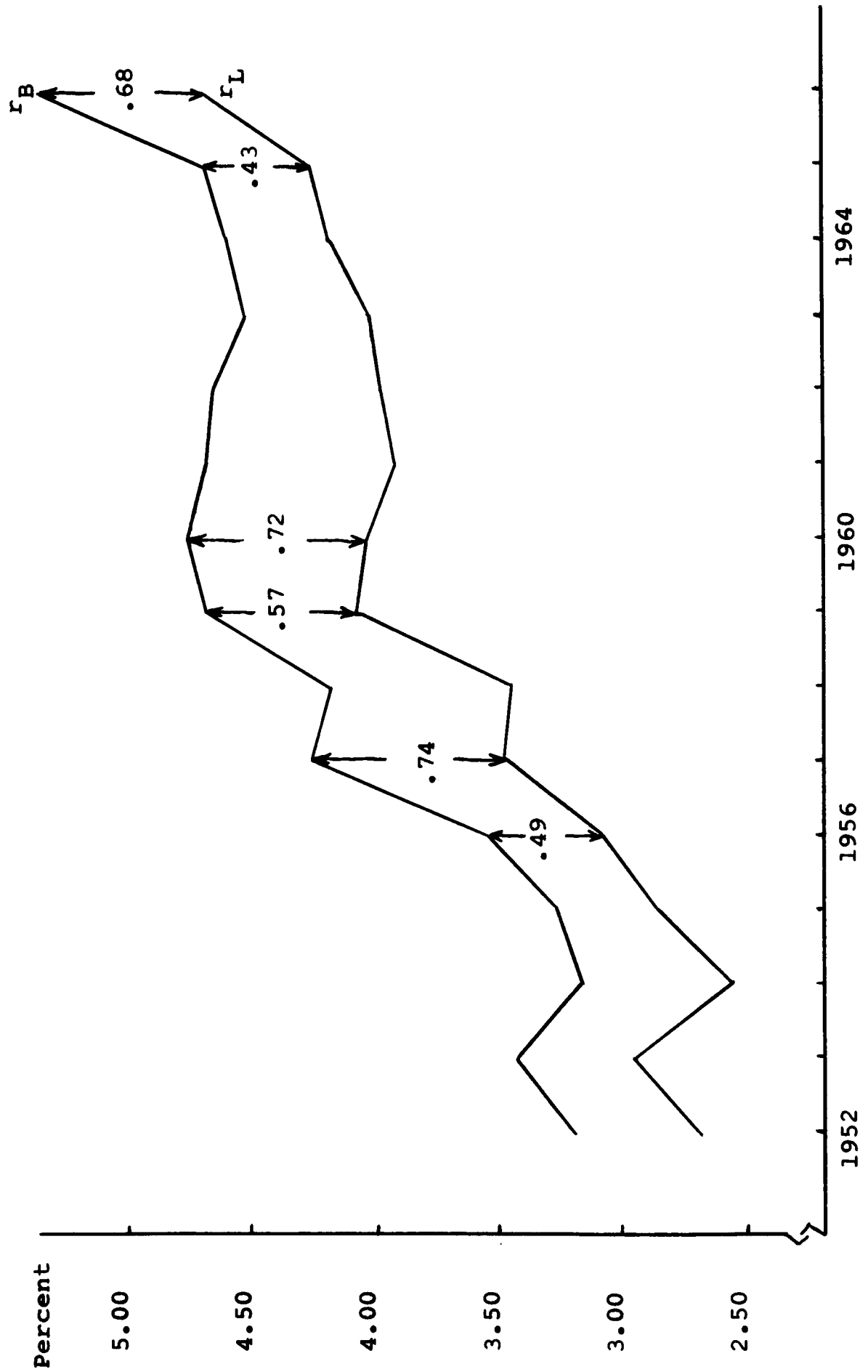
⁵The corporate bond yield series is compiled by Moody's Investor Service and is published monthly in the Federal Reserve Bulletin.

issues used to compile the series for yields on long-term U. S. bonds, and for all practical purposes, corporate and long-term U. S. bonds may be said to lie at the same point along the term structure of interest rates. This is an important realization; for it means that corporate bond yields deviate from 90-day Treasury bill yields largely for the same reasons that long-term U. S. bond yields do -- because of the differences in expectations on future capital gains or losses associated with securities of differing maturities.

Yet, in the case of corporate bond yields (henceforth denoted by r_B), expectations cannot provide the whole explanation. Otherwise how are we to account for the fact that corporate and long-term bond yields, do themselves consistently differ (see Figure 4-1)? The existence of a differential ($r_B - r_L$) cannot be explained by expectations of future capital gains and losses but is, instead, the result of two quite different factors. First, unlike U. S. Government securities, corporate bonds bear some risk of default. While this is probably small for the average corporate issue, the fact that it exists at all means that corporations must pay a risk premium in the form of a higher interest rate.

Secondly, corporate bonds are purchased by a much smaller segment of the economy than are U. S.

Figure 4-1
COMPARISON OF YIELDS ON CORPORATE AND LONG-TERM U.S. BONDS



bonds. Households buy relatively few corporates and, in addition, commercial banks, savings and loan associations, and many state chartered mutual savings banks are prohibited from investing in them. The bulk are purchased by life insurance companies who presently hold some sixty-five percent of all outstanding issues. They purchase such a large proportion of corporate bonds that many (in recent years as much as one-half of the total) new issues are not offered for public sale but are, instead, placed directly with life insurance companies. With the demand for corporate bonds so heavily concentrated in this one sector of the economy, the possibility exists that the differential between corporate and U.S. bond yields might fluctuate with variations in the elements of supply and demand in the corporate market. However if fluctuations do arise for this reason, they cannot be very large; for a mere glance at the two series plotted in Figure 4-1 shows that the differential ($r_B - r_L$) fluctuates only within a narrow range. Yet, upon closer examination, these curves do show some evidence that supply and demand factors might play some small role in determining ($r_B - r_L$). The differential tends to widen during the late stages of a boom and early parts of a recession, e.g., it rose from .49 in 1956 to .74 in 1957 and from .57 in 1959 to .72 in 1960. This corresponds to the periods of the business cycle when new bond floatations are

highest.

Consideration of the preceding arguments suggests that a reasonable approximation to the determination of corporate bond yields might be obtained by expressing r_B as a markup over r_L (to reflect the risk premium), supplemented by supply and demand factors specific to the market for corporate bonds. We have accordingly arrived at the following expression:

$$(4-6) \quad \Delta r_B = A_0 + A_1 \Delta r_L + A_2 (PE-CRE) - A_3 \Delta SD_{LI}$$

The symbols PE and CRE denote corporate outlays for plant and equipment and corporate retained earnings (=profits after taxes less dividends plus capital consumption allowances), respectively. The differential (PE-CRE) is a measure of the external financing requirements of corporations, and serves to represent the influence of changes in the supply of outstanding bonds. When (PE-CRE) is positive, corporations must seek net external financing much of which is derived from the floatation of new bond issues. Since corporations may have difficulty in placing new issues, the likely effect of an increased rate of floatations is to cause corporate bond yields to be bid upward relative to other long-term yields. Note that (PE-CRE) affects the rate of new issue, i.e., changes in the stock of outstanding bonds. Thus the causal relationships is between (PE-CRE) and changes in bond yields, and it is for this

reason that the dependent variable is expressed in first-differences.

The symbol SD_{LI} denotes the sum of policy reserves and accumulated dividends less policy loans at life insurance companies. It is our familiar measure of the volume of funds available for investment purposes at life insurance companies. Other things being equal, an increase in SD_{LI} will increase the demand for corporate bonds by insurance companies and tend to force corporate bond yields downward relative to other long-term yields.

The empirical results are presented as Equation (4-7) below. This regression equation differs from (4-6) on one count. In the regression equation we have measured PE by total rather than corporate fixed investment. The switch was made after experimentation showed the two measures to have equal explanatory power. Since the RSQE model, to which our financial model is to be appended, contains an equation representing total but not corporate PE, it is preferable that we use the broader definition here. This allows the two models to be merged without the necessity of deriving an equation which would spin corporate plant and equipment expenditures off the total. Note that when the broader definition of PE is used, the constraint that the coefficients of PE and CRE be of equal magnitude but

opposite sign no longer applies. We have entered these two variables into the regression with free coefficients.

$$(4-7) \Delta r_B = -.304 + .903 \Delta r_L + .048 \text{ PE } -.050 \text{ CRE} \\ (.079) \quad (.010) \\ + .003 \Delta SD_{LI} \\ (.049)$$

$$df = 9$$

$$R^2 = .96$$

$$S.E. = .06 \text{ percent}$$

data period: 1953-66

Empirically, nearly all of the variables perform as expected. The overall fit of the regression equation is good and all coefficients, save that of ΔSD_{LI} , are more than four times their respective standard errors. The failure of ΔSD_{LI} to obtain a significant (negative) coefficient might be explained by the fact that this variable exhibited little variation over the period under investigation. The large negative intercept in the equation may be measuring movements in corporate bond yields that are actually due to trend increases in SD_{LI} . However, this is pure conjecture on our part.

