PRIVATE SECTOR TREASURY SECURITIES PORTFOLIOS:

A COMPARATIVE REEXAMINATION AND ESTIMATION

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PREFACE

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CHAPTER I

INTRODUCTION

A. Issues and Objectives

The Department of Treasury issues securities with diverse maturities to finance federal budget deficits. The transactions proceed through the primary and secondary markets in which the Treasury securities are sold by auction, exchange, and subscription. The net amount supplied to the markets in each period is equal to the total amount supplied minus the amount of Federal agency--including Federal Reserve--holdings. The total supply of the Treasury securities is determined by the government budget restraint. The Federal Reserve's holdings of such securities are determined by mone-tary policy. The Treasury securities market is therefore a primary link between monetary and fiscal policy activity.

A clear specification of the structure of the private demand for Treasury securities can be one of the basic frameworks for analyzing various issues. While there has been considerable research on nonfinancial economic activity, studies on financial economic activity, especially on the Treasury securities market, have been few.

Most of the past studies on the market structure of financial asset instruments did not consider explicitly both the entire spectrum of financial assets available for private investors and the theoretical asset demand functions based on portfolio selection theory. Moreover, past empirical studies of the Treasury securities market have the following characteristics: (1) no estimation has been done by whole maturity classes, and (2) no sample has gone beyond 1976.

A study on the demand structure of financial asset instruments is closely connected with the study of interest rate determination, given the supply of such financial asset instruments. An interest rate on any one financial market instrument is the result of the market interactions of the whole credit instruments which are in substitute-complement relationships with that particular financial market instrument.

Among numerous credit instruments, Treasury securities are the most liquid financial asset instrument. The Treasury securities market is but one segment in a highly complex financial apparatus in which investment funds are in constant motion, both among securities of different types and among different maturities. The interest rates on Treasury securities are both one of the major indicators that show how the economy works and one of the leading barometers by which other interest rates are determined in the markets.

However, the issue concerning the demand structure of the Treasury securities market should be resolved before issues concerning the determination of the interest rates on Treasury securities. This is because the rates of interest on Treasury securities are determined by the interactions between demand for and exogenously given supply of Treasury securities in the market. To analyze the demand structure of the Treasury securities, the whole maturity class should be explicitly considered due to their simultaneous interactions in the markets. An analysis that does not cover the whole maturity classes cannot be regarded as complete because it may transmit incorrect information about the Treasury securities market. The other financial market instruments should also be included because portfolio selection theory indicates that private investors take the entire spectrum of asset instruments available for them into account when they make portfolio choice. The financial asset instruments available for private investors' portfolio choice are shown below.

Demand Deposit and Currency

Bonds

U. S. Government Securities
Municipal Bonds
Corporate Bonds

Stock

Money Market Fund Shares

Mortgages

Open Market Paper

Time and Savings Deposits

Other Financial Assets

The objectives of this study are as follows: (1) the specification of private investors' demand for marketable U. S. Treasury securities both theoretically and empirically by whole maturity classes[1] and, therefore, (2) the examination of the gross substitute relationships between different maturity classes of the Treasury securities and other financial assets of the private investors. A clear, theory-based examination of the degree of substitutability among private investors'

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[1]The private investors in this study are commercial banks, individuals, insurance companies, money market funds, corporations, state and local government employee retirement funds, foreigners, and other investors.

financial assets could shed light on the analysis of the impact of monetary policy on the real sector. For instance, the lower the degree of substitutability between money and U. S. Treasury securities, the larger is the effect of a given dollar amount of open market operations on total spending (Silber, 1969, p. 198). Also, the higher the degree of substitutability between different Treasury securities, the greater is the effect of a change in demand for one Treasury security on the interest rate of other Treasury securities. Hence, the degree of substitutability, if measured correctly, can be used to evaluate the impact of monetary policy.

The empirical specification in this study is to be done for four maturity classes of Treasury securities: (1) within one year, (2) one-to-five years, (3) five-to-twenty years, and (4) more than twenty years. The data cover from 1975:I to 1984:II because the private investors' securities holdings by maturity classes are simply not reported prior to the year 1975.

B. Organization of the Study

The current study deals only with the Treasury securities market. It estimates the private investors' demand for Treasury securities by four maturity classes. To specify the demand functions, this study follows the mean-variance hypothesis of investment behavior and uses the framework of the structural approach.

The structural approach is in the tradition of both the portfolio-theoretic approach and the general equilibrium approach. Therefore, the portfolio-theoretic approach, the general equilibrium approach, and the structural approach are discussed in Chapter II.

In Chapter III, the private investors' demand equation for Treasury securities is developed. Before doing this, however, six empirical works are reviewed and the theoretical application of the structural approach is considered. The theoretical application of the structural approach is then discussed. This discussion centers on both the expected utility maximization in terms of mean-variance analysis and the portfolio adjustment mechanism, which are major elements of the structural approach.

The model specification and the empirical estimations are presented in Chapter IV. Four demand equations are estimated and some implications of the empirical results are discussed. Then, a comparison of the coefficients and related statistics of three estimates of the aggregated demand for Treasury securities is made to find a clue to the benefit of disaggregation. The three estimates are: (1) the horizontal summation of four-maturity-class estimates, (2) the aggregated Treasury securities demand equation estimated by using the same explanatory variables as the four-maturity-class estimates, and (3) the aggregated Treasury securities demand equation estimated by using the explanatory variables indicated by the typical equation. This is because, although the current study is estimating the Treasury securities demand by maturity classes, a justification for adopting the maturity-class estimation should be discussed.

In Chapter V, the summary and conclusions resulting from this study are discussed.

CHAPTER II

POST-KEYNESIAN THEORIES OF THE DEMAND FOR FINANCIAL ASSETS

Keynes (1930, 1936) divided financial market instruments into money and long-term bonds for households and money and working capital for business firms. Many economists, accordingly, have classified assets with reference to their hypothetical substitutabilities among assets.[1]

However, the most widely used way of modeling financial markets to determine interest rates is based on Keynes' demand for and supply of money approach which assumes only two assets, money and bonds. Thus it can only be used if all the securities are combined into one aggregate, i.e., bonds. According to the expectations theory of the term structure of interest rates (Conard, 1959; Meiselman, 1962; Malkiel, 1962, 1964), the long-term interest rate is an average of current and expected short-term rates. Then, to determine the current short-term rates the Keynesian liquidity preference theory is used. In other words, term and risk differential are used to homogenize all the different securities so that they can be treated like a single bond.

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[1]Patinkin (1965, Ch. V; 1969) classifed cash and bank deposits as one financial market instruments and long-term government bonds and real capital as another, with assets in each category regarded as close substitutes. Tobin (1958, pp. 301-306; 1969a) classified money and short- and long-term government debt as one financial market instrument and private debt and capital as another. He regarded all debt instruments in each group as close substitutes for money.

But the existence of diverse asset market instruments and interest rate spreads between short- and long-term securities facilitates the development of the more sophisticated theories.

This chapter discusses the post-Keynesian theories of the demand for financial assets to provide a theoretical basis for specifying demand equations. Concentrations are put on three approaches: the portfolio-theoretic approach, the general equilibrium approach, and the structural approach.

A. Portfolio-Theoretic Approach

This approach is represented by the portfolio selection theory that can be divided into the safety-first approach (Roy, 1952; Telser, 1956), the maximum equity value approach (Michaelsen and Goshay, 1967; Pyle, 1971; Pringle, 1974), and the expected utility maximization theory (Markowitz, 1952; Tobin, 1958).

1. Safety-First Approach

Roy (1952) and Telser (1956) mainly proposed the safety-first principles as an alternative to the expected utility maximization theory. This approach claims that individual behavior under the principle of maximizing expected return is rational only if individuals are free to expose themselves to independent risks on a large number of occasions. The safety-first approach asserts that it is reasonable and practical that an individual seeks to reduce as far as is possible the chance of a disaster occurring. Therefore, an individual's portfolio behavior is determined by the individual's current exposure to risk because, in a disaster-existing world, an individual's major concern is to maximize safety by avoiding possible disaster.

The safety-first analysis tries to specify the objective function of an investor in more precise terms than those of expected utility maximization theory. According to Roy (1952, p. 432), who was the original proponent of this criterion, disaster minimization can be interpreted as the expected utility maximization if the utility function assumes only two values, e.g., one if disaster does not occur, and zero if it does. Given a pair of values of m, (the expected value of the gross return) and σ (the standard error of m), the upper bound of the probability of the final return being d (some assumed quantity) or less can be expressed as[2]

$$P(\xi \leq d) < \frac{\sigma^2}{(m - d)^2}, \tag{2.1}$$

where ξ is the random variable of the final return (Roy, 1952, p. 434). In this case, the minimization of $P(\xi \leq d)$ is equivalent to the maximization of $(m - d)/\sigma$ which can be regarded, in general, as the expected gain or profit maximization if σ is constant for all values of m.

By deriving the equation for the envelope curve relating m and σ, he estimates the upper bound of the probability of disaster as

[2]This can be done by an appeal to the Chebyshev's inequality which states that for an arbitrary continuous distribution with finite variance σ^2, the probability that the variant ξ deviates from the expectation m by k time the standard deviation or more is at most equal to $(1/k^2)$

$$p[|\xi - m| > k\sigma] \leq (1/k^2) \quad \text{for any } k > 0.$$

$$\frac{|W|}{\sum_{i=1}^{N} \sum_{j=1}^{N} \frac{(P_i - d/k)}{\alpha_i} W_{ij} \frac{(P_j - d/k)}{\alpha_j}} , \qquad (2.2)$$

where $\underline{W_{ij}}$ is the cofactor of the element, $\underline{r_{ij}}$, of the correlation matrix $\underline{W}$, $\underline{|W|}$ is the determinant of $\underline{W}$. The $\underline{p}$s are the asset prices at the end of the period, and the $\underline{\alpha}$s are the standard errors of the prices. Last, $\underline{k}$ is equal to $\sum_{i=1}^{n} X_i$, where $\underline{X_i}$ is the amount of resources which we hold in the form of $\underline{\text{i-th}}$ asset (Roy, 1952, p. 437). His equation for the required values of the $\underline{X_i}$ is

$$X_i = \frac{\lambda}{\alpha_i} \underset{j=1}{\overset{n}{R}} \frac{(P_i - d/k)}{\alpha j} \frac{W_{ij}}{|W|} , \text{ i=1, 2,...,n,} \qquad (2.3)$$

where $\underline{\lambda}$ is chosen so that $\sum_{i=1}^{n} X_i = k$ (Roy, 1952, p. 438). He attaches particular significance to the ratio $\underline{d/k}$ which he calls the critical price. He asserts that if the estimated price of an asset exceeds the critical price then an agent should hold some resources in this form of the asset. In Telser (1956), the expected portfolio return is maximized subject to a given probability of a given level of disaster return, i.e.,

$$\text{Max } E(R) \quad \text{subject to} \quad P(R \leq d) \leq \alpha , \qquad (2.4)$$

where $\underline{R}$ is portfolio return, $\underline{d}$ is the disaster level of return, and $\underline{\alpha}$ is a given probability of disaster.

The safety-first approach, however, has several problems. First, even though Roy (1952, p. 431) stood by his opinion that the safety-first principle should be considered because, among other things, the principle of maximizing expected return does not explain the phenomenon of the diversification of resources among a wide range of assets, his equation for $\underline{X_i}$ does not show any diversification if there exists a riskless asset. Second, as equation (2.3) for $\underline{X_i}$ shows, the demand for asset $\underline{X}$ in this approach depends only upon the level of other prices, the standard errors of both own price and other prices, the critical price, and the correlation matrix. In other words, the level of other asset holdings does not directly influence the holdings of $\underline{X_i}$ except through the ambiguous $\underline{\lambda}$. Third, both the disaster level of return, $\underline{d}$, and the acceptable probability of disaster that describe an investor's desire to avoid risk with respect to portfolio return are arbitrary, preassigned assumptions. They are simply exogenously imposed parameter. This makes the theory difficult to use in actual modeling of an investor's behavior.

2. Maximum Equity Value Approach

The theory of the maximization of market value of equity has been developed mainly for the portfolio selection problem of investor groups such as nonfinancial corporate business, insurance companies, and commercial banks. In other words, this approach is the natural application of Markowitz-type portfolio selection analysis which says that a portfolio is defined as efficient if it offers a higher overall expected return than any other portfolio with comparable standard deviation of return to the portfolio selection of financial intermediaries. According to the maximum equity value approach, financial intermediaries, like any other investors, also select a portfolio in order to achieve a maximum equity value of a particular structure of assets.

However, Michaelsen and Goshay (1967, pp. 166-167) point out that the limitations of maximizing behavior as an explanation of the selection of asset and liability structures in financial intermediaries are obscured. The maximum equity value approach, according to Michaelsen and Goshay (1967, pp. 168-169), has a potential problem in that the direction of cause and effect may become reversed if investors can substitute "homemade" diversification for corporation-made diversification, which would result in an indeterminate balance sheet of the financial firm. Michaelsen and Goshay (1967) employed Sharpe's (1964) extension of Markowitz (1952). They contend that, given a perfect capital market, maximization of equity value does not provide the intermediary with information on the portfolio of loans and deposits to hold. Hence, they argue that a corporate preference function is necessary to explain the asset and liability choices of financial intermediaries because of the indeterminacy of share maximization when individuals can engage in "homemade" diversification--the counterpart to Modigliani-Miller's "homemade" leverage. It appears, therefore, that investors' attitudes toward risk can have no direct influence on the risk aspects of portfolio decisions in large, publicly-held financial intermediaries.

Michaelsen and Goshay supplement the maximizing behavior as an explanatory device with a theory of institutional attitudes toward uncertainty. They attempt to provide the constraints necessary for maximizing behavior to lead to the selection from those consistent with a maximum equity value of a particular structure of assets and liabilities. A theory of institutional behavior which explains how firms determine the risk characteristics of their equity should explain asset and liability structures jointly and should also include the choice of leverage alone as a special case. To develop this theory, they cite and compare four explanations of how the riskiness of the equity of financial intermediaries is determined. The four explanations are the hedging hypothesis, the managerial skills hypothesis, the managerial preference hypothesis, and the institutional utility function hypothesis (pp. 170-175). They choose the institutional utility function hypothesis because it can be a convenient device to draw attention to the institutional processes that produce portfolio policies.

They derive the expected yield on stockholders' equity (ρ_k) from the definition of the expected net yield on the asset holding (ρ'_a) as (pp. 177-179)

$$\rho_k = \frac{\rho'_a}{s} , \qquad (2.5)$$

where $\rho'_a = (s + d)\ \rho_a - dr,\ s + d = 1.0,$

ρ_a : the expected yield on the asset holding,

s : the proportion of assets financed by the firm's stockholders,

d : the proportion provided by issued debt, and

r : the riskless rate of interest.

They also derive the risk on the stockholders' equity (σ_k) from the definition of the risk on the levered assets (σ'_a) as (p. 179)

$$\sigma_k = \frac{\sigma'_a}{s} , \qquad (2.6)$$

where $\sigma'_a = \sigma_a = ((s + d)^2 \ \sigma_a^2 + d^2 \ \sigma_r^2 + 2(s + d)d\sigma_{a,r})^{1/2}$,

σ_r : the risk on the debt, and

$\sigma_{a,r}$: the covariance of the risk between assets and liabilities.

With these two conditions a firm can attain $\underline{\sigma_k}$, $\underline{\rho_k}$ by choosing any of an indefinite number of asset combinations $\underline{\sigma_a}$, $\underline{\rho_a}$, and leverage positions, $\underline{s}$. They claim that under the institutional utility function hypothesis the desired equity characteristics, $\underline{\sigma_k}$, $\underline{\rho_k}$, among firms in a given financial industry are identical. By constructing proxy measures for $\underline{\sigma_a}$ and $\underline{s}$ from asset and liability data reported in intermediary balance sheets they try to develop the implications of (2.6).

Michaelsen and Goshay chose the fire and casualty insurance industry for the empirical study (p. 183). Their typical equation for the institutional utility function hypothesis is (p. 183)

$$y = \alpha + \beta x, \tag{2.7}$$

where y : directly proportional to asset risk, and

x : inversely proportional to liability risk.