In any event, we have refit the equation after omitting SD_{LI} . The results, shown below, are substantially unchanged.

$$(4-8) \Delta r_B = -.293 + .904 \Delta r_L + .047 \text{ PE } -.049 \text{ CRE} \\ (.075) \quad (.007) \quad (.006)$$

$$df = 10$$

$$R^2 = .96$$

$$S.E. = .06 \text{ percent}$$

data period: 1953-66

It comes as a mild surprise that the coefficient on the long-term U. S. bond yield is estimated as low as .904. The arguments in favor of the existence a risk premium suggest that this coefficient have a value slightly in excess of unity. However, with a standard error of .075, the estimate .904 does not necessarily invalidate this hypothesis, since it falls within a ninety-five percent confidence interval for true values of the coefficient as large as 1.05.

Both of the supply variables PE and CRE exhibit rather strong impacts in the regression equation. Over the data period the average value of PE was \$51.9 billion and the average value of CRE was \$43.3 billion. The average net impact of these two variables contributed an upward pressure of 32 basis points to changes in corporate bond yields -- sufficient to offset the negative intercept. Inclusion of these variables helps explain the cyclical movements in corporate bond yields that are not shared by long-term U. S. bond yields. In the early stages of an upswing corporate profits and retained earnings increase faster than outlays for plant and equipment as business firms make more efficient use of existing plants. External financing requirements are light during such periods and the differential between interest yields on corporate bonds and those on long-term U. S. bonds narrows. The opposite

occurs during the late stages of an upswing and the early stages of a recession. In these stages of the business cycle, corporate earnings positions deteriorate relative to financing requirements and they are forced to seek outside funds. The equation is able to predict the subsequent widening that occurs in the differential between corporate and long-term bond yields.

D. Miscellaneous Equations

Several of the independent variables appearing in the expression for 90-day Treasury bill yields are, in actuality, endogenous to the U. S. economy. Among them are the public's holdings of hand-to-hand currency (CURR) and total time deposits adjusted at all commercial banks (TD), which belong in the financial model. In this section equations are developed to represent them. In the case of time deposits, we have already established an equation for that portion held by households (Equation 3-23); so our task has been considerably lightened. Here we need only examine the demand for time deposits by non-household sectors. In what follows, time deposits held by non-household sectors are measured as the simple difference between total time deposits adjusted and household deposits. They are denoted by the symbol CD.

The Demand for Hand-to-Hand Currency

We have specified the demand for hand-to-hand currency to be a simple transactions demand. That is, variations in currency holdings are viewed as resulting only from variations in the level of transactions for which currency is used as a medium of exchange. Transactions involving currency occur primarily at the retail level, in sales where goods and payment are exchanged over a counter. On a National Accounts basis, the variable most closely related to retail sales of this sort is personal consumption expenditures. We have regressed annual changes in currency holdings on annual changes in personal consumption expenditures from 1950 to 1966 with the following results:

$$(4-9) \Delta \text{CURR} = .734 + .086 \Delta C$$

(.013)

$$df = 15$$

$$R^2 = .73$$

$$S.E. = \$.44 \text{ Bil.}$$

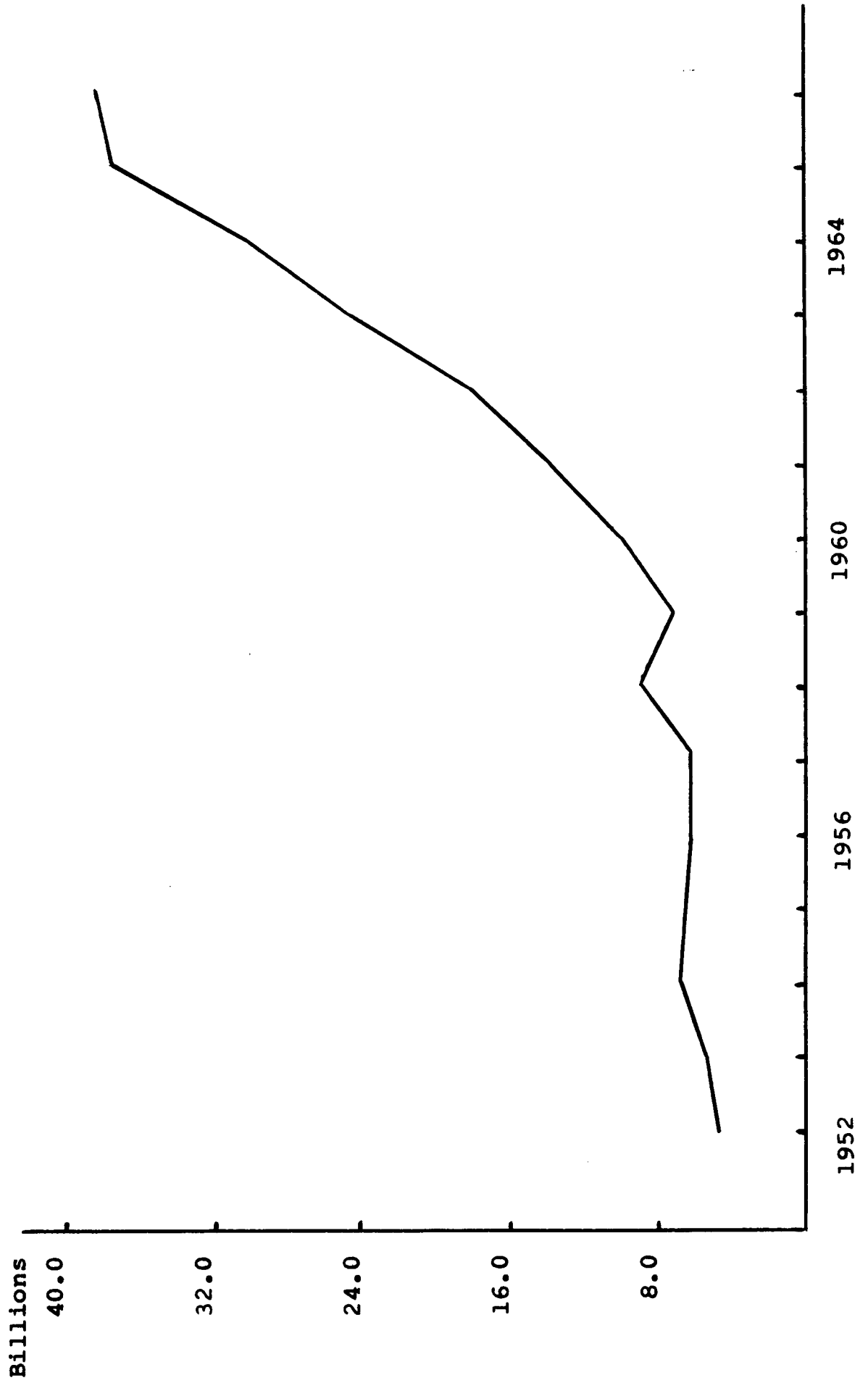
The explanatory power of the regression equation is not outstanding. The standard error of estimate of \$.44 billion is rather large in view of the fact that the mean annual change in currency holdings over the data period was only \$.81 billion. Yet prediction errors made by this equation fall within the range of accuracy required for the use to which it will be put. A large prediction error here has relatively little impact on other variables in the financial model.

The coefficient of .086 on changes in personal consumption expenditures is, in any event, plausible. It translates into an implied elasticity (valued at the means) of the demand for hand-to-hand currency with respect to personal consumption expenditures of .88, which is of a magnitude consistent with the hypothesis that this is a transactions demand.

The Demand for Time Deposits by Non-Household Sectors

In our definition, time deposits held by non-household sectors are the sum of deposits held by all sources except the U. S. Government, domestic commercial banks, and, of course, individuals as members of households. End of year values of these holdings from 1950 to 1966 are plotted in Figure 4-2. A sharp increase in the rate of acquisition of deposits beginning in 1961 is clearly distinguishable. From the end of 1961 to the end of 1966 deposits increased by 185 percent -- from \$13.4 billion to \$38.2 billion. This very rapid acceleration in the rate of acquisition was the result of decisions by non-household investors to replace other kinds of liquid assets by the new (introduced in 1961) large denomination CD's. Precise breakdowns are not available, but the proportion of deposits held in the form of large denomination CD's currently runs well over one-half the total. It is evident from Figure 4-2 that the introduction of these deposit instruments

Figure 4-2
TIME DEPOSITS OF NON-HOUSEHOLD SECTORS



has had a dramatic impact on the demand for time deposits by non-household sectors.

In developing an equation, our approach will be to concentrate on the period after the advent of large CD's. In the early period -- through the transition year 1961 -- the demand for deposits fluctuated mildly about a trend rate of increase of \$.85 billion per year. Errors produced by representing the demand for deposits with this trend rate of increase for years up to and including 1961 are not disturbingly large; consequently we have made no attempt to establish a behavioral equation that might reduce them. What this means is that, when the financial model is used to simulate periods prior to 1962, the demand for time deposits by non-household sectors will be represented simply by

$$(4-10) \Delta CD = \$.85 \text{ billion.}$$

In the years after 1961, movements in large denomination CD's so dominate the total that we have proceeded as if non-household deposits after this date consisted of nothing but large CD's. Large denomination CD's are issued with various terms to maturity, but those of short duration, especially ninety days, have been most popular.⁶ The task of analyzing factors con-

⁶Investors have exhibited flexibility with respect to term-to-maturity on large denomination CD's. From early 1961 to mid 1963, CD's with maturities of 6-12 months were the most popular because Regulation Q

tributing to their demand is probably best approached on a time period of similar length. Therefore our equation is developed from quarterly data and then converted to an annual basis.