They assume that $\underline{y}$ and $\underline{x}$ are monotonic transformations of $\underline{\sigma_a}$ and $\underline{s}$. Therefore the hypothesis implies only that $\underline{\beta}$ will be significantly greater than zero. But they claim that nothing can be said about $\underline{\sigma}$ or the precise form of the relationship. Their specification for actual estimation is (p. 188)

$$\ln y_2 = a_1 \ln X_1 + a_2 \ln X_2 + a_3 \ln X_3 + a_4 \ln X_4 + a_5 \ln X_5 + b, \tag{2.8}$$

where y_2 : the ratio of common stock holdings to nonequity assets less cash

X_1 : the ratio of shareholders' equity to equity plus underwriting liabilities,

X_2 : the ratio of casualty to total underwriting liabilities,

X_3 : the ratio of fire to total underwriting liabilities,

X_4 : the ratio of cash to total assets, and

X_5 : total assets.

They find the strongly significant positive values for $\underline{a_1}$, which supports the hypothesis that portfolio selection policies in stock fire and casualty insurance companies can best be regarded as determined by the same institutional utility function. They also find that the coefficients are most significant for the traded firms, least significant and most unstable between years for the mutuals.

Their study has several problems. First, they claim that the institutional utility function characterizes the process of portfolio policy formation. Unfortunately, however, they do not present any specific form of utility function which shows the process of policy formation. Second, as they pointed out, the divergence in expectations is not taken into account. This failure to allow for heterogeneous expectations could bias their test against the institutional utility function hypothesis because all firms in an industry may not aim at producing common stock with the same risk and return characteristics, which is contrary to what the institutional utility function hypothesis implicitly assumes. Third, their typical equation for the hypothesis, equation (2.7), does not indicate anything typical but implies very basic fact. It simply shows that the higher the liability risk is the lower the asset risk will be. In other words, they think that there exists an inverse linear relationship between the liability risk and the asset risk, which may not be a phenomenon only for publicly-traded firms. Therefore the causal relationship between the institutional utility function hypothesis and the typical equation (2.7) is not clear.

3. Expected Utility Maximization Theory

The expected utility maximization theory which was initiated mainly by Markowitz (1952) and extended by Tobin (1958) to explain liquidity preference provides a natural choice-theoretic framework that is based on a utility function either of households or of business firms. Its framework provides a useful approximation to the portfolio selection criterion of an investor group. It is flexible enough to include several special characteristics of the investor groups. In the pioneering work of Markowitz (1952), a theoretical model which can explain the phenomenon of portfolio diversification is presented. His major concern is finding the efficient set of portfolios which provides the maximum return for every possible level of risk that implies minimizing the risk for every level of return. His formulation of the problem assumes that the only investment objectives are to maximize the differences between the expected return and the variance of return from a portfolio. Even though this formulation may ignore some other objectives, the ability of the model to explain the phenomenon of portfolio diversification is so important to the development of portfolio selection theory that such possible problems can be overlooked.

Markowitz's framework of seeking the solution for diversified portfolios assumes that investors try to maximize their utility by making the differences between the expected return from a portfolio and the variance of a portfolio as large as possible. In other words, if we know the differences (Z) between the expected return (E) and the variance (V), then a certain point on the efficient set can be found by constructing the line Z=E-V and maximizing the value of Z subject to the constraint that at least one point on the line Z remains in the portfolio possibility set. This portfolio is found at the point where the line Z is tangent to the portfolio possibility set. The expected return from a portfolio of n securities is the weighted sum of the expected returns from each of those n securities, which can be expressed as (p. 83)

$$E = \sum_{i=1}^{n} X_i \mu_i , \tag{2.9}$$

where X_i : the proportion of the investor's capital invested in the i-th security, and

μ_i : the expected return from holding the i-th security.

The variance of a portfolio of n securities can be expressed as

$$V = \sum_{i=1}^{n} X_i^2 V_i + \sum_{i=1}^{n} \sum_{j=1}^{n} X_i X_j \sigma_{ij} , \quad i \neq j , \tag{2.10}$$

where V_i : the variance of the i-th security,

X_j : the proportion of the investor's capital invested in the i-th security, and

σ_{ij} : the covariance between the i-th and the j-th securities.

He then tries to show that his E-V hypothesis can imply the "right kind" of diversification for the "right reason" by using geometric tools (pp. 85-91) instead of solving formally the equations with the utility function as an objective function whose general arguments are portfolio rates of return and its variances.

Wallingford (1967, pp. 93-99) investigates empirical tests of the Markowitz model. He also points out some serious theoretical and practical limitations in the Markowitz model. The first and most frequently mentioned problem is the assumption that the variance is a satisfactory measure of risk. This assumption implies that deviations both above and below the level of expected return are equally undesirable. The second objection to the Markowitz approach arises from the assumption that the only investment objective is the acquisition of return and the avoidance of variance. Investors can have other important objectives such as the distribution of returns between dividends and capital gains, the timing of the realization of income, etc. (Wallingford, 1967, p. 94).

Tobin, in his celebrated article of 1958, makes an important application and extension of the Markowitz-type portfolio analysis. He suggests that the portfolio theory can offer a plausible explanation for the Keynesian liquidity preference notion. He shows that the portfolio selection problem can be partly solved by considering the market for risk-free funds and also shows that the investor needs only lever himself up or down by borrowing or lending to obtain the position consistent with his particular attitude towards risk vis-a-vis expected return (Sharpe, 1967, p. 78).

By using portfolio theory, it is possible to derive an implicit asset demand function. The mean-variance expected utility maximization problem can be expressed as[3]

$$\max_{S_g S_p \lambda} L = U(E,V) + \lambda(A-S_g-S_p), \tag{2.11}$$

where E : the period-by-period expected yield of the portfolio, i.e., $E=S_g\epsilon_g+S_p\epsilon_p$, where S_g, S_p are the end-of-period maturity value of government securities and that of alternative asset instruments, respectively; ϵ_g, ϵ_p are the expected value of the rates of return on S_g and S_p, respectively.

V : the variance of the portfolio's return, i.e., $V=S_g^2,\sigma_g^2 + 2S_gS_p\rho\sigma_g\sigma_p + S_p^2\ \sigma_p^2$, where σ_g^2, σ_p^2 are the variance of ϵ_g and ϵ_p, respectively; $\rho\sigma_g\sigma_p$ is covariance, and

A : the total dollar value of the private investors' portfolio.

By solving the first-order conditions of the equation (2.11) for S_g, the implicit asset demand function is derived, which also shows sign restrictions to the regressors. The actual derivation by using the equation (2.11) is done in Section 3 of Chapter III.

B. General Equilibrium Approach

Brainard and Tobin (1968) introduced a six-asset, three-sector, thirteen-equation, general equilibrium model of the financial sector which is concerned with the portfolio allocation of a level of prede-

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[3]This expression is only a simple Lagrangean function for maximization. The importance is, however, that this equation can be regarded as a starting point to derive a theoretical demand function in the next chapter.

termined wealth. One of the important characteristics of the model is, as they pointed out (p. 103), the inclusion of all asset yields and lagged asset holdings as explanatory variables in the asset demand equations. This is because they think the explicit recognition of the essential interdependence of markets in theoretical and empirical specifications of financial models is important. They assume that the public holds its net wealth in the form of six different types of financial assets and liabilities: currency and bank reserves, Treasury securities, private loans, demand deposits, time deposits, and equities. They divide the economy into three sectors: government, commercial banks, and public. They present thirteen equations: seven equations to determine the quantity variables, four equations to determine the rate variables, and two identities which imply restrictions on the coefficients of their static and dynamic behavioral equations (p. 102).

The structure of their model is composed of equations for the two sectors'--public and bank--desired holdings of each asset instrument and adjustment behaviors, equations for the market value of the capital stock and for total public wealth, and identities for the reserves and securities (pp. 107-111). Their model tells how the financial system operates in response to monetary policy changes or to other shocks.

The public's desired holding (X^p) of each asset and its adjustment behavior are expressed as

$$X^p = (a_0 + a_1 r_T + a_2 r_S + a_3 r_L + a_4 r_K + a_5 Y) W^p, \qquad (2.12)$$

and

$$\Delta X_i(t) = X_i(t) - X_i(t-1) = \sum_j \alpha_{ij}(X_j^{**}(t) - X(t-1)) + \beta_i H(t) + \gamma_i K(t-1)\, \Delta P(t), \qquad (2.13)$$

where r_T : time deposit rate,

r_S : Treasury security rate,

r_L : loan rate,

r_K : market yield on equity,

Y : national income,

W^P : public's total wealth holdings,

$X^{**}(t)$: the value of $\underline{X}^P$ yielded for contemporaneous $\underline{r}$'s, $\underline{Y}$, and $\underline{W}^P$,

$H(t)$: new saving, and

$K(t-1)\Delta P(t)$: capital gains on equities.

The assumed structure of adjustment behavior, (2.13), is a common and useful dynamic equation in which the deviation of a variable from its desired level is diminished by a certain proportion $\underline{\alpha_j}$ (j=1,....) each unit of time. The adjustment of any one asset holding, in general, depends not only on its own deviation but also on the deviations of other assets. The first terms of the equation (2.13) are simply the stock adjustment terms, including own and cross effects. The remaining two terms express initial allocations of new saving and of capital gains on equities.

The bank's desired holding (X^B) of each asset and its adjustment behavior are expressed as (pp. 109-111)

$$X^B = [(1-k_D)D(a_D + a_1 (r_S - r_F) + a_2 (r_L - r_F)]$$

$$+ (1-k_T)T[a_T + a_1 (r_S - r_F) + a_2 (r_L - r_F)], \quad (2.14)$$

and

$$Dr_L = 10\left\{\frac{L^*(t) - L(t-1)}{(1-K_D)D(t-1) + (1-K_T)T(t-1)}\right\}, \quad (2.15)$$

where K_D, K_T : required reserved ratios for demand and time deposits, respectively

r_F : central bank discount rate,

L^* : desired level of loans,

D : demand deposits, and

T : time deposits.

The bank's adjustment behavior is structurally similar to that of the public, which depends upon both the deviations from desired allocations and the changes in disposable deposits. However, in their paper it is argued that banks, to adjust asset holdings, adjust the loan rate to the level of deviations of current loans from its desired amount, which ends up with the equation (2.15). The equations for the capital stock and total public wealth are

$$V(t) = p(t)K(t), \quad (2.16)$$

and

$$W^P(t) = G(t) + V(t), \quad (2.17)$$

where V : equities,

P : the market evaluation of equities,

K : the stock of capital at replacement cost, and

G : government debt.

Finally, the identities for the reserves (R) and securities are

$$E(t) + K_D D(t) + K_T T(t) = R(t), \tag{2.18}$$

and

$$S^P(t) + S^B(t) = G(t) - R(t), \tag{2.19}$$

where E : net free reserves,

S^P : public's Treasury securities holdings, and

S^B : bank's Treasury securities holdings.

Brainard and Tobin's basic motivation in constructing this model is to show the linkages existing between the financial events and the real economy through changes in p and r_k. This is an endeavor to use Tobin's well-known proposition in financial model building, which says that the market valuation if equities, relative to the replacement cost of the physical assets they represent, is the major determinant of new investment. Four features of their model can be cited. First, they put desired holdings of the various assets and debts as homogeneous in wealth with respect to interest rate effects. Second, they also assume that the assets are gross substitutes. Third, the entire list of relevant interest rates occurs in their equations for the banks and public.

They advocate that it is a mistake to drop the cross-effects out because the sum of the cross-effects is equal to the own-effect in absolute terms. Fourth, they have two causal links from the real economy to financial markets the influences of the national income and the marginal efficiency of capital. The changes in those causal links result in a general reshuffling of portfolios and a new structure of rates.

Their equation for the public's Treasury securities holdings (S^P) is

$$S^P = S^P\,(\hat{r}^P,\ Y)W^P, \tag{2.20}$$

where $\underline{\hat{r}}^P$ stands for the vector of interest rates relevant to public portfolio decisions. And the equation for bank's Treasury securities holding (S^B) is

$$S^B = S^B_D(\hat{r})^L\ (1-K_D)D + S^B_T(\hat{r})^L\ (1-k_T)T, \tag{2.21}$$

where there is no explanation for the $\underline{(\hat{r})^L}$. Therefore, the equation for the Treasury securities holdings of the public and bank is the sum of (2.20) and (2.21) with substitution of $\underline{D^P(\hat{r}^P,Y)W^P}$ and $\underline{T^P(\hat{r}^P,Y)W^P}$ for $\underline{D}$ and $\underline{T}$;

$$S^P + S^B = [S^P(\hat{r}^P,Y) + S^B_D\ (\hat{r})^L\ (1-k_D)D^P(\hat{r}^P,Y) + S^B_T\ (\hat{r})^L\ (1-k_T)T^P(\hat{r}^P,Y)]W^P. \tag{2.22}$$

Since their model has been introduced there were several extensions, which did not change the major context of the original model. The extensions center on the form of the adjustment equations and the asset demand function for estimation. Ladenson (1971) tries to derive formally the restrictions on the coefficients of Brainard and Tobin's static and dynamic behavioral equations, which, he argues, were not derived by them. Clinton (1973), in his comments on Ladenson, shows that the same asset demand function can be developed without using the formal expression of the restrictions on the coefficients.

Smith (1975) tries to show that the coefficients of the linearly dependent explanatory variables can be identified and meaningfully interpreted, which he argues that both Landenson and Clinton failed to show. Purvis (1978) argues that Brainard and Tobin's separation of the portfolio balance decision and the consumption-saving decision is not legitimate in the presence of adjustment costs attached to changing the level of individual asset holdings. This is because if such adjustment costs are present, the rational household formulates consumption and asset flow demands dependent upon income, current holdings of individual assets, and long-run asset considerations. Purvis says that the natural extension of the Brainard and Tobin model is to treat saving and portfolio decisions in an integrated fashion and that this integrated approach is more general than the portfolio balance models (p. 404). Smith (1978) disagrees with what Purvis argues. Smith argues that the Brainard and Tobin asset demands are exceptionally rich and detailed, because the Brainard and Tobin sequential approach actually embodies the assumption that a number of explanatory variables in the consumption function do not separately appear in the asset equations but instead influence asset holdings only through wealth. Therefore wealth appears in the asset demand equations because a number of other variables have been omitted from these equations.

Backus, Brainard, Smith, and Tobin (1980) develop the four-sector, five-asset, one-commodity model of the process of asset accumulation and economic activity and estimate this model for the United States. They separate the portfolio decision into two parts: determination of a long-run desired portfolio and a short-run adjustment to that portfolio. The long-run portfolio allocation of each sector is assumed to depend on such variables as rates of return, income, and the expected quantity of disposable assets (p. 274). Their specification of the short-run asset demand functions takes the partial-adjustment form and has two distinctive features (p. 275). First, the adjustment depends upon a complete description of the short-run disequilibrium. Second, the partial adjustment in the demand for one asset brings about the offsetting adjustments in the demand for other assets, given the constraint on disposable assets.

C. Structural Approach

The structural approach that is mainly developed by B. Friedman and V. Roley (B. Friedman, 1977, 1979, 1980 a,b,c,d; V. Roley, 1979, 1980, 1982; Friedman and Roley, 1980) attempts to model long-term interest rate determination in an explicit demand-supply context by using multi-equation structural models. The basic equation for the desired asset holdings is the linear homogeneous form[4]

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[4]See B. Friedman (1977, p. 663; 1980b, p. 272; 1980d, p. 336); Friedman and Roley (1980, p. 38); and Roley (1979, Eq. 8 of Ch. II). The equation (2.23) comes from Friedman. In his later work, however, Friedman divides the second term of the right-hand side of the equation into the variances and covariances terms (Friedman and Roley, 1980, p. 38).

$$A^*_{it} = \sum_{K}^{N}\beta_{ik}r_{kt}W_t + \sum_{h}^{M}\gamma_{ih}x_{ht}W_t + \pi_i W_t, \qquad (2.23)$$

$$i,k=1,2,\ldots,N;\ h=1,2,\ldots,M,$$

where A^*_{it} : the investor's desired holding of the i-th asset at end of time period _t_ ($\sum_i A^*_{it} = W$),

W_t : the investor's total wealth at time _t_,

r_{kt} : the expected holding-period yield on the k-th asset at time _t_, and

x_{ht} : the value of any additional (risk related) variable influencing the desired allocation at time _t_.