The most striking feature of large denomination CD's has been the high degree to which they substitute for other short-term marketable securities. The extent of substitution is perhaps best illustrated by the large scale sell-off of CD's that occurred in the third and fourth quarters of 1966, when the interest rates paid on large CD's were prevented by Regulation Q ceilings from keeping pace with rising market yields. In order to capture such competitively induced fluctuations, we have formulated the quarterly demand for time deposits since 1962I in the following manner:

$$(4-11) \Delta CD = A_0 + A_1 \Delta(r_{CD} - r_{TB}) + (1 - \gamma) \Delta CD_{-1},$$

where r_{CD} is the interest rate paid on large denomination CD's.

The equation is a partial adjustment mechanism expressed in first-differences. It implies that actual movements in deposits represent adjustments toward some desired stock, which increases over time (measured by

⁶(continued) ceilings permitted banks to pay interest rates on these higher than on CD's of shorter maturity. On July 17, 1963 Regulation Q ceilings on all CD's were raised to 4.00 percent, and the shorter durations became the most popular.

the intercept) and also with a widening of the differential between interest rates paid on large denomination CD's and market yields on 90-day Treasury bills. The speed of adjustment parameter (λ) is expected to be less than unity since most CD's are issued with maturities ≥ 90 days, making full adjustment within one quarter impossible.

With this formulation we face a data problem. Data for interest rates paid on large denomination CD's, are not available for years prior to 1966. However, weekly publications of the Federal Reserve Bank of St. Louis contain a series for secondary market yields on large negotiable CD's maturing in ninety days, and this is available from 1962.⁷ We hasten to point out that the CD market is one case where the distinction between interest rates and yields is important. It is the interest rate, not the yield, that influences the demand for CD's, because it is this that banks are offering to pay to new depositors. Interest rates paid on large denomination CD's are institutionally determined by banks and are subject to the restrictions of Regulation Q. Secondary market yields, on the other hand, are determined by market forces and are not subject to such restrictions. However, since anyone who wishes to pur-

⁷The publication is titled U.S. Financial Data.

chase a large denomination CD may do so either from a bank or in the secondary market, yields in the secondary market will never be lower than the interest rates being paid by banks. They may, of course, be higher. Bankers probably watch secondary market yields closely and adjust deposit rates upward (Regulation Q permitting) whenever they are lower than secondary market yields; for bankers are well aware of the possibility of losing CD funds if interest rates paid on them are not kept in line with the yields on competitive marketable securities. Thus except during periods when the secondary market yield exceeds the Regulation Q ceiling rate, this yield should provide a good measure of the interest rates actually being paid on large denomination CD's by commercial banks.

Based on these considerations, we have generated a quarterly series for interest rates paid on CD's according to the following:

$$r_{CD} = \text{MIN} \left[r_{CD}^*, \bar{r}_{CD} \right],$$

where r_{CD}^* denotes the secondary market yield and $\bar{r}_{CD}$ the Regulation Q ceiling rate.⁸ In other words, r_{CD} is measured by r_{CD}^* if it is below the Regulation Q ceiling; otherwise r_{CD} is set equal to the ceiling rate.

⁸In light of investors' readiness to adopt that maturity CD which is paying the highest rate of interest, we have measured $\bar{r}_{CD}$ as the highest Regulation Q ceiling applicable to large denomination CD's.

Regression results are shown as Equation (4-12). The explanatory power of the regression equation is not very high as evidenced by the values for R^2 and S.E.

$$(4-12) \Delta CD = 1.145 + \frac{2.633}{(1.243)} \Delta(r_{CD} - r_{TB}) + \frac{.232}{(.223)} \Delta CD_{-1}$$

$$df = 16$$

$$R^2 = .20$$

$$S.E. = \$.83 \text{ Bil.}$$

data period: 1962II-1966IV

The coefficient of .232 on lagged changes in deposits implies that nearly seventy-seven percent of the discrepancy between desired and actual deposit holdings is eliminated during any one quarter. At this rate more than ninety-nine percent of any discrepancy will have been eliminated after four quarters. With such a rapid rate of adjustment, coefficients in an annual version of the equation will have values close to their equilibrium values. Little is lost and conversion to an annual basis is made easier if the equation is written in equilibrium form first. The equilibrium form of the quarterly equation is:

$$\Delta CD = 1.491 + 3.428 \Delta(r_{CD} - r_{TB}).$$

An annual equation is produced by summing this expression over four quarters. The result is:

$$(4-13) \Delta CD = 5.964 + 3.428 \Delta(r_{CD} - r_{TB}),$$

where ΔCD , now measured as end of year changes in deposits while r_{CD} and r_{TB} are measured as annual averages.

The annual version produces a mean absolute prediction error of \$1.5 billion over the five year period 1962-66, but the errors are small (less than \$.7 billion) for all years except 1966. In 1966 the equation overpredicts by a whopping \$5.5 billion. The principal cause of this large error is timing. Regulation Q ceilings were restrictive only during the third and fourth quarters of 1966, causing stocks of deposits to be depressed only near the end of the year. Since the annual equation uses annual averages of interest rates to predict end of year changes in deposits, a large error was inevitable.

Secondary Market Yields on Large Negotiable CD's.

If the secondary market for large negotiable CD's operated independently of the primary market, movements in secondary market yields would probably mirror those in interest yields on 90-day Treasury bills. The secondary market yield could be represented by an expression such as

$$(4-14) \quad r_{CD}^* = a_0 + a_1 r_{TB}$$

In actuality the secondary and primary markets do not function independently, and as a result, secondary market yields on large CD's are never permitted to fall below the interest rates being offered on these instruments by commercial banks. Therefore secondary market yields are actually determined according to:

$$r_{CD}^* = \text{MAX} \left[(a_0 + a_1 r_{TB}), r_{CD} \right]$$

The difficulty in establishing an empirical relationship for r_{CD}^* is obvious: we have no measure of the interest rates actually being paid by commercial banks. However, if our hypothesis of the preceding sub-section is correct and banks do adjust interest rates paid on large CD's quickly in response to changes in competitive conditions, then (4-14) may be sufficient to describe the determination of secondary market yields. There is at present no way of finding out whether banks do adjust deposit rates rapidly, but the observed high correlation (.99) between r_{CD}^* and r_{TB} over the period 1962I - 1966IV is at least consistent with the hypothesis that they do. Bolstered by this high correlation and having no alternative, we have regressed quarterly observations on r_{CD}^* on quarterly observations on r_{TB} for the period 1962I - 1966IV, with the following results:

$$(4-15) \quad r_{CD}^* = -.296 + 1.188 r_{TB} \\ \quad \quad \quad (.043)$$

df : 18

$R^2 = .98$

S.E. = .13 percent

The results are directly applicable to annual predictions; the coefficients do not change when annual averages on interest yields are used in place of quarterly values. In spite of its low standard error of

estimate, the ability of the regression equation to predict secondary market yields in periods other than those used to fit the regression remains in doubt. The regression was run over a period marked by rapidly rising interest rates. Of the twenty quarters between the beginning of 1962 and the end of 1966, interest yields on 90-day Treasury bills increased in sixteen and fell in only four. There is a strong possibility that the behavior of commercial banks in setting interest rates on large denomination CD's is asymmetric with respect to increases and decreases. Bankers know that a failure to increase deposit rates during periods of rising market yields can cost them a large withdrawal of deposits, but failure to lower deposit rates during periods of falling market yields cost them nothing except higher interest payments. Thus we may find that secondary market yields on large negotiable CD's follow 90-day bill yields upward but not downward. History has not yet afforded us an occasion to test for asymmetry.⁹ For this reason we may find that Equation (4-15) yields

⁹Market yields on 90-day Treasury bills did fall sharply in early 1967 as did secondary market yields on large negotiable CD's. However this is not sufficient to rule out the possibility of asymmetry because of the fact that secondary market yields started their decline from a level in the fourth quarter of 1966 that was twenty-two basis points in excess of the existing Regulation Q ceiling rate applicable to large denomination CD's. Secondary market yields could have declined even if the interest rates paid by banks did not.

over-estimates of secondary market yields during periods of generally declining interest rates.

CHAPTER V

PROPERTIES OF THE FINANCIAL MODEL

The analysis of the preceding chapters has produced a set of empirical equations which, when combined, constitute an econometric model of the financial sector of the U. S. economy. Our task in this chapter is to examine the properties and implications of that model. For the reader's convenience, the equations of the model are reproduced in Appendix I.

Examination of the financial model's properties proceeds in three parts. First, the model is used to generate predictions of the values of the variables endogenous to it for each of the four years beginning with 1963 and ending with 1966. This is done primarily to learn what sort of prediction errors the model generates after allowing for the simultaneous relationships that exists among the various equations. Next, the financial model is combined with the macroeconomic model developed by the Research Seminar in Quantitative Economics (RSQE) at the University of Michigan, and the combined models are used to generate impact multipliers associated with the various tools of monetary

policy.¹ Finally, a discussion of techniques appropriate for using the financial model to make forecasts of economic behavior in the future is presented.

A. Predictions Over the Period 1963-1966

Predictions generated with the financial model for the years 1963-1966 inclusive, are presented in Table 5-1. The variables appearing in parentheses alongside the predicted values are the actual values obtained by the variables in each of the years. The predictions were generated by supplying actual values of exogenous and lagged endogenous variables for each of the four years into a computer, which was programmed to solve the simultaneous system of equations (i.e., the financial model) by successive iteration.² Note that actual values of the lagged endogenous variables were used for each prediction; so the results are four independent predictions rather than one, successive, four-period simulation.

Before the results are discussed, a comment concerning the data period is appropriate. The years 1963-

¹An impact multiplier shows the effect that a one unit change in an exogenous variable has on an endogenous variable within one time period -- in our case one year.

²Barry Bosworth and Barbara Moores, "The RSQE Model Solution Program" (Ann Arbor: University of Michigan), 1967 (mimeographed).

1966 form part of the data period over which the equations of the model were estimated. For this reason generating predictions over the same years does not constitute the most rigorous test of predictive ability imaginable. Yet this period should suffice it to reveal the extent to which prediction errors in one equation affect the predictions made by other equations in the simultaneous system. If it should turn out that the errors generated by the complete financial model are substantially larger than the residual errors made by the single equation regressions over the same period, this would be an indication that allowing for the simultaneous interactions of the equations tends to produce instability in the system. Any evidence of instability would cast serious doubts as to the usefulness of the financial model -- either as a mechanism for analyzing the effects of monetary policy or as a tool for making forecasts of financial variables in the future. Fortunately no serious discrepancies between the full model errors and regression errors ever materialized. The predicted values of the variables shown in Table 5-1 are, in general, quite close to their actual values and are only slightly larger (on the average) than residual errors from the corresponding regression equations for the same period. For none of the variables is there evidence to suggest that pre-

Table 5-1

FINANCIAL MODEL PREDICTIONS: 1963-1966

	1963	1964	1965	1966				
$\Delta \overline{HE}$ (Bil \$)	0.4	(1.0)	1.3	(-0.6)	-1.1	(-1.2)	-3.4	(-3.5)
ΔHS (Mil.)	-0.3	(.14)	.06	(-0.05)	-.10	(-.05)	-.30	(-.29)
MS_{LI} (Bil \$)	3.7	(3.3)	4.5	(4.0)	4.5	(4.4)	4.7	(4.4)
MS_{SL} (Bil \$)	10.8	(12.1)	12.3	(10.4)	9.0	(8.9)	4.3	(3.9)
MS_{MS} (Bil \$)	3.2	(3.5)	3.7	(3.8)	3.7	(3.6)	2.5	(2.1)
MS_{CB} (Bil \$)	2.9	(3.0)	2.5	(2.4)	3.2	(3.5)	3.0	(2.5)
SD_{LI} (Bil \$)	112.2	(111.5)	118.3	(117.6)	124.4	(124.3)	130.1	(130.0)
SD_{SL} (Bil \$)	90.7	(91.3)	103.1	(101.9)	110.3	(110.3)	115.1	(114.1)
SD_{MS} (Bil \$)	44.9	(44.6)	48.4	(48.8)	52.6	(52.4)	54.7	(55.0)
SD_{CB} (Bil \$)	87.6	(86.6)	94.8	(94.8)	108.8	(108.0)	121.3	(118.7)
CD (Bil \$)	23.6	(24.4)	30.5	(30.4)	37.0	(37.2)	43.8	(38.0)

(continued)

Table 5-1 (continued)

r_{TB} (percent)	2.70	(3.16)	3.38	(3.55)	4.08	(3.95)	5.00	(4.88)
r_{CD}^* (percent)	2.90	(3.39)	3.70	(3.88)	4.56	(4.34)	5.65	(5.47)
r_L (percent)	3.90	(4.00)	4.03	(4.15)	4.31	(4.21)	4.68	(4.66)
r_B (percent)	4.64	(4.50)	4.42	(4.57)	4.68	(4.64)	5.22	(5.34)
r_M (percent)	5.57	(5.46)	5.46	(5.45)	5.48	(5.47)	6.45	(6.38)
r_{MS} (percent)	3.97	(3.96)	4.07	(4.06)	4.23	(4.13)	4.48	(4.50)
r_{CB} (percent)	3.26	(3.29)	3.38	(3.29)	3.71	(3.61)	4.28	(4.30)
+ r_{CD} (percent)	2.90	---	3.70	---	4.56	---	5.00	---

Figures in parentheses are actual values

+ Actual values not available

diction errors tend to be multiplied by the simultaneity that exists within the system of equations. This is especially comforting in the case of the residential mortgage and housing market variables, which are most susceptible to errors of this sort. These variables are the most susceptible to accumulated errors because they are affected by, but do not themselves affect, other variables endogenous to the financial model. In a sense the residential mortgage and housing markets are at one extreme end of the chain of causal relationships depicted in the model. It is conceivable that errors made in predicting interest rates (the other end of the causal chain) could accumulate with a whiplash effect on the mortgage and housing variables. However, the results of the full model predictions do not exhibit any such whiplash effects.³

On the basis of the relative size of the discrepancy between predicted and actual values in Table 5-1, the predictive ability of the model appears to be weakest in the area of short-term interest rates. The key equation in this sector is the one representing the yield on 90-day Treasury bills, because the 90-day

³The rather large prediction errors for housing starts and expenditures in 1963 and 1964 are not due to problems of simultaneity, but exist because the fits of the regression equations for these two variables are poor in these years.

bill yield appears as an independent variable in many of the other interest rate equations. The error made in predicting the 90-day Treasury bill yield is never less than twelve basis points and considerably larger than that in two of the four years. However these prediction errors are not terribly large by comparative standards. Simulations of the Federal Reserve model by De Leeuw and Gramlich, for example, produced an average error of nineteen basis in predicting 90-day bill yields over the seven quarters from 1965 III to 1967 II.⁴

The full model predictions seem to be relatively most accurate in the savings deposit sector. With the exception of the large over-prediction for CD's in 1966 (the reasons for which were discussed when the regression results for the CD equation were presented in Chapter IV), errors made in predicting all types of savings deposits are quite small for every year. This is highly encouraging, for the ability to make accurate predictions of movements in savings deposits at various financial intermediaries means that the financial model is capable of accurately predicting movements in the volume of loanable funds supplied by each of these in-

⁴Frank De Leeuw and Edward Gramlich, "The Federal Reserve - M.I.T. Econometric Model," Federal Reserve Bulletin, January 1968, pp. 11-40.

termediaries.

All things considered, the results of the full model predictions are highly pleasing.

B. Impact Multipliers

For purposes of analyzing the policy implications of the financial model, it has been integrated with the RSQE econometric model of the real sector of the U. S. economy. The combined models were used to generate numerical estimates of the impact multipliers associated with changes in the various tools of monetary policy. By integrating the financial model with the RSQE model, we have been able to make estimates of the impact multipliers relating changes in the tools of monetary policy to real sector variables such as GNP and employment as well as to financial variables. These estimates are presented in Table 5-2 and discussed in detail below.

However, before turning to a discussion of the numerical estimates, several comments concerning the structure of the RSQE model are in order. The RSQE model is not reproduced in the study, but it consists of a set of simultaneous equations representing at a disaggregate level the determination of GNP, national

income, employment, and price levels.⁵ The equations are specied on an annual basis. We might point out that integration of the financial model into the larger framework of the RSQE model is a relatively simple process. There are no redundencies in the equations that comprise the two models; that is, none of the equations in the financial model "explains" a variable that is also endogenous to the RSQE model. Moreover, all variables appearing in both models (either exogenous to both or endogenous to one and exogenous to the other) are defined and measured in precisely the same way in each. That the two models are so well mated should not be too surprising in light of the fact that the impetus behind the development of the financial model was provided by our desire to fill the void existing because of the RSQE model's lack of a financial sector.

It is worthwhile to comment on the interplay between real and financial variables in the two models. A number of equations in the financial model contain real sector variables as arguments and these have been discussed in detail in earlier chapters. By way of contrast, the number of equations in the RSQE model that have financial variables as arguments is quite small. In fact, the only avenue through which finan-

⁵The equations comprising the RSQE model may be found in The Economic Outlook for 1968 (Ann Arbor: University of Michigan, 1968).

cial variables enter the determination of income in the RSQE model is through the behavior of housing starts and housing expenditures.⁶ None of the other components of GNP are specified to depend on financial variables.

It should be pointed out that this is not a characteristic unique to the RSQE model. A lack of financial variables among the determinants of GNP is a characteristic common to nearly all large econometric models and is indicative of the present state of empirical research in the area. Except for the case of housing expenditures, there has been little empirical evidence to substantiate theoretical claims that financial variables are important determinants of aggregate demand. However, the possibility exists that empirical tests of these theoretical claims have been inappropriate, and that financial variables really do affect the determination of GNP in ways not yet quantified. In order to hedge against that possibility, we suggest that our estimates of the impact multipliers relating changes in tools of monetary policy to changes in income, employment, and price levels be viewed as "lower bound" estimates. They are "lower bound" estimates insofar as changes in monetary policy may have effects on the non-housing components of

⁶The equations we developed to represent housing starts and housing expenditures in Chapter II replace the ones formerly used in the RSQE model.

GNP which are not allowed for in the RSQE model.

The Impacts of Changes in Government Expenditures

Probably the best place to begin to analyze the policy implications of the combined RSQE - financial models is to look at the impact multipliers associated with a change in government expenditures. These appear in the first column of Table 5-2. How the multiplier estimates are to be interpreted may be illustrated by example. The impact multiplier relating changes in constant dollar GNP ($\overline{GNP}$) to changes in constant dollar government expenditures ($\overline{GOV}$) is estimated to be 2.27. This implies that $\overline{GNP}$ will increase within the course of one year by \$2.27 billion for every \$1 billion increase in $\overline{GOV}$. As a second illustration, the impact multiplier for the 90-day Treasury bill yield is .08 -- implying that 90-day bill yields will rise by .08 percent, or 8 basis points, for every \$1 billion increase in $\overline{GOV}$.