The equation for the desired asset holdings is the general expression of the implicit asset demand function that can be derived by using the expected utility maximization theory. By substituting this desired asset holdings equation into the optimal marginal adjustment model of portfolio adjustment in the presence of transactions costs which can be expressed as (Friedman, 1977, p. 669; 1980a, p. 35; 1980b, p. 272; 1980d, p. 336; Friedman and Roley, 1980, p. 38) one gets

$$\Delta A_{it} = \sum_{k}^{N} \theta_{ik}(\alpha^*_{kt}W_{t-1}) - A_{k,t-1}) + \alpha^*_{it}\Delta W_t,\ i=1,2,\ldots,N, \qquad (2.24)$$

where $\alpha^*_{kt} = (A^*_{kt}/W_t)$, $\alpha^*_{it} = (A^*_{it}/W_t)$, and

θ : the fixed coefficients satisfying the adding-up constraint $\sum_i \theta_{ik} = \overline{\theta}$ for all k (with $\overline{\theta}$ arbitrary).

The right-hand side of (2.24) stands for the reallocation of the investor's previous asset holdings, while the second term represents the allocation of the new investable flow according to the desired asset holdings determined by (2.23). In the long run, equation (2.24) converges to the same equilibrium given by the standard stock-adjustment model

$$\Delta A_{it} = \sum_{k}^{n}\theta_{ik}(A_{kt}^{*} - A_{k,t-1}),\ i=1,2,\ldots,N, \qquad (2.25)$$

where θ_{ik} : the fixed coefficients of adjustment, $0 \leq \theta_{ik} \leq 1$.

Because the utility function and the optimal marginal adjustment model can have different forms to incorporate the characteristics of the different investors and the divergent asset markets, the structural approach can be used in sectoral analysis with preassumed characteristics. There are three advantages of the structural model (B. Friedman, 1980b, p. 275; Friedman and Roley, 1980, p. 36). First, this approach can use the theory of portfolio behavior by regarding the implicit asset demand function which is the solution of the mean-variance expected utility maximization problem as the desired asset holdings (B. Friedman, 1980b, p. 275; 1980c, pp. 570-571; Friedman and Roley, 1980, p. 37). Second, this approach is, therefore, able to investigate directly hypotheses about portfolio behavior. Third, this approach can incorporate information pertinent to heterogeneous securities as well as heterogeneous investor groups because the final specification depends on the assumed utility function of the investor.

CHAPTER III

PRIVATE INVESTORS' DEMAND FOR TREASURY SECURITIES

This chapter derives a theoretical demand function for Treasury securities. As a first step, a comparison of the typical equations with the actual estimates of the previous empirical work is made. Then, a theoretical application of the structural approach is attempted in order to use the approach in formulating the theoretical demand function. Finally, demand functions are derived in both cases of the simple utility function and the quadratic utility function.

A. Review of the Empirical Work

There have been numerous empirical studies of the demand for U. S. Treasury securities. This section reviews the work of de Leeuw (1965), Goldfeld (1966), Silber[1] (1969, 1970), Hendershott (1971, 1977), Bosworth and Duesenberry (1973), and Roley (1979).[2] Several characteristics of these empirical works as a whole can be mentioned. First, with the exception of Goldfeld's short- and long-term estimates and

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[1]The estimates in each of Silber's works are exactly the same because his later work (1970) is an extended version of the previous work (1969).

[2]Friedman and Roley (1980, pp. 41-43) reported simulation results of the short-intermediate-term U. S. Government securities market model, which are exactly the same as that of Roley (1979).

Roley's two maturity-class estimates, most of the empirical work estimates the Treasury securities demand equation only by disaggregated sectors. In other words, there are few estimations by maturity classes. Second, the supply of Treasury securities is regarded as exogenous, i.e., there are no estimates of a Treasury securities supply function. Third, no empirical work examines the interrelationships among the private investors' financial market instruments.

Table I shows that all are quarterly models; most of them are estimated by two-stage least-squares; the disaggregation into sectors appears mostly in Roley's work. For simplicity, the comparison of previous empirical work is to be done by the objectives and assumptions of each work and by the explanatory variables of the typical and final equations.

1. Objectives and Assumptions

A comparison of objectives and assumptions shows no one-to-one relationships among them in each work. The objectives of the empirical works are: (a) the examination of substitutability among assets (Silber, 1969, pp. 197-198) and among different classes of maturity of the U. S. Government securities (Roley, 1979, Chapter I), (b) the examination of financial markets' portfolio behavior (de Leeuw, pp. 465-466) and of commercial banks' portfolio behavior (Goldfeld, pp. 1-3), (c) the analysis of the interactions throughout the security markets (Bosworth and Duesenberry, p. 42), and (d) the explanation of long-term security rates (Hendershott, 1971, p. 816).

TABLE I

COMPARATIVE SUMMARY OF THE EMPIRICAL WORKS

	Sample Period	Estimation Method	Number of Sectors Estimated	Number of Treasury Equations Estimated	Maturity Classes Estimated
de Leeuw (1965)	1948:I -1962:IV	2SLS[1]	4	4	aggregation of all maturities
Goldfeld (1966)	1950:III -1962:II	2SLS	2	4	-within 5 years -over 5 years
Hendershott (1971)	1952:IV -1967:IV	Not Reported	1	1	within 3 years
Silber (1969, 1970)	1953:I -1965:IV	2SLS	6	6	long-term
Bosworth and Duesenberry (1973)	1946:I -1971:IV[2]	Not Reported	1	1	over 5 years
Roley (1979)	1960:I -1975:IV	2SLS[3]	10	20	-2-4 years -over 12 years

Notes: 1) 2SLS: two-stage least-squares estimation.
2) For business sector, the sample covers from 1959:I through 1971:IV.
3) The final selection of explanatory variables are made on the basis of the ordinary least-squares estimate results.

The most common assumption among them are that there are stock adjustment models, and that the quarterly portfolio flows depend upon the discrepancies between the current and the desired levels of asset holdings and they adjust partially to those discrepancies (de Leeuw, pp. 467-472; Bosworth and Duesenberry, p. 63; Silber, 1970, p. 15; Goldfeld, pp. 24-27). For this common assumption, de Leeuw and Goldfeld assume that there exists a set of long-term preferences that brings about a desired composition of asset portfolios which depends on the entire constellation of yields on all financial assets. Hendershott did not report his assumption explicitly.

2. Typical Equations and Actual Estimations

(a) de Leeuw

De Leeuw (1965) presents a four-sector, six-market model of the financial sector in the Brookings quarterly econometric model of the United States. The sectors are banks, nonbank finance, the public, and the federal government. The markets are short- and long-term Federal Government debt, private debt, bank savings accounts, other savings and insurance claims, and money (including bank reserves). Four sectoral demands for Treasury securities (short- and long-term) and equality between demand and exogenous supply determines an average Treasury yield and the sectoral holdings. This average yield is then translated into a short- and long-term rate via a term-structure relation (pp. 498-503). Thus, a pure supply-demand framework was not used to explain the yields on short- and long-term Treasure securities. His study, however, can be considered as important for at least initial considerations of sectoral behavior regarding security supplies and demands.

His typical equation (p. 472) is

$$\frac{\Delta(X)t}{W_{t-1}} = a+b_1\frac{X_{t-1}}{W_{t-1}} +b_2r(1)_t+b_3r(2)_t +. \ . \ .+b_j\frac{f(1)_t}{W_{t-1}} +b_{j+1}\frac{f(1)_{t-1}}{W_{t-1}} \tag{3.1}$$

where ΔX_t : changes in portfolio holdings,

X_{t-1} : lagged holdings,

$r(1)$, $r(2)$,... : rates of return,

$f(1)_t$, $f(1)_{t-1}$: current and lagged short-run constraints (e.g., current income for the public), and

W : wealth.

The explanatory variables in de Leeuw's final equation for U. S. Treasury securities holdings (pp. 476-479) are different from one investor group to another as shown in Table II. It can be pointed out that, according to the table, there are no rates of return variables in the commercial banks' demand equation for Treasury securities.

(b) Goldfeld

Goldfeld (1966) develops an aggregate quarterly model of the postwar U. S. economy to examine commercial bank portfolio behavior, to relate investment and consumption expenditure directly to financial variables, and to investigate the impact of monetary policy on both financial and nonfinancial variables (pp. 1-3). He especially puts his effort to modeling the commercial banking sector.

TABLE II

COMPARISON OF VARIABLES IN DE LEEUW'S ESTIMATION

Sector	Dependent Variables	Explanatory Variables
Typical Equation	Ratio of increase in asset holdings to previous period's wealth	-previous period's ratio of total asset holdings to wealth -variables for rates of return -current and lagged constraint variable
Household	Ratio of increase in security holdings to previous period's GNP	-previous period's ratio of total security holdings to GNP -three-month Treasury bill rate -yield on commercial bank time deposit -previous period's ratio of private time deposit of commercial bank less comm'l bank's TD holdings to GNP
Non-Financial Business	Same as in the household	-same as in the household -same as in the household -ratio of business gross investment to previous period's GNP -ratio of increase in net accrual of corporate profit tax to GNP (-1)
Commercial Banks	Ratio of increase in security holdings to the sum of previous period's DD and TD	-previous period's ratio of excess reserves of Fed's member bank to the sum of DD and TD -ratio of increase in the sum of DD and TD of federal gov't's DD less the sum of RR, loans, and other private securities to the sum of DD(-1) and TD(-1) -ratio of previous period's increase in the same items as in the above to the sum of DD(-1) and TD(-1)
Nonbank Finance	Ratio of increase in security holdings to the previous period' holdings of savings and insurance claims (BNBF(-1))	-ratio of previous security holdings to BNBF (-1) -three month Treasury bill rate -difference between average yield on private securities and on U.S. securities maturing in 10 yrs. or more -ratio of increase in the sum of BNBF and FHLBB's advances to savings and loan ass'n to the BNBF (-1) -average ratio of the sum of the above lagged from 1 through 4 periods

Notes: GNP: weighted average of recent values of GNP, DD: demand deposits, TD: time deposits, FHLBB: Federal Home Loan Bank Board (-1): the previous period.

Two kinds of typical equations (p. 139) are presented. One is homogeneous of degree one in dollar magnitude and the other is not. They are

$$\Delta A_t = b_0 W_t + b_1 A_{t-1} + b_2 r_{1t} W_t + \ldots + b_n X_t + u_1, \qquad (3.2)$$

$$\Delta A_t = b_0 + b_1 A_{t-1} + b_2 r_{1t} + b_3 r_{2t} + \ldots + b_n X_t + u_2, \qquad (3.3)$$

where ΔA_t : changes in holdings of assets at time t,

A_{t-1} : total holdings of assets at time t-1,

r_{1t}, r_{2t} : rates of return,

X_t : constraint variables,

W_t : wealth, and

u_1, u_2 : error terms.

The regressors in Goldfeld's final equations (pp. 131-135) for the short-term and long-term U. S. Government securities are shown in Table III. According to this table, there are several points to be mentioned. First, there is no variable for current total wealth in his final equations, which is not implied by typical equation (3.2). Second, although it is suggested in typical equations (3.3), there is no variable for the rates of return in his city member bank's demand for short-term U. S. Government securities equation. Third, he uses variable for the actual amount of returns in his final equation, as suggested in equation (3.2), rather than variable for the rates of return as suggested in equation (3.3). Finally, the seasonal dummy variables are used for the estimation.

TABLE III

COMPARISON OF VARIABLES IN GOLDFELD'S ESTIMATION

Sector	Dependent Variables	Explanatory Variables
Typical Equation	Changes in portfolio holdings	(Eq. 3-2): -current wealth -previous period's total asset holdings -actual amount of returns -constraint variables (Eq. 3-3): -previous period's total asset holdings -rates of return -constraint variables
Short Term	Changes in holdings of short-term U.S. Gov't Securities	-previous period's total holdings of short-term U.S. Government securities -changes in public's total holdings of short-term U.S. Government securities ($\Delta\bar{S}$) -that of long-term U.S. securities ($\Delta\bar{O}$) -changes in TD of city member banks -changes in net DD of city member banks -changes in holdings of commercial loans (ΔCL) by city member banks -reserve requirements (RR) for city member banks -seasonal dummy variables
Long Term	Changes in holdings of long-term U.S. Gov't securities	-previous period's total holdings of long-term U.S. Government securities -$\Delta\bar{S}$ -$\Delta\bar{O}$ -ΔCL by city member banks -product of commercial loan rates and the sum of DD and TD of city banks -product of long-term yield on U.S. Gov't sec. and the sum of DD and TD of city member banks -seasonal dummy variables

Note: The above illustration is from his original estimation for the city member banks.

<u>(c) Silber</u>

Silber (1969, 1970) examines the importance of substitutability among assets for the efficacy of monetary policy. His work can be regarded as an amplification of de Leeuw's work. Because Silber disaggregates the nonbank financial sector into savings and loan associations, mutual savings banks, life insurance companies, other insurance companies, and pension and retirement funds, he also disaggregates the market for private securities and estimates demand equations for the various sectors. On the determination of primary security yields, Silber follows de Leeuw. Silber assumes that the commercial banks are rate setters regarding business loans. He also uses a term-structure relations to obtain the long-term Treasury yield from the Treasury bill rate. But, for corporate bonds, municipals, and mortgages the yields are determined directly by market clearing relationships, or the supply-demand equality.

He stock adjustment formulation (1970, p. 15) is

$$\Delta X_t = a(X_t^* - X_{t-1}),\ 0 < a < 1, \tag{3.4}$$

where ΔX_t : the flow for a particular portfolio into security <u>X</u> during time period <u>t</u>,

X_t^* : the desired holdings of security <u>X</u>, and

X_{t-1} : the amount of security <u>X</u> held in the portfolio of the particular intermediary at the end of last period.

He then expresses the desired level of security <u>X</u>, $\underline{X_t^*}$, in the intermediary's portfolio as

$$X_t^* = b_1 + b_j[i_j] + b_{j+n}\,A, \qquad (3.5)$$

where $[i_j]$: a set of interest rates that is relevant for the intermediary's choice regarding portfolio composition, and

A : the level of assets.

By substituting (3.5) into (3.4) and rearranging, the typical equation that is the general form of the demand for security X by a particular intermediary is:

$$X_t = \alpha_1 + \alpha_2 A + \alpha_j(i_j) + \alpha_{j+n}X_{t-1}, \qquad (3.6)$$

where X_t : the current holdings of security X, and

$\alpha_{j+n} = (1-a)$, where a stands for the speed of adjustment.

The explanatory variables in Silber's (1969, pp. 216-219) structural equations for long-term Treasury securities are examined in Table IV. His equations use seasonal dummy variables, as did Goldfeld. No interest rate variables appear in the commercial banks' securities demand equation.

After examining the investment behavior of six types of financial institutions, he concludes that the substitute-complement relationships are determined by the underlying risk relationships between different categories of securities (1970, pp. 110-111). He also says that Governments and corporates are substitutes for each other, whereas Governments and mortgages are complementary in demand.

(d) Hendershott

In his work of 1971, he presents the typical asset demand equation of the non-bank finance sector (p. 821) as

TABLE IV

COMPARISON OF VARIABLES IN SILBER'S EQUATIONS

Sector	Dependent Variables	Explanatory Variables
Typical Equation	Current holdings of security	-the level of assets -a set of interest rates -previous period's holdings of security
Mutual Savings Banks	Current holdings of U.S. Government bonds	-long-term U.S. Gov't bond rate (i_{GB}) -corporate bond rate (i_{CB}) -previous period's holdings of U.S. Gov't bonds -deposit holdings -changes in deposit holdings -seasonal dummy variable
Commercial Banks	Current holdings of U.S. Gov't bonds	-previous period's holdings of U.S. Gov't bonds -DD of commercial banks -(DD+TD) at commercial banks by federal and state-local government -changes in loans of commercial banks -DD(-1) of commercial banks -one period lagged (DD+TD)at commercial banks by federal and state-local gov'ts -seasonal dummy variable
Life Insurance Companies	Current holdings of U.S Gov't bonds	-assets of life insurance companies -changes in assets of life insurance co. -i_{GB} -previous period's holdings of U.S. Gov't bonds -rate of change in the GNP deflator -seasonal dummy variable
Savings and Loan Association	Current holdings of U.S. Gov't bonds	-i_{GB}, FHLB borrowing rate -previous period's holding of U.S. bonds -deposits of S&L Association -seasonal dummy variable
Other Insurance Companies	Current holdings of U.S. Gov't bonds	-assets of other insurance companies -changes in assets of other insurance co. -state-local bond rate; i_{GB} -previous period's holding of U.S. bonds -seasonal dummy variable
Pension Plans	Current holdings of U.S. Gov't bonds	-assets of pension plans -i_{GB}; i_{CB} -previous period's holding of U.S. bonds -seasonal dummy variable

Notes: -He reported another equation for commercial banks whose dependent variable is the ratio of short-term U.S. bonds to long-term U.S. bonds of commercial banks, which is disregarded due to its exceptionality compared to other equations.
-DD: demand deposit, TD: time deposit
-(-1) stands for the previous period

$$[FA_i/T] = \alpha_0 + \alpha_1 \sum_i W_i^1 RS_{t-1} + \alpha_2 \sum_j W_j^2 Rbe_{t-j} + \alpha_3 \sum_k W_k^3 Rrm_{t-k}$$

$$+ \alpha_4 \sum_m W_m^4 (CSV/T)_{t-m} + \alpha_5 \sum_n W_n^5 (\Delta T/T)_{t-n}, \qquad (3.7)$$

where FA_i : the i-th financial assets,

T : the sector's total financial assets ($= \sum_i FA_i$),

RS : the short-term security rates,

Rbe : the bond-equity yield,

Rrm : the residential mortgage rate,

CSV : the volume of contractual savings (insurance and pension fund reserves and insurance policy variables), and

W^i : lagged responses to changes in the variables, i = 1,2,.,5.