Actually the estimates in the first column of Table 5-2 show the impacts of not only a change in $\overline{GOV}$ but of any autonomous component of GNP. The impact multipliers associated with a change in autonomous consumption expenditures, for example, are identical to those for changes in government expen-

ditures.⁷ For this reason these multiplier estimates show how financial variables react to any disturbance originating in the real sector of the economy.

The multiplier for constant dollar housing expenditures ($\overline{HE}$) turned out to have a value of zero. However this is interesting because an autonomous change in GNP sets in motion several forces which act to influence the housing market. Apparently these forces offset one another and it would be worthwhile to trace them through the system in order to gain a better understanding how the real and financial sectors of the U. S. economy interact.

An autonomous increase in GNP stimulates an increased demand for loanable funds to finance the higher level of economic activity. Unless the Federal Reserve acts to satisfy these additional demands by increasing bank reserves, interest rates will be bid up. This is the reason for the positive impact multipliers for market interest rates. Higher market interest rates, in turn, induce some holders of savings deposits to shift into securities -- putting pressure on financial intermediaries to reduce their residential mortgage

⁷ The reason for this is that all exogenous expenditures changes have the same impacts on $\overline{GNP}$, and changes in $\overline{GNP}$ are the means through which real sector disturbances are transmitted to the financial sector in the combined models.

lending. At the same time, however, higher incomes generated by increased economic activity cause households to increase their demands for all financial assets. Part of this increase takes the form of increased acquisition of savings deposits, and acts to offset the drain on deposits. The offset is nearly perfect and the net effect is for savings deposits at the various financial intermediaries to increase slightly or not at all. Hence, mortgage lending is not affected and neither are housing starts or expenditures.

The Impacts of Changes in Unborrowed Reserves

The impact multipliers associated with a change in unborrowed bank reserves (RU) are shown in the second column of Table 5-2. The primary source of changes in unborrowed reserves are Federal Reserve open market operations. Ignoring possible currency drains, a one billion dollar purchase of securities in the open market by the Federal Reserve will increase unborrowed reserves by the same amount. A one billion dollar open market sale will reduce unborrowed reserves by \$1 billion. The impact multipliers associated with changes in unborrowed reserves may be used, therefore, to judge the effectiveness of open market operations as a tool of stabilization policy.

The multiplier estimates indicate that a one

Table 5-2
IMPACT MULTIPLIERS

Endogenous Variables	Exogenous Variables		
	<u>GOV</u> (Bil \$)	RU (Bil \$)	$\bar{r}_{CB}$ (percent)
$\overline{GNP}$ (Bil \$)	2.27	1.23	-4.21
+ U (percent)	-.14	-.08	.27
++P (percent change)	.05	.03	-.10
$\overline{HE}$ (Bil \$)	+.00	.53	-1.79
HS (Mil.)	+.00	.05	-.15
MS_{LI} (Bil \$)	.02	.39	-.50
MS_{SL} (Bil \$)	+.00	.62	-4.85
MS_{MS} (Bil \$)	.07	.25	-.30
MS_{CB} (Bil \$)	+.00	.08	1.10
SD_{LI} (Bil \$)	.04	.70	-1.69
SD_{SL} (Bil \$)	+.00	.71	-5.46
SD_{MS} (Bil \$)	.01	.44	-1.09
SD_{CB} (Bil \$)	.13	.45	6.17
CD (Bil \$)	.06	-.28	-.17
r_{TB} (percent)	.08	-.44	-.26
r_{CD}^* (percent)	.09	-.52	-.31
r_L (percent)	.02	-.10	-.06
r_B (percent)	.01	-.09	-.03
r_M (percent)	-.00	-.08	.28
r_{SL} (percent)	+.00	-.01	.11
r_{MS} (percent)	+.00	-.01	.16
r_{CB} (percent)	.01	-.03	.42
r_{CD} (percent)	.09	-.52	-.31

(continued)

With the exception of $\bar{r}_{CB}$, the Regulation Q ceiling on household-type time and savings deposits, a bar over a symbol signifies that the variable is measured in billions of dollars at 1958 prices.

+ U denotes the annual average civilian unemployment rate

++ P is the annual percent change in the implicit deflator for private non-farm GNP. —

billion dollar increase in RU has about the same expansionary impacts on $\overline{\text{GNP}}$, employment, and prices as a one-half billion dollar increase in government expenditures. The multipliers relating each of these real sector variables to a change in RU are smaller by a factor of one-half than their corresponding values in the first column of the table. The proportionality ends here, however, as a change in unborrowed reserves has a much greater impact on housing expenditures and financial variables. The multipliers for housing starts and expenditures reflect the response of mortgage lending by financial intermediaries to changes in savings deposits brought about by a change in RU. By increasing the volume of loanable funds available to commercial banks, a rise in RU leads to a substantial decline in market interest rates. This, in turn, induces securities holders to switch into saving deposits. Savings and loan associations appear to be the largest benefactors of these switches, but the other kinds of financial intermediaries also fare well.

The impact multipliers for the various interest rates are quite large relative to those for the real sector variables. The ratio of the multiplier for the unemployment rate to that for the yield on 90-day Treasury bills, for example, is .18. This implies that the unemployment rate will decline by only .18 percent

for every 1.00 percent decline in bill yields that can be induced through open market purchases of securities by the Federal Reserve. If these numerical estimates are to be believed, they suggest that open market operations are not a very effective means of coping with short-run stabilization problems of excessive unemployment or an excessive rate of inflation. The interest rate movements that would be necessary to lower the unemployment rate by one percent via open market purchases of securities would seem to be in the neighborhood of four or five hundred basis points. Surely interest rate movements of this magnitude could not be accomplished without serious damage and disruption of securities markets.

However, we hasten to remind the reader that our estimates of the impacts of changes in financial variables on the real sector of the economy show only those impacts which work through housing expenditures. They are, to use our earlier description, "lower bound" estimates. To conclude on the basis of these estimates that the use of open market operations is an ineffective means of stabilizing the economy would, therefore, be unwarranted. But at the same time, our results do not provide cause to be optimistic about the ability of the Federal Reserve to use open market operations as a stabilization tool. The housing sector is cer-

tainly the sector of the economy most sensitive to changes in monetary policy. Yet our impact multipliers suggest that it takes a big dose of open market operations to induce a relatively small response in housing expenditures.

The Impact of Changes in Legal Reserve Requirements

Impact multipliers associated with changes in legal reserve requirements on demand and time deposits at member banks are not shown explicitly in Table 5-2. However they may easily be calculated from the impact multipliers associated with changes in unborrowed reserves because changes in legal reserve requirements have the same effects as increases or decreases in the quantity of unborrowed reserves. A decrease in legal reserve requirements makes available to banks reserves that were formerly used to maintain legal reserve-to-deposit ratios. Banks will use reserves released in this way to expand loans and investments in the same manner as they would use new unborrowed reserves supplied by the Federal Reserve. To calculate impact multipliers associated with a change in legal reserve requirements one must simply calculate the quality of bank reserves affected and then apply the multiplier values appropriate for a change in unborrowed reserves of an equal amount.

To illustrate; at the end of 1966 demand deposits at member banks totaled \$119.1 billion and average legal reserve requirements were 14.77 percent. If the legal reserve requirements had been increased by one percent to 15.77, member banks would have been forced to add \$1.191 billion to required reserves. This would have had a contractionary impact on the economy of the same magnitude as a decline in unborrowed reserves of \$1.191 billion. Its effect on each of the real and financial variables in Table 5-2 can be obtained by multiplying the impact multipliers for changes in unborrowed reserves in the second column by the constant value - 1.191.

The effects of a change in legal reserve requirements on member bank time and savings deposits can be derived through the same procedure. At the end of 1966 the quantity of time and savings deposits held in member banks totaled \$127.9 billion. Therefore an increase in legal reserve requirements of one percent at that time would have had roughly the same effect as a decline of \$1.279 billion in unborrowed reserves.

Note that the actual size of the impact multipliers associated with a given change in legal reserve requirements on either demand or time deposits will be larger (in absolute value) the larger the quantities of those deposits held in member banks.

The fact that changes in legal reserve require-

ments work their impacts on the economy through the same mechanisms as changes in unborrowed reserves means that changes in legal reserve requirements are neither a more nor less effective tool of stabilization policy than are open market operations. The same can be said of changes in the discount rate which also works its effects on the economy by altering the reserve position of member banks.⁸ Therefore changes in legal reserve requirements and changes in the discount rate must share in the skepticism voiced earlier regarding the ability of open market operations to stabilize the economy.

The Impacts of Changes in Regulation Q

The impact multipliers in the third column of Table 5-2 show the effects of a change in the Regulation Q ceiling interest rates applicable to small denomination ($< \$100,000$) CD's. The impact on the economy of such a change is likely to vary widely, depending on the relationship between the initial level of the ceiling and the level of market interest rates. It will also vary according to whether the ceilings are lowered or raised. The estimates appearing in

⁸ Because of the problems associated with estimating the response of 90-day Treasury bill yields to changes in the discount rate (see Chapter IV, p. 85), we have not calculated estimates of impact multipliers associated with changes in the discount rate.

Table 5-2 show the likely response of the economy to an increase in Regulation Q ceilings under economic conditions similar to those prevailing at the end of 1966. At that time market interest rates were high by historical standards. An increase in Regulation Q would likely have led commercial banks to raise interest rates paid on small CD's quickly and by a considerable margin. The multiplier estimates presented here show, therefore, somewhat larger impacts than might be expected if Regulation Q changes were to occur under more normal financial market conditions.

The impact multipliers show that an increase in Regulation Q ceilings payable on small denomination CD's would have a strong contractionary effect on GNP, employment and prices. Such action would cause constant dollar GNP to decline by approximately \$4.2 billion for a one percentage point rise in the Regulation Q ceiling. The real sector impacts are, of course, transmitted through the housing market as are all disturbances originating in the financial sector of the integrated models.

The impact multipliers in the financial sector exhibit a pattern quite distinct from those for changes in monetary policies that affect bank reserves. By enabling commercial banks to pay higher interest rates to depositors, an increase in Regulation Q would generate

a considerable reallocation of savings funds. Savings deposits would flow out of other financial intermediaries and into commercial banks. Hence, the impact multiplier for commercial bank deposits is positive while those for the other intermediary deposits are negative. Hardest hit by deposit losses would be savings and loan associations. They would lose an estimated \$5.46 billion in deposits for a one percent increase in Regulation Q ceilings applicable to small denomination CD's. A reallocation of savings funds in this way would have a net effect of reducing total mortgage lending, since banks make fewer mortgage loans per dollar of deposits than do other financial intermediaries.

It is interesting to note what little impact on change in Regulation Q would have on securities yields. An increase in Regulation Q would cause mortgage yields to rise sharply as a result of the decline in mortgage funds, but bill and bond yields would actually decline slightly. This latter results because commercial banks would presumably use a higher volume of savings deposits to acquire additional loans and marketable securities -- thereby forcing down the yields on these types of instruments.

The net effect of a change in the Regulation Q ceiling applicable to small denomination CD's is, then, to cause a reallocation of loanable funds between the

mortgage market on the markets for bank-oriented investments. The resultant effects of such a reallocation on the housing market are substantial.

C₄ Forecasting With the Financial Model

One of the primary uses to which the financial model will be put is economic forecasting. The financial model will be used in conjunction with the RSQE model to prepare annual forecasts of the U. S. economy. In keeping with the past tradition of the RSQE model, these joint forecasts will be presented at the Annual Conference on the Economic Outlook, held in Ann Arbor in mid-November of each year.⁹

The financial model could be used as a forecasting mechanism without modification; that is, there is nothing about its structure that would prohibit using it to generate forecasts of the future in the same manner as it was used to make predictions over the known period 1963-1966.¹⁰ However, there is one modification to the structure of the financial model that can be made which greatly simplifies the task of forecasting. That

⁹The Annual Conference on the Economic Outlook is sponsored by the Department of Economics at the University of Michigan.

¹⁰In forecasting into the future the values of exogenous variables are, of course, not known beforehand. They must be estimated, or projected, by the forecaster.

modification is to "suppress" the equation representing 90-day Treasury bill yields. By "suppress" we mean that this equation is removed from the model, and the yield on 90-day Treasury bills is treated as an exogenous variable. In forecasting with the equation suppressed, the value of the bill yield over the forecast period would be projected by the forecaster like the value of any other exogenous variable. Then this value would be used as part of the input from which the forecast values of variables endogenous to the model are generated.

The primary advantage to be gained from suppressing this equation is that it makes the problem of projecting monetary policy in the future much simpler than it otherwise would be. It does this because the equation for 90-day Treasury bill yields is the only place that the quantitative tools of monetary policy -- un-borrowed bank reserves, legal reserve requirements, and the discount rate -- enter the financial model. With the equation suppressed, the forecaster does not have to specify the tools through which the Federal Reserve will conduct policy operations during the forecast period. He need only project (exogenously) what he anticipates will be the net effect of Federal Reserve action on the level of 90-day Treasury bill yields. If, for example, the Federal Reserve is expected to pursue a more contractionary policy over the

forecast period, this can be reflected in the forecast simply by projecting an increase in the 90-day Treasury bill yield. If a more expansionary policy is anticipated, a decline in the 90-day Treasury bill yield will be projected. Since monetary policy is often judged to be expansionary or contractionary by its effects on short term interest rates, suppressing the 90-day bill yield equation streamlines the task of forecasting without sacrificing any necessary information.

It is important to recognize that to suppress its equation and treat the 90-day Treasury bill yield as exogenous to the financial model is not very different from allowing that variable to be endogenously determined in the model through an equation whose primary arguments are the exogenous policy variables of the Federal Reserve. In both cases the 90-day bill yield may be seen to be largely determined by actions of the Federal Reserve. Yet is advantageous to view the 90-day bill yield as an exogenous variable at some times and as an endogenous variable at others. To take the former view is advantageous, as we have seen, when the financial model is used for purposes of economic forecasting. However, when policy analysis rather than economic forecasting is the objective, then the latter view is appropriate. The impacts of a change in a

specific tool of monetary policy can be analyzed only if the 90-day bill yield is endogenous to the financial model; for it is through this equation that the quantitative tools of monetary policy enter the model. The answer to the question of when to suppress and when not to suppress the 90-day bill yield equation is, therefore, dictated by the use to which the financial model is to be put. The equation may be suppressed for purposes of forecasting, but it should never be suppressed for purposes of policy analysis.

CHAPTER VI

CONCLUDING COMMENTS

In the course of the preceding chapters an econometric model of the financial sector of the U. S. economy has been developed and its short-run predictive accuracy and policy implications have been examined. The financial model will be used in the future as an integral part of the RSQE econometric model of the U. S. economy. In that capacity it will be utilized for purposes of policy analysis and short-term forecasting. The more obvious short-comings of the financial model and the analysis which underlies it are, therefore, worthy of comment.

To begin with, the estimated coefficients in the financial model are subject to error. This, of course, is a shortcoming of all econometric models whose equations are statistically estimated. In our case, however, the possibility of large estimation errors is increased by the fact that most of the equations in the model were estimated by regression from relatively few annual observations. As is well known, the probability of making a large error in estimating a coefficient increases as the number of observations (or more properly,

the degrees of freedom) decrease. A high probability of a large estimation error shows up in the form of a large standard error for an estimated coefficient. A scan of the estimated coefficients in the financial model reveals that a number of coefficient estimates do have large standard errors. Thus there is a very real possibility that large errors do exist in the coefficients of the model.

There are, however, two considerations that lend confidence to our estimates. First, the estimated coefficients have values that, in general, appear reasonable. Second, and more importantly, the equations of the financial model were able to generate accurate predictions when used to prepare the predictions for the period 1963-1966 which were described in the previous chapter. These two considerations alone go a long way toward justifying the accuracy of our results.

Another shortcoming of the financial model has to do with the treatment of the determination of the level of interest rates. It was argued in Chapter IV that the competitive forces linking the markets for different kinds of credit are so strong that fluctuations in the supply and demand for any one type of credit will cause all interest rates to rise or fall together. The yield on 90-day Treasury bills was

chosen to represent the general level of interest rates, with the idea that it would be specified to depend on elements of the supply and demand for total credit and thereby encompass factors common to all interest rates. Yet when it came time to actually specify that equation, a shortage of degrees-of-freedom forced us to limit the number of independent variables in the equation to elements of the supply and demand for commercial bank- rather than total-credit. As it now stands, the equation for 90-day Treasury bill yields probably suffers biases arising from the omission of variables that properly belong in its specification. Furthermore the omission of variables in this equation means that the financial model is not equipped to provide answers to questions relating to changes in those omitted variables. It seems clear that an alternative specification that would introduce more variables would be an improvement. This could perhaps be accomplished by re-estimating an enlarged version of the equation from quarterly data, which could then be converted to an annual basis.

Probably the aspect of the study most open to criticism is the fact that it excludes a large segment of the financial sector. Chief among the financial markets not included are those for municipal

bonds, corporate stock, and commercial and industrial (bank) loans. These three markets alone account for a considerable portion of total financial activity, and it is legitimate to ask whether a model that excludes them can rightfully be called a model of the financial sector of the U. S. economy. In defense of our position in excluding them, it was obviously not possible to construct a model that deals with each and every financial market in the U. S. economy. Something had to be left out as a matter of expediency. The means by which it was decided whether to include or exclude any particular financial market was to ask the following question: How important is that market in determining the levels of output and employment in the short-run? Consideration was limited to those financial markets which existing empirical studies have shown to play a significant role in the short-run determination of output and employment. Unfortunately, it has not been empirically demonstrated how municipal bonds, corporate stock, and commercial and industrial loans enter into these processes; consequently they were omitted.

The structure of the financial model is, however, quite flexible. To increase its size would simply be a matter of obtaining equations for additional financial variables and adding them to the

existing equations. But there would be little point in making the model larger, unless it can also be shown how additional variables would either affect the real sector of the economy or substantially alter the behavior of the financial variables already included in the model.

APPENDIX I

THE COMPLETE FINANCIAL MODEL

The final equations of the financial model are reproduced below.