The explanatory variables in Hendershott's final equation (p. 827) for the short-term securities are shown in Table V.

Even though he presents eight sectors' typical asset demand equations in his work of 1977, those equations have essentially the same form as equation (3.7), in the sense that the demand for an asset is a function of the interest rates and related wealth level.

(e) Bosworth and Duesenberry

Bosworth and Duesenberry (1973) study the behavior of four financial institutions: commercial banks, savings and loan associations, mutual savings banks, and life insurance companies. They treat credit unions, other finance except life insurance companies, and federally sponsored credit agencies as exogenous. This differs from the work of Hendershott. They divide primary securities into negotiated loans and marketable securities. Their study tries to analyze the interactions throughout the security markets, because they think that the effect of any action by the monetary authority depends on the interaction between the central bank's action and the complex financial structure.

TABLE V

COMPARISON OF VARIABLES IN HENDERSHOTT'S EQUATION

Sector	Dependent Variables	Explanatory Variables
Typical Equation	Ratio of i-th financial assets to sector's total financial assets (T)	-the short-term security rate (RS) -the bond-equity yield (Rbe) -the residential mortgage rate (Rrm) -ratio of contractual savings to T -$\Delta T/T$
Nonbank Finance	Ratio of short-term securities to T	-RS -(Rbe-RS) -ratio of contractual savings to T

The desired stock of each asset of liquidity (A_i^*) is assumed as (pp. 63-64)

$$A_i^* = a_i + \sum_j b_{ij} (r_j W) + c_i W + \sum_k d_{ik} X_k, \tag{3.8}$$

where r : a vector of interest rates,

W : a wealth constraint, and

X : other factors (e.g., income or transactions requirements).

And the short-run stock adjustment process can be generalized as

$$\Delta A_i = \sum_j \lambda_{ij} (A_j^* - A_{j-1}) + \gamma_k Z, \tag{3.9}$$

where $\underline{Z}$ is the various flow disturbance terms. Therefore, the typical equation for asset demand can be derived by substituting $\underline{A_i^*}$ into $\underline{\Delta A_i}$ equation. Therefore, it becomes

$$\Delta A_i = \sum_j \lambda_{ij} a_j + \sum_i \sum_j \lambda_{ij} b_{ij} (r_i W) + \sum_j \lambda_{ij} c_j W + \sum_j \sum_k \lambda_{ij} d_{jk} X_k$$

$$- \sum_j \lambda_{ij} A_{j-1} + \gamma_k Z. \tag{3.10}$$

In their model, only the commercial banks' holdings of U. S. Government bonds over five years is estimated (p. 127). The explanatory variables of this equation are shown in Table VI. As already pointed out in the cases of de Leeuw, Goldfeld,[3] and Silber, Bosworth and Duesenberry also did not use variables for yields in their final estimation. This is because Bosworth and Duesenberry argue that normalizing the equation on rates instead of quantities will reduce simultaneous equations bias.

(f) Roley

Roley (1979) estimates the Treasury securities demand equations for two maturity classes (2-4 years; over 12 years) of ten investor groups. In his study, he tries to develop a structural model of the

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[3]His equation for the city member banks falls under this case.

U. S. Government securities market and to determine the substitution relationship among different maturity classes of U. S. Government securities. His study bases the specification of the asset demands on an explicit portfolio selection theory.

TABLE VI

COMPARISON OF VARIABLES IN BOSWORTH-DUESENBERRY'S ESTIMATION

Sector	Dependent Variables	Explanatory Variables
Typical Equation	Changes in asset holdings	-amount of actual return on wealth -amount of wealth -variables for other factors -previous period's holdings of assets -various flow distrubance terms
Commercial Banks	Changes in holdings of U.S. bonds over 5 years	-total bank earning assets -previous period's total bank earning assets -changes in total holdings of U.S. bonds over 5 years -previous period's holdings of U.S. bonds over 5 years

He uses an adjustment model with a linearization of desired asset holdings to derive actual asset flow demands. The ratio of desired asset holdings (α_t^*) is (Ch. V, Eq. (5-1))

$$\alpha_t^* = (a_t^*/W_t) = b + B_i\ \mu_t + B_2\ \sigma_t, \qquad (3.11)$$

where W_t : total dollar value of financial assets at time t,

b : vector of constants, and

B_1, B_2 : coefficient matrices on expected holding-period yields and variances of holding-period yields, respectively.

He then applies diverse institutional and behavioral characteristics[4] of each investor group to a simple stock adjustment model to describe each group's short-run portfolio adjustment behavior. The simple stock adjustment models, which are based on B. Friedman's optimal marginal adjustment model (B. Friedman, 1977, p. 669; 1980b, p. 272), are (Ch. IV, Eq. (4-2) and Eq. (4-3))

$$\Delta a_{it} = \sum_{k}^{N} \theta_{ik} (\alpha^{*}_{kt} W_{t-1} - a_{k,t-1}) + \sum_{kj}^{NJ}\sum \theta^{j}_{ik} (\Delta a^{j}_{t}/W_{t-1}) (\alpha^{*}_{kt} W_{t-1}$$

$$- a_{k,t-1}) + \sum_{j}^{J} \pi^{j}_{i} \Delta a^{j}_{t}, \quad i = 1,2,\ldots,N, \tag{3.12}$$

and

$$\frac{a_{it}}{W_t} - \frac{a_{i,t-1}}{W_{t-1}} = \sum_{k}^{N} \theta_{ik}(\alpha^{*}_{kt} - \frac{a_{k,t-1}}{W_{t-1}}) + \sum_{kj}^{NJ}\sum \theta^{j}_{ik}(\frac{\Delta a^{i}_{t}}{W_{t-1}})(\alpha^{*}_{kt} - \frac{a_{k,t-1}}{W_{t-1}}),$$

$$i = 1,2,\ldots,N, \tag{3.13}$$

where θ_{ik}, θ^{j}_{ik} : fixed coefficients of adjustment, and

Δa^{i}_{t} : flows of exogenous assets and liabilities.

The model (3.12) considers the adjustment for levels of assets whereas the model (3.13) deals with proportional adjustment. He aggregates ten

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[4]In Chapter V of Roley (1979), five properties applicable, either in part or as a whole, to each investor are presented.

investor groups into five groups according to the aforementioned properties and describes each large group's typical equation specifically (Ch. V, Eqs. (5-2) - (5-6)).

The comparison of variables between typical equations and final estimations is done only for commercial banks among his ten investor groups because his typical equations and estimations are very complicated but have similar explanatory variables. The comparison for the case of short-intermediate term (2-4 years) is presented in Table VII and for long-term (over 12 years) in Table VIII.

Compared to the other models, there are two distinctive features in Roley's equations. First, his estimation explicitly includes inflationary effects as explanatory variables. Second, his model includes variables for the variance of yields and capital gains, which is inferred by the mean-variance expected utility maximization approach.

He did not, however, fully analyze the reason for the instability of the commercial banks' long-term equation and also did not report the reason for the omission of the nonfinancial corporate business's long-term equation.

B. Theoretical Application of the Structural Approach

The brief review of the theory and empirical work so far indicates that the structural approach is broader than the other theories, although the empirical equations are very complicated, because it combines the solutions for the expected utility maximization approach with the optimal marginal adjustment model of portfolio adjustment in

TABLE VII

COMPARISON OF VARIABLES IN COMMERCIAL BANK'S

SHORT-INTERMEDIATE-TERM DEMAND EQUATIONS

	Dependent Variables	Explanatory Variables
Typical Equation	Changes in asset flow	(a) discrepancies between asset holdings, i.e., $\alpha_k^* W_{t-1} - a_{k,t-1}$ (b) product of (a) and the ratio of changes in exogenous asset flows to previous period's total financial assets (W_{t-1}) (c) product of (a) and the ratio of changes in exogenous liabilities flow to W_{t-1} (d) changes in exogenous assets flow (e) changes in exogenous liabilities flow
Actual Estimation	Comm'l bank's flow demand for Treasury Securities	(a) previous period's comm'l banks' holdings of -short-term Treasury securities (US1) -short-intermediate-term Treas. sec. (US2) -state and local Gov't obligations (SL) -open-market paper (CP) (b) product of 3-5 yr Treas. sec. rate (r2) and the sum of the comm'l banks' ΔDD,ΔGD and L (c) product of the inverse of r2 and the sum of the comm'l banks' DD, GD, mortgages (M) (d) product of Treas. bill rate (rT) and the sum of the comm'l banks' GD, TD, L, and SC (e) product of the change in -DD and previous period's V2 -CD and previous period's V1 -DD and the inverse of previous period's V1 (f) product of ΔCC_t and ratio of previous period's long-term Treas. sec. to W_{t-1} of comm'l banks (g) product of the sum of ΔGD_t, ΔM_t, ΔCC_t and the ratio of $US3_{t-1}$ to W_{t-1} of comm'l banks (h) product of the sum of ΔTD_t and ΔCD_t and the ratio of $US1_{t-1}$ to W_{t-1} of comm'l banks (i) product of the sum of ΔGD_t and ΔCC_t and the ratio of SL_{t-1} to W_{t-1} of comm'l banks (j) product of the sum of ΔTD_t and ΔCC_t and the ratio of CP_{t-1} to W_{t-1} of comm'l banks (k) product of the sum of ΔDD_t and ΔCD_t and the ratio of previous period's U.S. Gov't agency issues to W_{t-1} of comm'l banks

Notes: US3--long-intermediate-term Treasury securities; L--bank loans; GD--government deposit; SC--security credit; V1--four-quarter moving average variance of percentage change of CPI; V2--four-quarter moving average variance of r2; CD--large negotiable certificates of deposit; CC--comsumer credit.

TABLE VIII

COMPARISON OF VARIABLES IN COMMERCIAL BANK'S LONG-TERM SECURITIES DEMAND EQUATIONS

	Dependent Variables	Explanatory Variables
Typical Equation: same as in Table VII.		
Actual Estimation:		
(1) for 1960:I -1965:I	flow demand for Treasury securities	$-US4_{t-1}$ of commercial banks -product of ΔW_t of comm'l banks and yield on 10 yr and over Treas. sec. at t ($r_{4,t}$) -product of ΔW_t of comm'l banks and the inverse of $r_{4,t}$ -product of ΔW_t of comm'l banks and the municipal bond yield at time t($r_{s,t}$) -product of ΔW_t of comm'l banks and the inverse of $r_{s,t}$ -product of W_{t-1} of comm'l banks and $r_{s,t}$
(2) for 1965:II -1975:IV	Same as above	$-US4_{t-1}$ of commercial banks $-US2_{t-1}$ of commercial banks -product of W_{t-1} of comm'l banks and $r_{4,t}$ -product of W_{t-1} of comm'l banks and $r_{s,t}$ -product of the sum of ΔDD_t, ΔTD_t, ΔCD_t, and ΔSC_t of commercial banks and the $r_{4,t}$ -product of the comm'l banks' ΔCD_t and the $r_{T,t}$ -product of the comm'l banks' ΔDD_t and the inverse of previous period's eight-quarter moving average variance or r_4 -product of the comm'l banks' ΔSC_t and the ratio of $US4_{t-1}$ to W_{t-1} of comm'l banks -product of the comm'l banks' ΔL and the ratio of $US2_{t-1}$ to W_{t-1} of comm'l banks -product of the sum of ΔTD_t and ΔM_t and the ratio of CP_{t-1} to W_{t-1} of comm'l banks

Notes: US4: long-term Treasury securities
r_T: three-month Treasury bill rate

the presence of transactions cost (B. Friedman, 1977, p. 669; 1980b, p. 272). This is one of the very distinctive features of B. Friedman's model.

This study uses, as already mentioned in Chapter I, the framework of the structural approach to specify empirically tractable demand equations for Treasury securities. The final form of the explicit asset demand equations in this approach is determined by two factors: the utility function and the stock-adjustment framework, because the final asset demand equation is the combination of the implicit asset demand function with the stock-adjustment framework. The implicit asset demand equations used in this study are derived by using the expected utility maximization approach. As already mentioned in Chapter II of this study, the expected utility maximization approach is more flexible than the other portfolio-theoretic approaches because it allows for a wide range of application and the explicit treatment of risk aversion.

1. Utility Function

A decision problem under uncertainty consists essentially in establishing a preference ordering over a set of stochastic variables. The utility function describes a person's tastes or preferences. Just as a mathematical functions shows the relationship among variables, the utility function relates the person's utility to the quantity and quality of goods and services that he or she consumes.

(a) Arguments

The independent variables of the asset demand equations are determined directly by the arguments of the utility function. By maximizing either expected utility of end-of-period wealth or expected utility of the portfolio's rate of return, linearly homogeneous asset demand equations can be derived. If the asset demand equations are linearly homogeneous in portfolio wealth, then expected holding-period yields remain as important determinants for the holdings of assets regardless of the level of initial portfolio wealth. The most general specifications ar the utility of portfolio rate of return in the set of expected utility maximization frameworks which leads to linear homogeneous asset demand equations in portfolio wealth. To approximate actual portfolio selection behavior and to render reasonable asset demand equations in a time series context, the portfolio rate of return is used as the argument of the utility function (Roley, 1979, Chapter II).

(b) Structures

There are various assumptions about the structure of the direct utility function--homotheticity, additivity, and general separability.

(i) Homothetic Utility Functions. Assume that there are two kinds of asset instruments: (1) government securities, and (2) the rest of the asset instruments. Assume further that private investors as a whole have only financial market instruments for portfolio choice and let $\underline{S_g}$ be the end-of-period market value of holdings of Treasury securities and $\underline{S_p}$ be that of the rest of the financial market instruments. Then the general form of the direct utility function of the private investors in this case can be written as

$$U = U(S_g, S_p). \tag{3.14}$$

The locus of tangencies to a budget line of constant slope lies, in any homothetic function, along a ray from the origin, since (U_1/U_2) depends only on (S_g/S_p). It follows that, for given relative prices, the relative shares of expenditure going on S_g and S_p are constant. In this case, the share of each good for someone of given tastes is independent of income and depends only on relative prices. The Cobb-Douglas type utility function is a special case of the homothetic utility functions:

$$U = S_g^{\alpha_g} \, S_p^{\alpha_p}, \tag{3.15}$$

where α_g : the expenditure share of S_g,

α_p : the expenditure share of S_p, and

$\alpha_g + \alpha_p = 1.$

For this function the expenditure shares are independent of the prices of the financial instruments as well as income. Also, the homothetic utility function has unitary income elasticity of demand. If private investors have homothetic utility functions, the marginal propensities to spend on S_g and S_p must be the same even though their incomes differ.[5]

(ii) Additive Utility Functions. An additive utility function can be written as

$$U = U_g(S_g) + U_p(S_p), \tag{3.16}$$

[5]It is obvious that $\alpha=(S_gP_g/M)$ and $\alpha_p=(S_pP_p/M)$, where P_g stands for the price of S_g, P_p for the price of S_p, and M for the total expenditures on portfolio. Then $\alpha_g + \alpha_p = 1$ means $S_gP_g + S_pP_p = M$. Hence, the marginal propensities to spend in S_g and S_p are $(\partial S_gP_g/\partial M)$ and $(\partial S_pP_p/\partial M)$, respectively. The value of the marginal propensities is 1 which is always the same regardless of the level of incomes.

where $U_g = (\partial U/\partial S_g)$ and $U_p = (\partial U/\partial S_p)$.

this implies that the marginal utility of each financial market instrument is independent of the quantity of any other financial instrument. It also assumes the independence of wants. This assumption has two implications, provided all financial instruments account for sufficiently small proportions of expenditure: (a) no cross-substitution effects and (b) the same ratio of own-price elasticity to income elasticity for every financial instrument.