The Residential Mortgage and Housing Sectors

$$1. \quad MS_{LI} = -.077 + .518 \Delta SD_{LI} + 1.211 \Delta r_m + 1.306 \Delta r_{m-1} \\ - 5.205 \sum_{i=0}^2 W_i \Delta r_{B-i} + .285 MS_{LI-1},$$

$$W_0 = .214$$

$$W_1 = .429$$

$$W_2 = .357$$

$$2. \quad MS_{SL} = -.131 + .872 \Delta (SD_{SL} + FHLB) + .141 MS_{SL-1}$$

$$3. \quad MS_{MS} = .571 + .312 \Delta SD_{MS} - 1.278 \Delta r_B + .541 MS_{MS-1}$$

$$4. \quad MS_{CB} = .322 + .172 \Delta (SD_{CB} - RR_{CB}) + .273 \Delta (r_M - r_L) \\ + .083 \Delta GOV_{-1} + .222 MS_{CB-1}$$

$$5. \quad \Delta HS = .118 + .363 \Delta HF - .311 (HS - HF)_{-1}$$

$$+ 1.066 \Delta (R/P_{RC}) + .037 \Delta (\hat{J}/P_{RC})$$

$$6. \quad \Delta \overline{HE} = .290 + 11.908 \Delta HS + 3.321 \Delta HS_{-1}$$

Time and Savings Deposits

$$7. \Delta \left(\frac{SD_{LI}}{W} \right) = .0013 - .0056 \Delta r_{CB} - .0017 \Delta r_{TB} \\ + .5902 \Delta \left(\frac{SD_{LI}}{W} \right)_{-1}$$

$$8. \Delta \left(\frac{SD_{SL}}{W} \right) = .0040 - .0054 \Delta r_L + .0299 \Delta r_{SL} - .0270 \Delta r_{CB} \\ - .0046 \Delta (r_{SL} - r_{CB})^3 + .6336 \Delta \left(\frac{SD_{SL}}{W} \right)_{-1}$$

$$9. \Delta \left(\frac{SD_{MS}}{W} \right) = .0008 - .0047 \Delta r_L + .0089 \Delta r_{MS} - .0073 \Delta r_{CB} \\ - .0028 \Delta (r_{MS} - r_{CB})^3 + .4720 \Delta \left(\frac{SD_{MS}}{W} \right)_{-1}$$

$$10. \Delta \left(\frac{SD_{CB}}{W} \right) = -.0001 - .0025 \Delta r_{TB} - .0082 (2 \Delta r_{SL} + \Delta r_{MS}) \\ + .0287 \Delta r_{CB} - .0080 \Delta d_1 + .6111 \Delta \left(\frac{SD_{CB}}{W} \right)_{-1}$$

$$11. \Delta CD = 5.964 + 3.428 \Delta (r_{CD} - r_{TB})$$

Interest Rates Paid on Time and Savings Deposits

$$12. \Delta r_{SL} = .132 + .164 r_M + .153 r_{CB} - .367 r_{SL_{-1}}$$

$$13. \Delta r_{MS} = .831 + .374 r_{CB} - .503 r_{MS_{-1}}$$

$$14. \Delta r_{CB} = .201 + .743 \bar{r}_{CB} - 1.463 \frac{\bar{r}_{CB}}{r_L} - .498 r_{CB_{-1}}$$

$$15. r_{CD} = \text{MIN} \left[r_{CD}^*, \bar{r}_{CD} \right]$$

Yields on Marketable Securities

$$16. \ln r_{TB} = -.9662 + 3.606 \ln GNP - 3.934 \ln L^*$$

$$+ .767 \ln r_d + 2.297 \ln CURR$$

$$17. r_L = 2.131 + \sum_{i=0}^4 w_i r_{TB-i},$$

$$w_0 = .217$$

$$w_1 = .064$$

$$w_2 = .165$$

$$w_3 = .166$$

$$w_4 = .037$$

$$18. \Delta r_B = .293 + .904 \Delta r_L + .047 PE - .049 CRE$$

$$19. r_{CD}^* = -.296 + 1.188 r_{TB}$$

$$20. \Delta r_M = .117 + .189 \Delta HF - .075 (HS-HF)_{-1} + 2.220 \Delta (R/P_{RC}) \\ - .068 \Delta (\hat{J}/P_{RC}) + .832 \Delta \bar{r}_{FHA}$$

Miscellaneous: The Demand for Currency

$$21. \Delta CURR = .734 + .086 \Delta C$$

Definitions and Identities

$$22. RR_{CB} = k_2 z_2 SD_{CB}$$

$$23. \hat{J} = \sum_i \hat{MS}_i + FNMA - 1.484 \Delta r_m, \text{ where}$$

the MS_i are predicted values from equations 1-4 above.

$$24. W = .382 \sum_{i=0}^4 (.67)^i GNP_{-i}$$

$$25. \quad L^* = \left[\left(\frac{1 - k_1 z_1}{k_1 z_1} \right) RU + \left(\frac{k_1 z_1 - k_2 z_2}{k_1 z_1} \right) TD \right]$$

$$26. \quad TD = SD_{CB} + CD$$

Note: The way of defining $\hat{J}$ is equivalent to the lengthy definition given in Chapter II.

APPENDIX II

DATA SOURCES AND DESCRIPTIONS

Definitions and descriptions of the variables used in the study are presented below. The data series corresponding to the variables appear in Table A-1.

Variables Pertaining to the Residential Mortgage and Housing Sectors -

- MS_{LI} - The year end to year end change in residential mortgage holdings of life insurance companies, measured in billions of dollars. Source: Federal Reserve Bulletin.
- MS_{SL} - The year end to year end change in residential mortgage holdings of savings and loan associations, measured in billions of dollars. Source: Federal Reserve Bulletin.
- MS_{MS} - The year end to year end change in residential mortgage holdings of mutual savings banks, measured in billions of dollars. Source: Federal Reserve Bulletin.
- MS_{CB} - The year end to year end change in residential mortgage holdings of commercial banks, measured in billions of dollars. Source: Federal Reserve Bulletin.

- FNMA - The year end to year end change in residential mortgage holdings of the Federal National Mortgage Association, measured in billions of dollars. Source: Federal Reserve Bulletin.
- HS - Private nonfarm housing starts, in millions. Source: Business Statistics.
- $\overline{HE}$ - Residential construction expenditures, measured in billions of dollars at 1958 prices. Source: Survey of Current Business.
- HF - Net household formation, in millions. Source: Current Population Reports, Series P-20.
- R - Rent component of the consumer price index, 1957-59 = 1.000. Source: Business Statistics.
- P_{RC} - Implicit price deflator for residential construction expenditures, 1958 = 1.000. Source: Survey of Current Business.
- FHLB - Federal Home Loan Bank long-term advances outstanding at end of year in billions of dollars. Source: Federal Reserve Bulletin.
- GOV - Commercial bank holdings of direct and fully guaranteed U. S. Government securities at end of year, in billions of dollars. Source: Federal Reserve Bulletin.
- RR_{CB} - Reserves required on household time and savings deposits at member banks, in billions of

dollars. Source: constructed.

Variables Pertaining to the Time and Savings Deposits

- SD_{LI} - End of year total of policy reserves plus accumulated dividends less policy loans at life insurance companies, in billions of dollars. Source: Life Insurance Fact Book.
- SD_{SL} - End of year total of savings and loan shares, in billions of dollars. Source: Federal Reserve Bulletin.
- SD_{MS} - End of year total of deposits at mutual savings banks, in billions of dollars. Source: Federal Reserve Bulletin.
- SD_{CB} - End of year total of household holdings of deposits at commercial banks, in billions of dollars. Source: Federal Reserve Flow of Funds Accounts.
- CD - End of year total of private nonhousehold holdings of time and savings deposits at commercial banks, in billions of dollars. Source: constructed by subtracting SD_{CB} from total time and savings deposits, adjusted.
- TD - End of year total time and savings deposits adjusted at all commercial banks, in billions of dollars. Source: Federal Reserve Bulletin.

- W - Total household wealth, in billions of dollars. Source: constructed.
- r_{SL} - The average interest rate paid on savings and loan shares, in percentages. Source: Savings and Loan Fact Book.
- r_{MS} - The average interest rate paid on mutual savings bank deposits, in percentages. Source: Savings and Loan Fact Book.
- r_{CB} - The interest rate paid on household-type time and savings deposits at commercial banks, in percentages. Source: constructed in the following manner. For years up to and including 1964, r_{CB} is measured as the average rate paid on passbook savings deposits at commercial banks. For 1965 and later years, r_{CB} is measured as the sum of the average rate paid on the passbook savings and the differential between interest rates offered on small CD's and passbook savings deposits by commercial banks. Interest rates offered on these types of deposits by commercial banks are found in the Federal Reserve Bulletin, September 1967, p. 1504. Average interest rates paid on passbook deposits are to be found in, Rasche and Shapiro, "The Supply and Demand for Savings Deposits," unpub-

lished paper done in conjunction with the M.I.T.-F.R.B. project, 1967.

r_{CD} - The interest rate paid on large denomination CD's by commercial banks, in percentages.

Source: constructed.

r_{CD}^* - The secondary market yield on large negotiable CD's, in percentages. Source: U. S. Financial Data, prepared by the Federal Reserve Bank of St. Louis.

$\bar{r}_{CB}$ - The Regulation Q ceiling interest rate payable on household type time and savings deposits, measured as the higher of Regulation Q ceilings applicable to passbook savings and small denomination CD's, in percentages. Source: Federal Reserve Bulletin.

$\bar{r}_{CD}$ - The Regulation Q ceiling interest rate payable on large denomination CD's, measured as the maximum of the Regulation Q ceilings, applicable to large CD's of different maturities, in percentages. Source: Federal Reserve Bulletin.

d_1 - A dummy variable; equal to zero when $r_{CD}^* \leq \bar{r}_{CD}$, equal to one when $r_{CD}^* > \bar{r}_{CD}$.

Variables Pertaining to the Securities Yields Sector

r_{TB} - The market yield on 90-day Treasury bills, in percentages. Source: Federal Reserve Bulletin.