(iii) Separable Utility Functions. The previous assumption of additivity has little practicality because the linear expenditure system is normally estimated on time series, where prices also vary. It is more reasonable to assume that goods including financial market instruments fall naturally into groups. This grouping can be made in such a way that there is more independence in some forms of decision making than in others. In this case, the utility function should be separable and can be expressed as

$$U = U[f_1 (S_g, S_p) + f_2(X_1, X_2) + \dots], \qquad (3.17)$$

where X_i : the amount of the i-th commodity consumed.

This separability implies that if financial market instruments are separable from all other goods, then

$$\frac{\partial}{\partial X_i} \left(\frac{U_g}{U_p}\right) = 0, \text{ all } i \neq g,p,$$

which means that the ratio of marginal utilities of one bundle of commodities is not influenced by the change in the amounts of commodity of the other bundle.

2. Expected Utility Maximization and Mean-Variance Analysis

To construct an empirically tractable asset demand equation by using the expected utility maximization approach, it is necessary to reduce the number of parameters describing a given expected utility specification. According to Tobin (1958, p. 77; 1969, p. 13), the mean-variance analysis can be used to solve the portfolio choice problems of the expected utility maximization approach provided that either the investor's utility function is quadratic or the random variables for the portfolio return are normally distributed, or both. Tobin's separation theorem states that if money is a riskless asset and is held in the portfolio in any amount, the utility function is relevant only to the determination of the optimal proportion of money and net of the optimal mix of risky assets (Tobin, 1958, pp. 82-85).

Feldstein (1969, p. 5) suggests an alternative justification of mean-variance analysis. His alternative justification is that, regardless of the form of the investor's utility function, if the subjective probability distributions of the possible portfolios are all members of a two-parameter family of distributions, preferences can be analyzed in terms of mean and variance. Tobin (1969, p. 13) refutes what Feldstein suggests, and says that the family of two-parameter distributions with the requisite property has only one member, the normal. Roley (1979, pp. 54-57) demonstrates that joint normally distributed asset rates of return or quadratic utility are sufficient conditions for expected utility maximization to be reduced to a preference ordering in terms of the mean and variance of the arguments of the utility function.

The current study follows the mean-variance hypothesis of investment behavior, i.e., that the investor chooses among alternative portfolios on the basis of their contribution to the first two moments, E (expected returns) and V (variances). Both the simple form and the quadratic form of utility functions are used with the mean-variance analysis to derive and specify the private investors' asset demand function.[6] Sameulson (1970, p. 538, p. 542) argues that when risk is quite small, i.e., the variance is near zero, the mean-variance result is a very good approximation and the quadratic solution approximates the true general solution.

C. Model Formulation

In this section, the asset demand equations are formulated according to two utility functions--the simple Markowitz-type utility function and the quadratic utility function. As already mentioned, it is assumed that there are two kinds of asset instruments: (1) Treasury securities, $\underline{S_g}$, and (2) the alternative financial market instruments, $\underline{S_p}$. It is also assumed that the typical investor chooses a portfolio by maximizing the utility function $\underline{U(E,V)}$ subject to the conditions that the wealth constraint be satisfied and that the planned holdings of the numeraire asset and of Treasury securities be non-negative.

[6]Markowitz (1952, pp. 89-91) and Tobin (1958, p. 323) assert that the mean-variance framework can be justified not because of its precise and universal validity but because of its appeal as a tractable approximation useful for a variety of practical analytical purposes.

1. Simple Utility Function Case

Assume that the private investor's utility function has the following simple Markowitz form:[7]

$$U = E - V, \tag{3.18}$$

where E represents the period-by-period expected yield of the assets and V stands for the variance of E. Then equation (3.18) can be written as

$$U = (S_g \in_g + S_p \in_p) - (S_g^2 \sigma_g^2 + 2S_g S_p \rho\sigma_g\sigma_p + S_p^2 \sigma_p^2), \tag{3.19}$$

where $\in_g$ and $\in_p$: the expect value of the rates of return on S_g and S_p, respectively,

σ_g^2 and σ_p^2 : the variance of $\in_g$ and $\in_p$, respectively, and

$\rho\sigma_g\sigma_p$: covariance.

The constraint is

$$A = S_g + S_p, \tag{3.20}$$

where A is the total dollar value of the private investors' portfolio. Then, as shown in equation (2.11), the mean-variance expected utility maximization problem is

$$\underset{S_g, S_p, \lambda}{\text{Max}}\ L = S_g \in_g + S_p \in_p - (S_g^2 \sigma_g^2 + 2S_g S_p \rho\sigma_g\sigma_p + S_p^2 \sigma_p^2) + \lambda(A - S_g - S_p). \tag{3.21}$$

---

[7]This linear utility function implies that the expected value of utility is simply the expected value of E, and that maximizing expected utility leads to the same behavior as maximizing return in a world of certainty. Roley (1982, p. 55) expresses his utility function of an investors as $U=E-(\rho/2)V$, where ρ is a scalar measuring an investor's constant relative risk aversion.

The first-order conditions for the maximization of L are

$$\frac{\partial L}{\partial S_g} = \epsilon_g - (2S_g\sigma_g^2 + 2S_p\rho\sigma_g\sigma_p) - \lambda = 0,$$

$$\frac{\partial L}{\partial S_p} = \epsilon_p - (2S_g\rho\sigma_g\sigma_p + 2S_p\sigma_p^2) - \lambda = 0, \tag{3.22}$$

$$\frac{\partial L}{\partial \lambda} = A - S_g - S_p = 0.$$

By solving (3.22) for S_g, the implicit Treasury securities demand function can be derived as

$$S_g = \frac{\epsilon_g - \epsilon_p + 2S_p(\sigma_p^2 - \rho\sigma_g\sigma_p)}{2\sigma_g^2 - 2\rho\sigma_g\sigma_p}, \tag{3.23}$$

or, by substituting $S_p = A - S_g$ into (3.22) and solving for S_g,

$$S_g = \frac{\epsilon_g - \epsilon_p + 2A(\sigma_p^2 - \rho\sigma_g\sigma_p)}{2(\sigma_g - \sigma_p)^2}. \tag{3.24}$$

These solutions S_g guarantee the maximum expected utility as long as $\sigma_g \neq \sigma_p$ because the value of the principal minor of the second-order condition is positive.

Benjamin Friedman regards the solution (3.23) or (3.24) as the investors' desired holdings at time period t, $[(S_g^*)_{it}]$, as already pointed out. His optimal marginal adjustment model (1977, p. 669; 1980b, p. 272) is, as explained earlier in Chapter II:

$$\Delta A_{it} = \sum_{k}^{N} \theta_{ik}(\alpha_{kt}^{*} W_{t-1} - A_{k,t-1}) + \alpha_{it}^{*} \Delta W_t, \tag{3.25}$$

where α^{*} : A^{*}/W_t,

A^{*} : the investor's desired holdings of the asset at time _t_, and

W_t : the investor's total portfolio size at time _t_.

For the present purpose, the equation (3.25) can be rewritten as

$$(S_g)_{it} = \alpha_i[\beta_{it}^{*} A_{t-1} - (S_g)_{i,t-1}] + \beta_{it}^{*} \Delta A_t + (S_g)_{i,t-1}, \tag{3.26}$$

$$i = 1,2,3,4,$$

where $(S_g)_{i,t-1}$: the amount of holdings of the i-th maturity class Treasury securities at time period _t-1_,

$A_t = (S_g)_t + (S_p)_t$,

$\beta_{it}^{*} = [(S_g^{*})_{it}]/A_t$, and

α = adjustment coefficient, $0 \leq \alpha_i \leq 1$.

Substituting $\beta_{it}^{*} = [(S_g^{*})_{it}]/A_t$ into equation (3.26) gives

$$(S_g)_{it} = \alpha_i \frac{A_{t-1}}{A_t} (S_g^{*})_{it} - \alpha_i(S_g)_{i,t-1} + \frac{\Delta A_t}{A_t} (S_g^{*})_{it} + (S_g)_{i,t-1}. \tag{3.27}$$

By rearranging equation (3.27), the Treasury securities holdings of i-th maturity class at time period _t_ becomes

$$(S_g)_{it} = \alpha_i \frac{A_{t-1}}{A_t} (S_g^{*})_{it} + \frac{\Delta A_t}{A_t} (S_g^{*})_{it} + (1 - \alpha_i)\cdot(S_g)_{i,t-1}, \tag{3.28}$$

where $\underline{(S_g^*)_{it}}$ stands for the implicit Treasury securities demand function (3.23) or (3.24).

Therefore, by substituting (3.23) or (3.24) for $\underline{(S_g^*)_{it}}$, the actual demand equation for Treasury securities becomes

$$(S_g)_{it} = \frac{\epsilon_g - \epsilon_p + 2S_p(\sigma_p^2 - \rho\sigma_g\sigma_p)}{2A_t\ (\sigma_g^2 - \rho\sigma_g\sigma_p)}(\alpha_i\ A_{t-1} + \Delta A_t) + (1 - \alpha_i)\ (S_g)_{i,t-1}, \tag{3.29}$$

or

$$(S_g)_{it} = \frac{\epsilon_g - \epsilon_p + 2A_t(\sigma_p^2 - \rho\sigma_g\sigma_p)}{2A_t\ (\sigma_g - \sigma_p)^2}(\alpha_i\ A_{t-1} + \Delta A_t) + (1 - \alpha_i)\ (S_g)_{i,t-1}. \tag{3.30}$$

2. Quadratic Utility Function Case

If we assume that the private investor's utility function has the following quadratic form:[8]

$$U = E + c(V + E^2), \tag{3.31}$$

where $\underline{0 < c < 1}$ for a risk-lover, and $\underline{-1 < c < 0}$ for a risk-averter. This equation (3.31) can be rewritten as

$$U = (S_g\ \epsilon_g + S_p\ \epsilon_p) + c(S_g\ \epsilon_g + S_p\ \epsilon_p)^2 + c(S_g^2\sigma_g^2 + 2S_gS_p\rho\sigma_g\sigma_p + S_p^2\sigma_p^2). \tag{3.32}$$

The constraint is also

$$A = S_g + S_p.$$

---

[8]Borch (1969, p. 2) uses this form of utility function in two moments ($\underline{E}$ and $\underline{S}$ in his term) case. Tobin (1958, p. 312) uses $\underline{U(R)=(1+b)R+bR^2}$ as his quadratic utility function, which does not contain variances of the return.

Hence, the mean-variance expected utility maximization problem is

$$\underset{S_g, S_p, \lambda}{\text{Max}}\ L = S_g\epsilon_g + S_p\epsilon_p + c(S_g^2\epsilon_g^2 + S_p^2\sigma_p^2 + 2S_gS_p\epsilon_g\epsilon_p + S_g^2\sigma_g^2 + 2S_gS_p\rho\sigma_g\sigma_p + S_p^2\sigma_p^2) + \lambda(A - S_g - S_p). \tag{3.33}$$

The first-order conditions for the maximization of <u>L</u> are

$$\frac{\partial L}{\partial S_g} = \epsilon_g + c(2S_g\epsilon_g^2 + 2S_p\epsilon_g\epsilon_p + 2S_g\sigma_g^2 + 2S_p\rho\sigma_g\sigma_p) - \lambda = 0,$$

$$\frac{\partial L}{\partial S_p} = \epsilon_p + c(2S_p\epsilon_p^2 + 2S_g\epsilon_g\epsilon_p + 2S_g\rho\sigma_\eta\sigma_p + 2S_p^2\sigma_p) - \lambda = 0, \tag{3.34}$$

$$\frac{\partial L}{\partial \lambda} = A - S_g - S_p = 0.$$

By solving (3.34) for <u>S_g</u> and rearranging, the implicit Treasury securities demand function can be derived as

$$S_g = \frac{\epsilon_g - \epsilon_p + 2cS_p(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_p^2 - \sigma_p^2)}{2c(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_g^2 - \sigma_g 2)}, \tag{3.35}$$

or, by substituting <u>$S_p = A - S_g$</u> into (3.34) and solving for <u>S_g</u>,

$$S_g = \frac{\epsilon_g - \epsilon_p + 2cA(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_p^2 - \sigma_p^2)}{2c[-(\epsilon_g - \epsilon_p)^2 - (\sigma_g - \sigma_p)^2]}, \tag{3.36}$$

These solutions <u>S_g</u> also guarantee the maximum expected utility as <u>$\sigma_g \neq \sigma_p$</u> because the value of the principal minor of the second-order condition is positive for risk averter.

If we substitute this solution, (3.35) or (3.36), for $\underline{(S_g^*)_{it}}$ in the equation (3.28), then the equation for the Treasury securities holdings of i-th maturity class at time period $\underline{t}$ can be derived as:

$$(S_g)_{it} = \frac{\epsilon_g - \epsilon_p + 2cS_p(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_p^2 - \sigma_p^2)}{2A_t c(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_g^2 - \sigma_g^2)}(\alpha_i A_{t-1} + \Delta A_t) + (1-\alpha_i)(S_g)_{i,t-1}, \quad (3.37)$$

or

$$(S_g)_{it} = \frac{\epsilon_g - \epsilon_p + 2A_t c(\epsilon_g\epsilon_p + \rho\sigma_g\sigma_p - \epsilon_p^2 - \sigma_p^2)}{2A_t c[-(\epsilon_g - \epsilon_p)^2 - (\sigma_g - \sigma_p)^2]}(\alpha_i A_{t-1} + \Delta A_t) + (1-\alpha_i)(S_g)_{i,t-1}, \quad (3.38)$$

In the simple Markowitz-type utility function case, the actual demand equations, (3.29) and (3.30), are identical because the implicit Treasury securities demand functions, (3.23) and (3.24), are identical with each other. Also, in the quadratic utility function case the theoretical demand equations, (3.37) and (3.38), are identical because the implicit Treasury securities demand functions, (3.35) and (3.36), are actually the same with each other.

The theoretical demand equation, (3.37) or (3.38), can be preferred to its counterpart, (3.29) or (3.30), because focusing on the mean and variance of return can be justified on the assumption that the utility function is quadratic.

Among equation (3.37) or (3.38), however, the former is preferred because it explicitly has the argument $\underline{S_p}$, the alternative asset instruments.

Equation (3.37) indicates that the Treasury securities holdings in each period can be expressed as a linear function of the combinations of expected rates of return, variances of the expected returns, previous period's holdings of Treasury securities, holdings of the alternative asset instruments, previous period's total asset holdings, and the changes in total asset holdings. For simplicity, the actual yield on each asset is used as a proxy for the expected rates of return on each asset.[9]

[9]This implies that private investors continue to adjust their behavior to the actual market yield during each quarter. This is sometimes called an efficient markets assumption.

CHAPTER IV

EMPIRICAL ESTIMATIONS AND RESULTS

This chapter specifies the model and reports the empirical results. The specification is made by a linearization of the theoretical demand equation developed in Chapter III. The estimation results of the demand for four maturity classes of the Treasury securities and the evaluation of the estimates are presented in Section B 3.

Then, a comparison of the coefficients and related statistics of three estimates of the aggregated demand for Treasury securities is made to find a clue to the benefit of disaggregation. The three estimates are: (1) the horizontal summation of four-maturity-class estimates, (2) the aggregated Treasury securities demand equation estimated by using the same explanatory variables as the four-maturity-class estimates, and (3) the aggregated Treasury securities demand equation estimated by using the explanatory variables indicated by the typical equation (4.1). If the result of this comparison indicates that one estimate is more desirable than the other, the former can be regarded as a more satisfactory method of explaining the private investors' demand for Treasury securities.

Both the data description and the estimation results for the yields on Treasury securities are reported in the appendix.

A. Model Specification

1. Financial Market Instruments for Private Investors

The financial market instruments which are used as regressors in the actual estimation are chosen from the sector statements of the Federal Reserve's Flow of Funds Accounts. According to that sector statements, the financial asset instruments can be classified as:

- Deposits
  - Demand Deposit and Currency (DM)
  - Small Time and Savings Deposit (TD)
  - Large Time Deposit (TD)
  - Money Market Fund Shares (MF)
- Credit Market Instruments
  - U. S. Government Securities
  - Corporate and Foreign Bonds (CB)
  - Mortgages (MO)
  - Open-Market Paper (OP)
- Corporate Equities (CE)
- Life Insurance Reserves
- Pension Fund Reserves
- Security Credit
- Miscellaneous Assets

Among these financial market instruments the life insurance reserves, the pension fund reserves, the security credit, and the miscellaneous assets are excluded because they are not marketable for the private investors. The U. S. Government securities are the holdings of marketable interest-bearing Treasury securities by private investors reported in the Treasury Bulletin.

The rates (or price) on the alternative asset instrument which are also used as regressors are: corporate bond yield (RB, Moody's Aaa), rate of change in Standard and Poor's composite common stock price index (DS), yield on corporate equities (RE, Standard and Poor's preferred stocks dividend-price ratio), and mortgage yield (MR). The rates of return on Treasury securities for each maturity class are: yield on 3-month Treasury bills (R1) for the Treasury securities within 1 year maturity (TS1), yield on 3 year issues (R2; the yield on 3 to 5 year issues up to 1980; II and the yield on 3 year issues thereafter) for the 1 to 5 year maturity (TS2), yield on 10 year issues (R3) for the 5 to 20 year maturity (TS3), and yield on 20 year issues (R4) for the over 20 year maturity (TS4).

2. Specification

The functional forms of the private investors' demand for marketable interest-bearing Treasury securities can be expressed as the following simultaneous equation:

$$
\begin{aligned}
TS_{it} = {} & a_0 + a_1R_{it} + a_2R_{jt} + a_3RB_t + a_4MR_t + a_5DS_t + a_6DM_t \\
& + a_7TD_t + a_8CB_t + a_9CE_t + a_{10}OP_t + a_{11}MR_t + a_{12}MO_t \\
& + a_{13}(TS_{i,t-1}) + a_{14}(VR_{i,t-1}) \\
& + a_{15}(TS_{i,t-1} \cdot \Delta \frac{1}{R_{i,t-1}}) + a_{16}(CE_{t-1} \cdot \Delta \frac{1}{RE_{t-1}}) \\
& + a_{17}(\frac{\Sigma AS_{t-1}}{\Sigma AS_t} \cdot RAS_{t-1}) + a_{18}[\frac{\Delta(\Sigma TS_{it} + \Sigma AS_t)}{(\Sigma TS_{it} + \Sigma AS_t)} \cdot RATS_t] \qquad (4.1)
\end{aligned}
$$

where i : maturity classes, $i = 1,2,3,4$,

$VR_{i,t-1}$: four-quarter moving average variance of market yield on the i-th Treasury securities at time period t-1,

j : other maturity classes except the i-th maturity,

$\Sigma TS_{it} = TS1 + TS2 + TS3 + TS4$,

$\Sigma AS_t = DM + TD + CB + CE + OP + MF + MO$,

RAS : average rates of return on the alternative asset instruments, and

RATS : average rates of return on the alternative assets and Treasury securities.

The equation (3.37) shows that the demand for the i-th maturity Treasury securities is a linear function of the expected rates of return, variances of the expected returns, previous period's holdings of Treasury securities, holdings of the alternative asset instruments, previous period's total asset holdings, and the changes in total asset holdings. The typical equation (4.1) is, therefore, a linear specification of the general expression of the demand equation for the Treasury securities, (3.37).

The usual presumption is that investors' demand for any asset responds positively to the own yield on that asset and negatively to the yield on alternative assets. In equation (4.1), the $\underline{a_1}$ term is for the own-yield effect and a positive sign is expected. By examining the signs of the coefficients of the yields on other assets in the asset demand function, gross substitutability between asset instruments can be observed. Two assets are gross substitutes if an increase in the yield on an alternative asset decreases the demand for the asset under consideration, holding all other endogenous variables constant. If the relations is positive then the two assets are complements. According to the theoretical demand equation (3.37), the coefficients of the yields on alternative assets are supposed to have negative sign, which implies that the alternative assets are all substitutes. In the equation (4.1), the terms $\underline{a_2}$ through $\underline{a_4}$ are for this purpose.

The sign of the coefficients of the independent variables for the actual amount of asset holdings in the demand function shows the direction of the movements of the Treasury securities holdings due to the accumulation of the alternative asset instruments over the relevant estimation period. If the coefficients of the variables for the alternative financial asset instruments in a Treasury securities demand equation are negative, that implies that the trend between the alternative asset accumulation and the demand for Treasury securities is opposite to each other over the relevant estimation period. If the amount of total wealth remains the same, the negative coefficient implies that the Treasury securities are inferior assets over the relevant estimation period (Silber, 1969, p. 205). In the equation (4.1), the terms $\underline{a_6}$ through $\underline{a_{12}}$ are for this purpose.

The term $\underline{a_{13}}$ is the adjustment coefficient which reflects the stock adjustment effects. The own-variance effects are shown by the term $\underline{a_{14}}$ and the expected sign is negative. The term $\underline{a_{15}}$ is for the effects of own capital gains or losses due tot he price change and the expected sign is positive. The effects of the corporate equities' capital gains or losses are reflected by the term $\underline{a_{16}}$ and the expected sign is negative if the Treasury securities securities and the corporate equities are substitutes for each other. The term $\underline{a_{17}}$ is for the effects of the previous period's total alternative asset returns and the expected sign is negative if the Treasury securities and the whole alternative assets are substitutes for each other. The effects of the changes in total financial asset returns are reflected by the term $\underline{a_{18}}$. The variable for the ratio of total financial asset returns to total financial asset holdings is an expression for the term $\underline{\Delta A_t}$ in the theoretical demand equation (3.37). The expected sign of the term $\underline{a_{18}}$ cannot be judged in advance because it may depend on the importance of the Treasury securities in the investor's portfolio.

Roley (1979, Ch. IV) emphasizes the importance of the above variables, although he does not mention explicitly the variables such as the own capital gains or losses, the capital gains or losses on corporate equities, and the previous period's total alternative asset returns, because he thinks that those variables represent cash flows and to affect the size and composition of the government securities portfolio. Roley (1979, Ch. V) also uses a variable such as the changes in total financial asset returns to measure the effect of the investable cash flow on the short-run asset demands.

B. Data and Estimation

1. Data

The primary data sources are the various issues of the Treasury Bulletin, Flow of Funds Accounts, Federal Reserve Bulletin, and Economic Report of the President. The quarter-end amounts of private investors' holdings of marketable interest-bearing Treasury securities are from the Treasury Bulletin's monthly data. The end-of-quarter amounts of holdings of the alternative financial asset instruments are constructed by decrementing backward the seasonally unadjusted quarterly flows from the end-of-year stocks for each year, which are reported in the Federal Reserve System's Flow of Funds Accounts. Market yields on Treasury securities by maturity classes, R_i where $i = 1,2,3,4,$ are the rates in the market reported in the Federal Reserve Bulletin. The four-quarter moving average variances of the market yield on the Treasury securities are calculated by the usual formula, i.e., the squared deviation of each quarter's market yield from four-quarter moving average on market yields. In the final equations, the interest rate variables are percentages; an interest rate of eight percent is 8.00. All dollar variables are in billions of dollars.

2. Estimation Procedure

The ordinary least-squares technique is used to perform a preliminary screening of independent variables for specifying the final form of the Treasury securities demand equations. Even though the estimates by ordinary lest-squares may in inconsistent, the signs of the estimated coefficients remain unchanged with respect to the two-stage and ordinary least-squares results. Also, the orders of magnitude of the coefficients remain virtually unchanged.

The preliminary estimation of Treasury securities demand functions was carried out for five maturity classes following the classifications of the Treasury Bulletin. The five maturity classes of the Treasury securities and the corresponding rates of return which are used as own-yield variables are: within 1 year maturity with 3-month Treasury bill rates, 1 to 5 year maturity with yield on 3 year issues, 5 to 10 maturity with yield on 7 year issues, 10 to 20 year maturity with yield on 10 year issues, and over 20 year maturity with yield on 20 year issues. According to the results of the preliminary estimation by the ordinary least-squares methods, the coefficient of the own-yield variable in the equation for the 5 to 10 year maturity class has a negative sign which is contrary to the designated sign of that variable in the theoretical demand functions for the Treasury securities as equations (3.29), (3.30), (3.37), and (3.38). To avoid this inconsistency, attempts such as substituting several other yield rates one by one for the yield on 7 year issues and aggregating the maturity classes of both 5 to 10 years and 10 to 20 years were made. Thus, a new class, 5 to 20 years, was formed.

The variables for the final equations are selected as follows. First, the signs of the coefficients of the OLS estimates are compared with the preassigned signs of the coefficients by the theoretical demand equation (3.37). For example, the equation (3.37) indicates that the coefficients of the yield on other assets are negative. Hence, the variables for the yield on other financial market instruments that have position coefficients are dropped.

Second, both the stepwise regression procedure and t-ratio comparison are used as a reference for variable selection. Due to the possible existence of the multicollinearity in the data, the t-ratio criteria alone may not be a good measure because the variances of the OLS estimates of the parameters of the collinear variables may be quite large. The backward elimination procedure computes the partial F-statistic for each regressor as if it were the last variable to enter the model. Hence, the t-ratio criteria and the stepwise procedure are also employed for variable selection of the final specification.

On the basis of the results of these attempts, the variables for the final specifications of the private investors' Treasury securities demand function are chosen. Then, by applying the two-stage least-squares methods, the final form of the demand equations is estimated.

3. Estimation Results

The estimation results for the Treasury securities demand equations by using quarterly data are presented in this subsection. The estimation results for the related interest rate equations which are estimated additionally are reported in the appendix to this chapter because the major objective of the current study is to analyze the private investors' demand structure. The estimation technique applied here is the two-stage least-squares procedure.

In the estimates, the endogenous variables are TS_i, i = 1,..,4. Hence, there are four endogenous variables. The exogenous variables are RB, DS, CE, MF, TD, OP, MO, CB, MR, DM, and R_i.

The numbers in parentheses below the estimated coefficients are t-ratios, i.e., ratio of estimates for each coefficient to their standard errors. These t-ratios are asymptotically standard normal due to the simultaneous-equations estimation procedure. R^2 is the coefficient of determination, SE is the standard error of regression, and DW is the Durbin-Watson statistic for serial correlation. The sample period covers from 1975:I to 1984:II.

The typical equation (4.1) shows that the private investors' demand for Treasury securities is determined by own yield that is determined jointly in the market, other instrument yields, previous period's holdings of Treasury securities, holdings of other financial asset instruments, variances of own yield, own capital gains or losses, corporate equities' capital gains or losses, ratio of previous period's alternative asset returns to present period;'s total holdings of alternative assets, and ratio of changes in total asset returns to present period's total asset holdings. However, the following estimates show that the private investors' demand for Treasury securities is determined by fewer variables than initially specified in typical equation (4.1). This is because several variables are eliminated during the process of judging the goodness-of-fit of the structural equations on the basis of the preliminary OLS estimates.

One of the major differences between the typical equation (4.1) and the estimated equations is that the variances of own yield, $\underline{VR_{i,t-1}}$, and the lagged dependent variables, $\underline{TS_{i,t-1}}$, do not have any significant roles in explaining the private investors' demand for Treasury securities. The virtually zero own-variance effect on private investors' Treasury securities demand may be attributed to the relatively negligible variances of the yield on Treasury securities and the private investors' disregard to the variances itself due to zero risk of the Treasury securities.

The zero coefficient of the $\underline{TS_{i,t-1}}$, variable implies that immediate portfolio adjustments during each quarter. Most of the empirical works that were discussed in the Section A of Chapter III, however, have stock adjustment terms in their asset demand equations, which implies the partial portfolio adjustment during a given time period. The immediate adjustments in private investors' Treasury securities portfolios may reflect the high liquidity of the Treasury securities, the investors' active participation in the Treasury securities market, the no-risk accessibility to the Treasury securities market, etc..

(a) Within One Year Maturity Treasury Securities

$$TS1_t = \underset{(0.74)}{44.15} + \underset{(0.70)}{1.345}\, R1_t - \underset{(-2.19)}{9.097}\, RB_t - \underset{(-2.27)}{0.673}\, DS_t + \underset{(3.63)}{0.050}\, CE_t$$

$$+ \underset{(3.63)}{0.417}\, MF_t + \underset{(9.98)}{0.537}\, TD_t - \underset{(-3.90)}{0.890}\, OP_t + \underset{(-3.81)}{0578}\, CB_t,$$

$$R^2 = 0.995 \quad SE = 7.07 \quad DW = 2.047, \qquad (4.2)$$

where $TS1_t$: quarter-end holdings of Treasury securities within 1 year maturity at time t,

$R1_t$: 3-month Treasury bill rates at time t,

RB_t : corporate bond yield at time t (Moody's Aaa),

DS_t : rate of change in Standard and Poor's composite common stock price index at time t,

CE_t : quarter-end holdings of corporate equities at time t,

MF_t : quarter-end holdings of money market fund shares at time t,

TD_t : quarter-end holdings at time and savings deposits at time t,

OP_t : quarter-end holdings of open-market paper at time t, and

CB_t : quarter-end holdings of corporate bonds at time t.

Private investors' holdings of this Treasury securities are influenced by yield rates on the three-month Treasury bill and the corporate bonds. However, the three-month Treasury bill rate turns out statistically insignificant. The negative sign of the coefficient of the corporate bond yield indicates that the Treasury securities of this maturity class and the corporate bonds are gross substitutes. Also, the negative sign of the variable for the rate of change in common stock price index implies that this maturity class Treasury securities and the common stocks are gross substitutes. The positive rate of change in common stock price index makes the private investors to think the stock prices are increasing. The negative rate of change in common stock price index indicates that the stock prices in the stock market are decreasing. The rate of changes in common stock price index therefore exhibits the possibility of either capital gains or losses in the stock market. Hence, the private investors will react more, among other things, to this rate of change in common stock price index when they make portfolio choice in the stock market than to the common stock price index itself.

The holdings of alternative asset instruments which influence the demand for this maturity class Treasury securities are time and savings deposits, corporate bonds, open-market paper, money market fund shares, and corporate equities. The negative signs of the coefficients of the two of these alternative assets indicate that this maturity class Treasury securities have been inferior asset instruments to both of the open-market paper and the corporate bonds over this estimation period. In other words, the coefficients of the variables for these alternative assets, $\underline{OP_t}$ and $\underline{CB_t}$, are negative. It implies that the accumulation of these asset instruments has, in general, brought about a decrease in the demand for this maturity class Treasury securities, other things remain the same.

(b) One to Five Year Maturity Treasury Securities

$$TS2_t = \underset{(-1.72)}{-\ 79.07} + \underset{(1.70)}{2.817}\ R2_t + \underset{(2.72)}{0.427}\ MF_t + \underset{(5.93)}{0.386}\ TD_t$$

$$\underset{(-3.76)}{-\ 0.279}\ MO_t \underset{(-1.81)}{-\ 7.158}\ MR_t + \underset{(2.27)}{0.354}\ CB_t \underset{(-1.28)}{-\ 0.260}\ OP_t$$

$$\underset{(-2.74)}{-\ 10.191}\left(\frac{\Sigma AS_{t-1}}{\Sigma AS_t}\cdot RAS_{t-1}\right) \underset{(-2.88)}{-\ 0.003}\left(CE_{t-1}\cdot\Delta\frac{1}{RE_{t-1}}\right),$$

$$R^2 = 0.996 \quad SE = 5.23 \quad DW = 1.394, \qquad (4.3)$$

where $TS2_t$: quarter-end holdings of Treasury securities of one to five year maturity at time t,

$R2_t$: yield on Treasury securities of three year maturity at time t,

MO_t : quarter-end holdings of mortgages at time t,

MR_t : mortgage yield (FHLBB series) at time t,

ΣAS_t : $DM_t + TD_t + CB_t + CE_t + OP_t + MF_t + MO_t$,

RAS_{t-1} : average rates of return on the alternative financial market instruments at time t, and

$\Delta(1/RE_{t-1})$: changes in the inverse of the yield on corporate equities (Standard and Poor's preferred stocks' dividend/price ratio) at time t-1.

The yields which are important in explaining the private investors' holdings of this Treasury securities are, although the statistical significance of the variables is not strong enough, the yield on three-year Treasury securities and the mortgage rates. The negative sign of the variable for the mortgage yield indicates that the mortgages and this maturity class Treasury securities are gross substitutes.

The holdings of alternative asset instruments which influence the holdings of this maturity class Treasury securities are time and savings deposits, mortgages, money market fund shares, corporate bonds, and open-market paper. The negative signs of the coefficients of the open-market paper and the mortgage imply that the one to five year maturity Treasury securities have been inferior to those asset instruments over this estimation period.