- r_L - The market yield on long-term U. S. Government bonds, in percentages. Source: Federal Reserve Bulletin.
- r_B - Moody's composite yield on corporate bonds, in percentages. Source: Federal Reserve Bulletin.
- r_M - The secondary market yield on FHA-insured mortgages, in percentages. Source: Federal Reserve Bulletin.
- $\bar{r}_{FHA}$ - The annual average maximum permissible interest rate payable on FHA-insured mortgages, in percentages. Source: Savings and Loan Fact Book.
- r_d - The Federal Reserve discount rate, measured as the annual average of the discount rate set by the Federal Reserve Bank of New York City, in percentages. Source: Federal Reserve Bulletin.
- RU - Unborrowed member bank reserves, in billions of dollars. Source: Federal Reserve Bulletin.
- k_1 - Average legal reserve requirement on member bank demand deposits, measured as a proportion, e.g., .14 - Source: constructed.
- k_2 - Legal reserve requirement on member bank time deposits, measured as a proportion. Source: Federal Reserve Bulletin.
- z_1 - The proportion of total demand deposits subject to reserve requirements. Source: Federal

Reserve Bulletin.

- z_2 - The proportion of total time deposits adjusted subject to reserve requirements.
Source: Federal Reserve Bulletin.
- CURR - The currency component of the money supply, in billions of dollars. Source: Federal Reserve Bulletin.
- GNP - Gross national product, in billions of dollars.
Source: Survey of Current Business.
- PE - Non-residential fixed investment expenditures, in billions of dollars. Source: Survey of Current Business.
- CRE - Corporate gross retained earnings, measured as the sum of corporate retained earnings plus corporate capital consumption allowances, in billions of dollars. Source: Survey of Current Business.
- C - Personal consumption expenditures, in billions of dollars. Source: Survey of Current Business.

Table A-1
Basic Data

	MS _{LI}	MS _{SL}	MS _{MS}	MS _{CB}	FNMA	HS	HE
1951	3.0	1.9	1.5	0.9	---	1.42	19.5
1952	1.7	2.8	1.3	0.9	0.4	1.45	18.9
1953	1.9	3.6	1.4	0.7	0.3	1.40	19.6
1954	2.5	4.1	1.9	1.3	-0.1	1.53	21.7
1955	3.3	5.3	2.4	1.7	0.2	1.63	25.1
1956	3.3	4.3	2.1	1.1	0.4	1.32	22.2
1957	2.2	4.3	1.3	0.1	-0.3	1.17	20.2
1958	1.7	5.5	1.9	1.5	1.2	1.31	20.8
1959	2.0	7.5	1.6	1.7	1.6	1.49	24.7
1960	2.4	7.1	1.8	0.1	0.7	1.23	21.9
1961	2.2	8.7	2.0	0.8	-0.1	1.28	21.6
1962	2.5	10.0	2.9	2.3	-0.2	1.44	23.8
1963	3.3	12.1	3.5	3.0	-1.3	1.58	24.8
1964	4.0	10.4	3.8	2.4	-0.2	1.50	24.2
1965	4.4	9.9	3.6	3.5	0.3	1.45	23.2
1966	4.4	3.9	2.1	2.5	2.4	1.14	20.2

Table A-1
(continued)

	HF	R	PRC	FHLB	GOV	SD _{LI}	SD _{SL}
1951	--	.823	.886	0.3	61.3	---	16.1
1952	0.84	.857	.908	0.3	63.1	61.5	19.2
1953	0.67	.903	.919	0.3	63.5	65.6	22.8
1954	0.82	.935	.904	0.3	68.9	69.8	27.3
1955	1.05	.948	.929	0.4	61.7	74.3	32.1
1956	0.88	.965	.974	0.4	59.3	78.7	37.1
1957	0.81	.983	.998	0.5	59.2	82.9	41.9
1958	0.93	1.001	1.000	0.6	67.2	87.3	48.0
1959	1.23	1.016	1.031	0.9	60.3	92.5	54.6
1960	0.87	1.031	1.045	0.9	62.1	96.6	62.1
1961	1.00	1.044	1.050	1.2	67.2	101.2	70.9
1962	1.00	1.057	1.067	1.5	67.2	106.1	80.2
1963	0.86	1.068	1.089	1.9	64.3	111.5	91.3
1964	1.22	1.078	1.123	2.5	64.0	117.6	101.9
1965	0.97	1.089	1.164	2.9	60.8	124.3	110.3
1966	0.84	1.104	1.209	1.9	57.2	130.0	113.9

Table A-1
(continued)

	SD _{MS}	SD _{CB}	CD	W	r _{SL}	r _{MS}	r _{CB}
1951	20.9	33.7	4.3	-----	2.60	2.00	0.90
1952	22.6	36.4	4.5	313.7	2.70	2.30	1.10
1953	24.3	38.9	5.3	336.1	2.80	2.40	1.10
1954	26.3	41.4	6.6	351.1	2.90	2.50	1.30
1955	28.1	43.1	6.5	372.4	2.90	2.60	1.40
1956	30.0	45.3	7.1	392.6	3.00	2.80	1.60
1957	31.7	50.5	6.2	413.5	3.30	2.90	2.10
1958	34.0	55.8	8.8	428.9	3.38	3.07	2.21
1959	35.0	59.4	7.2	453.1	3.53	3.19	2.36
1960	36.3	62.2	9.9	475.3	3.86	3.47	2.56
1961	38.3	68.4	13.4	495.3	3.90	3.55	2.71
1962	41.3	78.7	18.0	522.9	4.08	3.85	3.18
1963	44.6	86.6	24.6	552.6	4.17	3.96	3.29
1964	48.8	94.8	30.4	586.6	4.18	4.06	3.29
1965	52.4	108.0	37.2	628.0	4.21	4.13	3.61
1966	55.0	118.8	38.2	677.6	4.46	4.50	4.30

Table A-1
(continued)

	r_{CD}	r_{CD}^*	$\bar{r}_{CB}$	$\bar{r}_{CD}$	r_{TB}	r_L	r_B	r_M
1951	---	---	2.50	---	1.55	2.57	3.08	4.27
1952	---	---	2.50	---	1.77	2.68	3.19	4.32
1953	---	---	2.50	---	1.93	2.94	3.43	4.56
1954	---	---	2.50	---	0.95	2.55	3.16	4.62
1955	---	---	2.50	---	1.75	2.84	3.25	4.64
1956	---	---	2.50	---	2.66	3.08	3.57	4.80
1957	---	---	3.00	---	3.27	3.47	4.21	5.42
1958	---	---	3.00	---	1.84	3.43	4.16	5.49
1959	---	---	3.00	---	3.40	4.07	4.65	5.79
1960	---	---	3.00	---	2.93	4.01	4.73	6.17
1961	3.00	3.00	3.00	3.00	2.38	3.90	4.66	5.80
1962	3.07	3.07	4.00	3.50	2.78	3.95	4.62	5.63
1963	3.39	3.39	4.00	3.75	3.16	4.00	4.50	5.46
1964	3.88	3.88	4.04	4.04	3.55	4.15	4.57	5.45
1965	4.34	4.34	4.58	4.58	3.95	4.21	4.64	5.47
1966	5.36	5.45	5.29	5.50	4.88	4.66	5.34	6.38

Table A-1
(continued)

	$\bar{r}_{FHA}$	r_d	RU	k_1	k_2	z_1	z_2
1951	4.25	----	19.65	.192	.060	.903	.792
1952	4.25	1.75	19.59	.191	.060	.895	.789
1953	4.44	2.00	19.48	.178	.060	.891	.783
1954	4.50	1.59	19.04	.165	.050	.894	.782
1955	4.50	1.90	18.40	.164	.050	.891	.784
1956	4.58	2.78	18.84	.164	.050	.892	.788
1957	5.12	3.12	18.71	.163	.050	.888	.788
1958	5.25	2.11	18.34	.149	.050	.884	.786
1959	5.50	3.35	18.03	.148	.050	.877	.787
1960	5.75	3.47	19.20	.148	.050	.876	.785
1961	5.31	3.00	19.97	.154	.040	.881	.813
1962	5.25	3.00	19.74	.148	.040	.875	.812
1963	5.25	3.23	20.42	.148	.040	.862	.818
1964	5.25	3.54	22.15	.153	.040	.863	.816
1965	5.25	4.04	22.67	.150	.047	.854	.818
1966	5.73	4.50	23.27	.146	.041	.850	.813

Table A-1
(continued)

	CURR	GNP	PE	CRE	C
1951	-----	328.4	----	----	206.3
1952	27.8	345.5	31.6	22.5	216.7
1953	28.2	364.6	34.2	24.7	230.0
1954	27.9	364.8	33.6	26.3	236.5
1955	28.4	398.0	38.1	33.9	254.4
1956	28.8	419.2	43.7	34.8	266.7
1957	28.9	441.1	46.4	35.0	281.4
1958	29.2	447.3	41.6	32.8	290.1
1959	29.5	483.7	45.1	39.4	311.2
1960	29.6	503.7	48.4	38.1	325.2
1961	30.2	520.1	47.0	39.7	335.2
1962	31.2	560.3	51.7	46.1	355.1
1963	33.1	590.5	54.3	48.4	375.0
1964	35.0	632.4	61.1	54.5	401.2
1965	37.1	683.9	71.1	61.9	433.1
1966	39.1	743.3	80.2	66.8	465.9

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