The holdings of this maturity class Treasury securities are also influenced by the ratio of previous period's total alternative asset returns to present period's total holdings of alternative assets and by the corporate equities capital gains or losses. These variables are, as already mentioned in the previous section, representing the flow components that may affect the size and composition of the Treasury securities portfolio. The coefficients of these two variables indicate that their effects on the private investors' demand for one to five year maturity Treasury securities are negative. In other words, an increase in the previous period's total alternative asset returns and the capital gains on corporate equities would reduce the demand for one to five year maturity Treasury securities.

(c) Five to Twenty Year Maturity Treasury Securities

$$TS3_t = \underset{(2.97)}{62.88} + \underset{(0.54)}{1.925}\ R3_t - \underset{(-0.79)}{2.404}\ R5_t - \underset{(-3.42)}{4.847}\ MR_t$$

$$+ \underset{(2.40)}{0.237}\ DM_t + \underset{(5.98)}{0.175}\ TD_t - \underset{(-6.31)}{0.479}\ CB_t + \underset{(2.53)}{0.104}\ MF_t$$

$$+ \underset{(2.66)}{0.084}\ MO_t,$$

$$R^2 = 0.998 \quad SE = 2.31 \quad DW = 1.996, \tag{4.4}$$

where $TS3_t$: quarter-end holdings of Treasury securities of five to twenty year maturity at time _t_,

$R3_t$: yield on Treasury securities of ten year maturity at time _t_,

$R5_t$: yield on Treasury securities of seven year maturity at time _t_, and

DM_t : quarter-end holdings of demand deposit and currency at time _t_,

The equation for private investors' holdings of five to twenty year maturity Treasury securities is one of the most unsatisfactory equations because neither single yield nor average yield of several other yields turns out to be a good own-yield regressor. This might be attributed to either the fact that the coverage of this maturity class of five to twenty years is too vast to express the portfolio activity in a single equation or the fact that the yield variables do not have any significant role in explaining the portfolio behavior on this maturity class Treasury securities.

In this estimated equation, the chose own-yield variable, yield on ten year maturity Treasury securities, has positive coefficients as the theory says. However, the variable for the yield on seven year maturity Treasury securities has a negative coefficient. The net yield effect is, therefore, negative, which is contrary to what the theoretical demand equation (3.37) indicates. But, according to the t-ratios for both variables, both of the yield variables do not contribute significantly to explaining the private investors' holdings of vie to twenty year maturity Treasury securities. The other yield variable which is important in explaining the demand for this maturity class Treasury securities is the mortgage yield. But the negative sign of that variable's coefficient indicates that the mortgages and this stabrity class Treasury securities are gross substitutes.

The alternative financial asset instruments which influence the holdings of this maturity class Treasury securities are corporate bond, time and savings deposits, mortgage holdings, money market fund shares, and demand deposit and currency. The negative sing of the coefficient of the corporate bond indicates that this maturity class Treasury securities have been inferior asset instruments to the corporate bond over this estimation period.

(d) Over Twenty Year Maturity Treasury Securities

$$TS4_t = \underset{(0.70)}{5.92} + \underset{(3.17)}{4.519}\, R4_t - \underset{(-3.79)}{5.570}\, RB_t - \underset{(-1.68)}{0.064}\, DS_t$$

$$+ \underset{(2.98)}{0.057}\, MF_t + \underset{(5.23)}{0.047}\, TD_t + \underset{(4.06)}{0.048}\, MO_t - \underset{(-3.53)}{0.105}\, CB_t$$

$$- \underset{(-2.99)}{1.703} \left(\frac{\Sigma AS_{t-1}}{\Sigma AS_t} \cdot RAS_{t-1}\right) - \underset{(-2.48)}{0.0004} \left(CE_{t-1} \cdot \Delta \frac{1}{RE_{t-1}}\right),$$

$$R^2 = 0.997 \quad SE = 0.93 \quad DW = 2.374, \qquad (4.5)$$

where $TS4_t$: quarter-end holdings of Treasury securities of over twenty year maturity at time t, and

$R4_t$: yield on Treasury securities of twenty year maturity at time t.

The yields which are important in explaining the private investors' holdings of this long-term Treasury securities are the yield on Treasury securities of twenty year maturity and the corporate bond rates. The negative signs of the coefficients of the corporate bond yield and the rate of change in common stock price index indicate that the corporate bonds and the common stocks are gross substitutes for this long-term Treasury securities.

The holdings of alternative asset instruments which influence the holdings of this long-term Treasury securities are time and savings deposits, mortgages, corporate bonds, and money market fund shares. The negative coefficient of the variable for the holdings of alternative asset is only appeared in the corporate bonds term. This may imply that this long-term Treasury securities have been inferior to the corporate bonds over this estimation period.

The holdings of this long-term Treasury securities are also influenced by the ratio of previous period's total alternative asset returns to present period's total holdings of alternative assets and by the corporate equities' capital gains or losses. As is the case for one to give year maturity Treasury securities, these variables are representing the flow components that may affect the size and composition of the Treasury securities portfolio. The coefficients of the two variables indicate that their effects on the private investors' demand for this long-term Treasury securities are negative.

4. Comparison Between Individual Estimates and Aggregated Estimates

To justify the use of the maturity-class estimation for the Treasury securities demand function, a comparison of the maturity-class estimates with the aggregated estimates is necessary. The individually estimated linear equations can be summed horizontally by simple addition of the coefficients of same regressors in each equation, other things remain equal. Hence, this summation becomes

$$TS1_t + TS2_t + TS3_t + TS4_t = f \text{ (all variables in each individual equation)} \tag{4.6}$$

To compare the result of this summation with the combined Treasury securities demand equations, two new estimates of the combined equations are made. The first form of the equation is

$$TS_t^A = g \text{ (same variables that are significant in the individual equations)}, \tag{4.7}$$

where $\underline{TS_t^A = TS1_t + TS2_t + TS3_t + TS4_t}$. This is a demand function of the combined Treasury securities whose explanatory variables are constrained to be the same as those explanatory variables in the individually estimated equations. The second form of the equation is

$$TS_t^B = h \text{ (variables indicated by the typical equation of (4.1))}, \tag{4.8}$$

where $\underline{TS_t^B = TS_t^A}$. This is a demand function of the combined Treasury securities whose explanatory variables are estimated directly from the typical equation (4.1).

A comparison between the result of the summation and the newly estimated, combined demand equations is presented in Table IX. According to this table, the net own-yield effects in both of the combined demand equations are positive, i.e., the sum of the

TABLE IX

COMPARISONS OF ESTIMATION RESULTS

	Summation of Individual Estimates	Estimates of Aggregated Equation TS_t^A	TS_t^B
Intercept	33.88	-226.77 (-1.40)	-331.390 (-27.26)
R1	1.345	5.595 (1.07)	
R2	2.817	-22.479 (-0.66)	-36.998 (-4.68)
R3	1.925	77.484 (0.98)	
R4	4.519	19.394 (0.50)	43.004 (4.16)
R5	-2.404	-50.418 (-0.62)	
RB	-14.667	-21.034 (-0.77)	
MR	-12.005	-18.817 (-1.14)	
DS	-0.737	-0.852 (-1.70)	
CE	0.050	0.064 (1.88)	0.036 (2.10)
MF	1.005	0.957 (1.39)	
TD	1.145	1.021 (4.29)	1.396 (25.72)
OP	-1.150	-0.965 (-1.53)	
CB	-0.808	0.164 (0.31)	
MO	-0.147	-0.493 (-1.77)	-0.686 (-11.45)
DM	0.237	0.249 (0.30)	
$(\frac{\Sigma AS_{t-1}}{\Sigma AS_t} \cdot RAS_{t-1})$	-11.894	-9.834 (-1.12)	-17.112 (-8.96)
$(CE_{t-1} \cdot \Delta\frac{1}{RE_{t-1}})$	-0.0034	-0.0006 (-0.29)	
		R^2 = 0.999 SE = 9.89 DW = 1.931	R^2 = 0.998 SE = 9.33 DW = 1.938

Notes: ( ): t-ratios.
R^2: coefficient of determination.
DW: Durbin-Watson statistic.

coefficients of R_i, $i = 1,...,5$, is greater than zero. However, the t-ratios in the case of TS_t^A equation imply that only one variable, time and savings deposits, is statistically significant. In the case of TS_t^B equation, all of the six explanatory variables are statistically significant.

According to the Table X, the summation of individual estimates, ΣTS_i, has the largest sum of squared residuals. Therefore, if tracking the demand for Treasury securities is the sole objective of the current study, either the aggregated estimate TS_t^A or the summation of individual estimate TS_t^B would be chosen. But, in the current study, the tracking itself is not the major objective.

TABLE X

COMPARISON OF SUM OF SQUARED RESIDUALS

	Sum of Squared Residuals
ΣTS_i	3024.1
TS_t^A	1175.4
TS_t^B	2006.3

Moreover, most of the post-Keynesian portfolio theories, especially the expected utility maximization theory and the general equilibrium approach, have tried to analyze the diversification in the investor's portfolio behavior. It can be pointed out that the greater the number of financial asset instruments, the more diversification may occur in an investor's portfolio choice. Therefore, it can also be pointed out that the more significant variables for asset instruments included in an asset demand equation, the broader is the explanation about the portfolio behavior by using that demand equation. In the case of $\underline{TS_t^A}$ equation, according to Table IX, the only significant explanatory variable, chosen mostly by the t-ratios, is time and savings deposits. In the case of $\underline{TS_t^B}$ equation, there are six significant explanatory variables. In the case of the individually estimates equations, however, each equation has its own explanatory variables whose numbers are either eight or nine. And these individually estimated equations as a whole have seventeen explanatory variables which mostly are statistically significant except for some of the own-yield and the alternative asset variables. This may imply that the individual estimates can rather be used for the analysis of the private investors' diverse portfolio behavior.

According to this comparison, therefore, the individual estimates by maturity class may be a better method of explaining the demand for Treasury securities than the aggregated estimation method. Hence, this model, although it is a static partial equilibrium model, can be considered as one of the comprehensive quarterly models which may explain private sector Treasury securities portfolios.

5. Degree of Substitutability

In the current study, as already mentioned, the substitutability between financial market instruments is gross substitutability. The term gross refers to the fact that the effect over the entire market are measured with all influences from income effects, redistribution effects, and so on, included. However, the exact degree of substitutability between asset instruments can not be directly measured by estimating asset demand equation. This is because the coefficients of the relevant yield variables in the demand equations are not quantitative measurements of the degree to which one asset instrument can in fact be substituted for another.

Silber (1969, pp. 211-213) regards the coefficients of the yield on other asset instruments in each demand equation as the degree of substitutability between asset instruments. He uses the coefficients to test the impacts of monetary policy on the rates of interest on private securities. This test is performed by comparing the changes in impact multipliers on interest rates when the values of the coefficients are increased or decreased. He believes that the impact multipliers on interest rates reflect the substitutability between securities after all markets are equilibrated (1969, p. 208).

The coefficients of the yield variables which may show the degree of substitutability are the responses of the dependent variable to the unitary changes of the independent variables. However, they are not the dimensionless measure.

One dimensionless measure for substitutability is the elasticity of substitution. Neoclassical production theory recognizes the possibility of substituting one factor of production for another. By applying the factor substitution framework of the neoclassical production theory to the current study, the elasticity of substitution (σ) can be expressed as

$$\sigma = - \frac{p}{x} \frac{dx}{dp},$$

where x : the ratio of one asset instrument holdings (x_2) to another asset instrument holdings (x_1), i.e., $x = x_2/x_1$, and

p : the ratio of yield on x_2, p_2, to yield on x_1, p_1, i.e., $p = p_2/p_1$.

This measures (roughly) the percentage change in the asset holding ratio per percentage change in yields on asset instruments. A minus sign is added to make the measure positive.

Knowledge of $\underline{\sigma}$ at any point would undoubtedly be a useful technological datum for empirical work. However, this framework has a difficulty. For strict application of this notion to the current study, there should be only two substitutable asset instruments at one time. The current study, on the contrary, deals simultaneously with the whole spectrum of asset instruments available for private investors. Moreover, in estimating a quantity like $\underline{\sigma}$, a useful first approximation is to assume that the production process is linearly homogeneous and exhibits constant elasticity of substitution everywhere.

Therefore, in the current study whose primary purpose is to specify the demand equations by whole maturity classes, the exact calculation of a quantity like the elasticity of substitution is left for future research. As a result, only the approximate substitute relationships are examined.

APPENDIX TO CHAPTER IV

A. Description of the Data

The data are already described briefly in Chapter IV. The role of this appendix is to report exactly what each variable is, and to relate it to publicly available sources. The first section covers Treasury securities. The second covers interest rates. The third covers alternative financial market instruments.

1. Treasury Securities

The quarter-end amounts of private investors' holdings of marketable interest-bearing Treasury securities are from the table of maturity distribution and average length of marketable interest-bearing public debt held by private investors in the Treasury Bulletin. In that table, the private investors' holdings of the Treasury securities are classified into five maturity classes. They are: within 1 year, 1 to 5 year, 5 to 10 year, 10 to 20 year, and 20 years and over.

However, as mentioned earlier, the resulting inconsistency in the estimates of the demand for 5 to 10 year maturity class Treasury securities by the preliminary OLS estimation makes the maturity class of 5 to 10 years combined with the 10 to 20 year maturity class. Therefore, the estimates are made by four maturity classes.

The quarterly data for the private investors' holdings of Treasury securities are presented in Table XI.

TABLE XI

PRIVATE INVESTORS' TREASURY SECURITIES

HOLDINGS (IN BILLIONS OF DOLLARS)

	TS1	TS2	TS3	TS4
1975:I	108.6	61.1	24.5	4.1
II	115.7	65.9	24.3	4.6
III	130.6	72.2	24.1	5.2
IV	150.1	74.7	25.2	5.9
1976:I	154.3	86.2	29.9	6.1
II	150.3	90.6	32.3	6.7
III	153.3	94.8	39.1	7.3
IV	157.5	103.7	38.4	8.2
1977:I	166.4	110.0	38.4	8.8
II	157.4	107.0	39.5	9.6
III	161.3	113.3	41.5	10.5
IV	171.4	119.0	41.0	11.6
1978:I	178.5	132.5	39.0	12.7
II	162.5	137.5	40.3	13.4
III	163.8	133.0	44.9	14.8
IV	174.2	128.3	47.4	15.3
1979:I	187.0	129.5	46.3	17.3
II	184.1	124.4	50.7	18.5
III	181.9	127.6	50.8	20.3
IV	190.4	133.2	56.4	22.3
1980:I	208.5	137.5	61.9	22.1
II	198.4	147.8	61.9	23.8
III	220.1	156.2	64.7	22.7
IV	239.7	160.0	68.5	24.6
1981:I	263.2	167.2	75.5	26.9
II	252.5	172.8	77.3	29.0
III	256.2	182.2	81.3	30.1
IV	275.3	188.4	85.0	32.0
1982:I	295.5	200.5	88.4	34.6
II	293.3	207.1	94.1	34.5
III	314.4	221.8	108.7	37.1
IV	346.3	239.3	113.3	37.3
1983:I	367.4	263.0	123.8	40.9
II	373.7	282.4	130.9	44.3
III	379.6	295.0	140.0	48.1
IV	394.1	298.3	149.1	52.5
1984:I	413.1	311.6	160.5	57.2
II	415.5	322.7	169.2	61.9

2. Interest Rates

Market yields on Treasury securities of the chosen maturities (R_i, where i = 1,2,3,4), yield on corporate equities (RE, Standard and Poor's preferred stock's dividend/price ratio), corporate bond rates (RB), and mortgage yields (MR) are from the Federal Reserve Bulletin. The other variables, RAS (average rates of return on the alternative financial market instruments) and $\Delta(1/RE)$ which is the changes in the inverse of the yield on corporate equities, are calculated. These are presented in Table XII.

3. Alternative Financial Market Instruments

As mentioned earlier, the private investors' holdings of the alternative financial asset instruments at the end of each quarter are constructed by decrementing backward the seasonally unadjusted quarterly flows from the end-of-year stocks for each year, which are reported in the sector statements of saving and investment table and the sector statements of financial assets and liabilities table of the Federal Reserve System's Flow of Funds Accounts. Table XII exhibits these input data.

DS (the rate of change in Standard and Poor's composite common stock price index) is included to consider the effects of stocks, another financial market instrument. But the actual input data for DS are not shown in Table XIII, because the figure is not the amount of private investors' actual holdings.

TABLE XII

INPUT DATA FOR INTEREST RATES (%)

	R1	R2	R3	R4	RB	MR	RE	D(1/RE)	RAS
1975:I	5.49	7.00			8.67	9.06	8.04	1.05	8.59
II	5.34	7.26			8.77	8.96	8.34	-0.45	8.69
III	6.42	8.22			8.95	8.94	8.56	-0.31	8.82
IV	5.44	7.50			8.79	9.01	8.57	-0.01	8.79
1976:I	5.00	7.25			8.52	8.93	8.07	0.72	8.51
II	5.41	7.40			8.62	8.89	8.10	-0.05	8.54
III	5.08	6.84		7.78	8.38	9.08	7.80	0.47	8.42
IV	4.35	5.96		7.30	7.98	9.10	7.70	0.17	8.26
1977:I	4.60	6.73	7.46	7.73	8.10	8.95	7.56	0.24	8.20
II	5.02	6.58	7.28	7.64	7.95	8.98	7.62	-0.10	8.18
III	5.81	6.92	7.34	7.57	7.92	9.04	7.58	0.07	8.18
IV	6.07	7.40	7.69	7.87	8.19	9.09	7.85	-0.45	8.38
1978:I	6.29	7.76	8.04	8.21	8.47	9.26	8.07	-0.35	8.60
II	6.73	8.31	8.46	8.53	8.76	9.46	8.31	-0.36	8.84
III	7.85	8.38	8.42	8.47	8.69	9.73	8.24	0.10	8.89
IV	9.08	9.23	9.01	8.90	9.16	10.02	8.84	-0.82	9.34
1979:I	9.48	9.25	9.12	9.08	9.37	10.30	8.77	0.09	9.48
II	9.06	8.89	8.91	8.91	9.29	10.66	8.87	-0.13	9.61
III	10.26	9.56	9.33	9.21	9.44	11.02	9.16	-0.36	9.87
IV	12.04	10.45	10.39	10.18	10.74	11.64	7.42	2.56	9.93
1980:I	15.20	13.41	12.75	12.49	12.96	12.62	11.26	-4.60	12.28
II	7.07	8.91	9.78	9.89	10.58	12.66	9.78	1.34	11.01
III	10.27	11.57	11.51	11.47	12.02	12.35	10.14	-0.36	11.50
IV	15.49	13.65	12.84	12.49	13.21	13.28	11.94	-1.49	12.81
1981:I	13.36	13.51	13.12	12.74	13.33	14.02	11.81	0.09	13.05
II	14.73	14.29	13.47	13.20	13.75	14.67	12.23	-0.29	13.55
III	14.70	16.22	15.32	15.07	15.49	15.29	13.01	-0.49	14.60
IV	10.85	13.66	13.72	13.73	14.23	15.87	12.83	0.11	14.31
1982:I	12.68	14.13	13.86	13.75	14.58	15.67	12.97	-0.08	14.41
II	12.47	14.48	14.30	14.18	14.81	15.40	12.96	0.01	14.39
III	7.92	12.03	12.34	12.16	12.94	14.98	12.41	0.34	13.44
IV	7.94	9.88	10.54	10.62	11.83	13.69	11.20	0.87	12.24
1983:I	8.35	9.84	10.51	10.80	11.73	13.41	10.86	0.28	12.00
II	8.79	10.32	10.85	11.12	11.74	12.36	10.81	0.04	11.64
III	9.00	11.07	11.65	11.82	12.37	12.54	11.06	-0.21	11.99
IV	9.00	11.13	11.83	12.02	12.57	12.42	11.49	-0.34	12.16
1984:I	9.52	11.59	12.32	12.45	12.57	12.02	11.39	0.08	11.99
II	9.87	13.18	13.56	13.54	13.55	12.10	12.04	-0.47	12.56

TABLE XIII

ALTERNATIVE FINANCIAL ASSET INSTRUMENTS

(IN BILLIONS OF DOLLARS)

	CE	MF	TD	OP	MO	CB	DM
1975:I	1029.5	2.4	756.4	39.0	830.4	484.4	255.6
II	1037.6	2.4	778.4	35.8	850.3	507.4	267.3
III	1040.6	2.4	793.0	32.2	870.7	521.3	269.7
IV	1049.5	3.7	815.8	33.9	890.6	542.7	272.3
1976:I	1225.1	4.0	845.0	30.8	901.5	559.2	278.4
II	1229.6	3.7	869.9	34.6	924.3	573.9	282.2
III	1233.1	3.6	891.2	33.3	948.2	590.2	283.5
IV	1241.1	3.7	922.3	34.2	972.9	609.4	292.0
1977:I	1166.0	3.8	963.3	36.2	983.3	629.3	295.1
II	1167.5	3.5	987.6	41.4	1022.2	643.1	305.2
III	1168.8	3.5	1016.3	41.7	1060.4	659.0	311.7
IV	1173.1	3.9	1040.6	45.4	1099.1	680.0	317.7
1978:I	1205.5	5.7	1072.7	48.1	1123.5	698.3	326.5
II	1205.7	7.0	1099.7	53.9	1167.3	715.6	335.4
III	1211.4	8.4	1133.2	54.0	1209.9	728.1	342.2
IV	1217.6	10.8	1159.5	63.4	1252.7	743.5	350.4
1979:I	1427.2	18.0	1180.6	74.2	1287.6	750.9	356.5
II	1432.6	25.9	1200.5	82.6	1333.9	768.7	365.9
III	1438.5	34.2	1234.7	86.2	1379.6	782.3	378.6
IV	1444.8	45.2	1253.0	91.0	1419.2	791.9	385.9
1980:I	1882.5	60.5	1286.5	102.2	1461.4	793.7	385.4
II	1890.8	76.1	1311.7	109.9	1483.1	821.0	389.4
III	1902.5	77.4	1352.2	106.2	1515.1	835.9	407.3
IV	1915.9	74.4	1411.8	104.7	1550.8	843.0	410.3
1981:I	1834.5	111.5	1448.4	120.1	1573.8	845.7	409.7
II	1839.6	126.5	1471.0	137.5	1609.9	865.6	412.6
III	1840.3	160.8	1506.3	151.4	1640.8	873.9	422.9
IV	1841.8	181.9	1541.2	153.6	1662.8	889.8	440.5
1982:I	2088.8	191.5	1563.9	166.2	1673.7	894.3	432.3
II	2099.7	201.6	1594.1	175.9	1693.5	899.9	441.1
III	2112.1	223.6	1622.6	165.1	1715.2	913.9	462.9
IV	2141.1	206.6	1657.7	153.9	1736.5	933.6	483.9
1983:I	2177.3	180.3	1707.9	150.8	1760.7	943.2	498.6
II	2217.7	164.6	1736.0	154.1	1799.9	966.2	513.7
III	2240.6	163.0	1779.9	150.2	1855.1	974.9	522.1
IV	2261.7	162.5	1831.1	151.9	1909.8	989.0	536.2
1984:I	2265.5	170.7	1878.9	165.5	1953.2	996.5	541.2
II	2255.0	177.6	1945.0	186.1	2012.6	1013.2	551.8

B. Estimation Results for the Treasury Securities Yields

As already mentioned, the estimation results for the Treasury securities yields, the $\underline{R_i}$, are reported in this section as a reference. The variable $\underline{TS_i}$ is treated as exogenous in each estimate.

$$R1_t = \underset{(-3.19)}{-22.11} + \underset{(0.79)}{0.043}\ TS1_t + \underset{(5.19)}{2.261}\ RB_t + \underset{(0.57)}{0.034}\ DS_t - \underset{(-1.03)}{0.003}\ CE_t$$

$$\underset{(-2.33)}{-0.055}\ MF_t - \underset{(-1.12)}{0.033}\ TD_t + \underset{(0.63)}{0.038}\ OP_t + \underset{(1.62)}{0.058}\ CB_t$$

$R^2 = 0.902 \quad SE = 1.12 \quad DW = 1.602$

$$R2_t = \underset{(0.97)}{8.57} + \underset{(2.17)}{0.123}\ TS2_t - \underset{(-4.23)}{0.096}\ MF_t - \underset{(-1.22)}{0.033}\ TD_t$$

$$+ \underset{(1.81)}{0.036}\ MO_t + \underset{(3.97)}{1.949}\ MR_t - \underset{(-3.17)}{0.077}\ CB_t + \underset{(2.14)}{0.066}\ OP_t$$

$$+ \underset{(1.71)}{1.392} \left(\frac{\Sigma AS_{t-1}}{\Sigma AS_t} \cdot RAS_{t-1}\right) + \underset{(2.83)}{0.0005} \left(CE_{t-1} \cdot \Delta \frac{1}{RE_{t-1}}\right)$$

$R^2 = 0.931 \quad SE = 0.86 \quad DW = 1.840$

$$R3_t = \underset{(0.35)}{0.38} + \underset{(1.16)}{0.016}\ TS3_t + \underset{(35.75)}{0.870}\ R5_t + \underset{(2.26)}{0.175}\ MR_t - \underset{(-1.11)}{0.005}\ DM_t$$

$$- \underset{(-0.37)}{0.001}\ TD_t + \underset{(0.21)}{0.002}\ CB_t - \underset{(-1.62)}{0.003}\ MF_t + \underset{(0.03)}{0.00005}\ MO_t$$

$R^2 = 0.999 \quad SE = 0.07 \quad DW = 1.657$

$$R4_t = \underset{(-0.59)}{-\ 0.97} + \underset{(3.34)}{0.178}\ TS4_t + \underset{(14.01)}{1.187}\ RB_t + \underset{(1.15)}{0.010}\ DS_t$$

$$\underset{(-3.11)}{-\ 0.011}\ MF_t \underset{(-2.21)}{-\ 0.008}\ TD_t \underset{(-2.34)}{-\ 0.008}\ MO_t + \underset{(1.91)}{0.017}\ CB_t$$

$$+ \underset{(2.30)}{0.310} \left(\frac{\Sigma AS_{t-1}}{\Sigma AS_t} \cdot RAS_{t-1}\right) + \underset{(1.98)}{0.00007} \left(CE_{t-1} \cdot \Delta\frac{1}{RE_{t-1}}\right)$$

$R^2 = 0.996$ $SE = 0.17$ $DW = 2.424$

CHAPTER V

SUMMARY AND CONCLUSIONS

This is a study of specifying the private investors' demand for marketable U. S. Treasury securities by using B. Friedman's structural approach. It estimates the demand equations by the two-stage least-squares technique because the yields and the amount of Treasury securities demanded are assumed as being determined jointly in the Treasury securities markets. The mean-variance version of the expected utility maximization framework is utilized to derive the implicit demand function for the Treasury securities which is in turn regarded as a long-term desired portfolio allocation. Therefore, by substituting the implicit Treasury securities demand function for the desired asset holdings in the short-run portfolio adjustment model, the final forms of the demand function are derived. The final specifications of this demand function for the Treasury securities are the simple linear expressions of those theoretical solutions.

The actual estimation results are summarized in Table XIV. As explained already, the final specification of the empirical equations is based on the statistical results of the preliminary estimates by ordinary least-squares method. A close examination of this table gives the following three general concluding remarks.

TABLE XIV

SUMMARY OF ESTIMATION RESULTS

Jointly Determined and Predetermined Regressors	Regressands TS1	TS2	TS3	TS4
3-month Treasury Bill Rate	1.345 (0.70)			
Yield on 3-Year Treasury Securities		2.817 (1.70)		
Yield on 10-Year Treasury Securities			1.925 (0.54)	
Yield on 20-Year Treasury Securities				4.519 (3.17)
Yield on 7-Year Treasury Securities			-2.404 (-0.79)	
Corporate Bond Yields	-9.097 (-2.19)			-5.570 (-3.79)
Mortgage Yield		-7.158 (-1.81)	-4.847 (-3.42)	
Rate of change in Stock Price Index	-0.673 (-2.27)			-0.064 (-1.68)
Corporate Equities	0.050 (3.63)			
Money Market Fund Shares	0.417 (3.63)	0.427 (2.72)	0.104 (2.53)	0.057 (2.98)
Time and Savings Deposit	0.537 (9.98)	0.386 (5.93)	0.175 (5.98)	0.047 (5.23)
Open-Market Papers	-0.890 (-3.90)	-0.260 (-1.28)		
Corporate Bonds	-0.578 (-3.81)	0.354 (2.27)	-0.479 (-6.31)	-0.105 (-3.53)
Mortgage		-0.279 (-3.76)	0.084 (2.66)	0.048 (4.06)
Demand Deposit and Currency			0.237 (2.40)	
Previous Period's Alternative Asset Return Ratio		-10.191 (-2.74)		-1.703 (-2.99)
Corporate Equities' Capital Gains or Losses		-0.003 (-2.88)		-0.0004 (-2.48)
R^2	0.995	0.996	0.998	0.997
SE	7.07	5.23	2.31	0.93
DW	2.047	1.394	1.996	2.374

Notes: ( ): t-ratios.
R^2: coefficient of determination.
SE: standard error of regression.
DW: Durbin-Watson statistic.

A. Substitute Relationships Among Financial Asset Instruments

The estimation results as a whole show that the four maturity classes of U. S. Treasury securities are not perfect substitutes for each other. The statistical fits of the variables for other yields in each estimate are poor. In other words, none of the $\underline{a_2}$ terms in the typical equation (4.1) is statistically significant. This may indicate a relatively low degree of substitutability among Treasury securities with different maturities.

Table XIV shows that both corporate bonds and common stock have substitute relationships with 3-month Treasury securities (TS1) and over twenty-year Treasury securities (TS4). This may imply that an economic policy which influences the excess demand for corporate bonds or common stock or both can affect the demand for Treasury securities with both less than one year and more than twenty year maturity classes. This would cause changes in both the short-term and long-term rates of interest on Treasury securities.

Mortgages are substitutes for both of one-to-five-year (TS2) and five-to-twenty-year (TS3) Treasury securities. This result may also imply that an economic policy which has strong impact on the mortgage market can change the demand for Treasury securities with both one-to-five-year and five-to-twenty-year maturity classes more than other maturity class Treasury securities. This would also cause changes in both the short-intermediate-term and the long-intermediate-term interest rates on the Treasury securities.

Hence, this fact may imply that private investors have a few of substitutable asset instruments when they make demand for Treasury securities portfolio behavior. In other words, private investors take a few of alternative asset instruments into account when they make a portfolio decision on Treasury securities.

B. Optimal Marginal Portfolio Adjustment Hypothesis

When B. Friedman (1977, 1980 d), Friedman and Roley (1980), and Roley (1982) utilized the optimal marginal adjustment for an investor's short-run portfolio adjustment to construct their disaggregated model, they regarded their adjustment framework as more desirable than the standard stock-adjustment model. This is because the main hypothesis underlying their adjustment model is that investable cash flow variables, $\underline{\Delta W_t}$ in their expression, are a significant determinant of investors' short-run asset demands.

However, the estimation results show that the investable cash flow variable, $\underline{\Delta A_t}$ term in the equation (3.37) or the $\underline{a_{18}}$ term in the typical equation (4.1), is excluded due to its statistical insignificance in explaining the private investors' demand for Treasury securities. This can be attributed to a possibility that the explicit effects of this variable in the disaggregated model may be offset by each other in the aggregated model of the current study.

As already mentioned in the previous chapter, the lagged dependent variables, $\underline{TS_{i,t-1}}$, reflecting the stock adjustment effects do not have any significant roles in explaining the private investors' demand for Treasury securities. This implies that the private investors complete any reshuffling in their Treasury securities portfolios due to the changes in market situation in each quarter.

C. Effects of Alternative Asset Accumulations

According to the Table XIV, only three alternative asset instruments, i.e., money market fund shares, time and savings deposits, and corporate bonds, influence the private investors' demand for Treasury securities in general. The Treasury securities have generally been less preferred asset instruments than the corporate bonds, except for the case of TS2, over the relevant estimation period.

Among the two flow component variables, i.e., the previous period's total alternative asset return ratio and the corporate equities' capital gains or losses, the total alternative asset return ratio appeared to be significant in explaining the private investors' demand for TS2 and TS4, while the effect of the corporate equities' capital gains or losses is negligible. This indicates that the flow components, such as the total alternative asset returns in the previous quarter, may affect the demand for TS2 and TS4 only. However, the reasons why the flow component variables influence only the demand for short-intermediate-term and the long-term Treasury securities are not clear.

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