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THE EFFECT OF FEDERAL DEBT MANAGEMENT POLICY ON CORPORATE BOND AND EQUITY YIELDS

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ABSTRACT

In theory, Federal debt management policy potentially plays an important role in determining Treasury and private security yields. However, empirical studies have been unable to detect any significant effects from Federal debt management. In large part the insignificance of relative asset supply effects associated with Federal debt management policy may result from the use of unrestricted reduced-form models of interest rate determination. Using a disaggregated structural model of the markets for corporate bonds, equities, and four distinct maturity classes of Treasury securities, Federal debt management policy is found to significantly affect Treasury and private security yields. Furthermore, the yields on corporate bonds and equities are influenced disproportionately.

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The maturity composition of Federal debt has exhibited dramatic changes during the past 30 years. In 1950 the average maturity of the U.S. Treasury's outstanding debt held by private investors was 124 months. During the next 10 years the average maturity fell steadily and reached 58 months in 1960 as the Treasury shifted from bond-financed wartime deficits to a greater reliance on shorter term issues to finance deficits and to refund maturing issues. Despite the emergence of the "Operation Twist" policy, the maturity composition of Federal debt remained relatively stable during the early 1960s. Beginning in 1966, however, average maturity began to decline and continued until it reached 29 months in 1975. In large part this decline was due to the 4 1/4 per cent interest rate ceiling on new issues of Treasury bonds. Several exemptions from this 4 1/4 per cent ceiling were granted by Congress in the 1970s, and beginning in 1975 the Treasury embarked on a policy to lengthen the average maturity of Federal debt. As a consequence of this policy the mean maturity has risen to 46 months in May 1980.

The theoretical analyses presented by Rolph [34], Tobin [39], Okun [27], Brownlee and Scott [7], and others in the late 1950s and early 1960s, and by Friedman [13] and Roley [29] more recently imply that these shifts in Federal debt-management policy may have significantly affected security yields. In particular, these studies have shown that under plausible conditions shifts in the composition of a given dollar amount of outstanding Treasury securities can alter the slope of the Treasury security yield curve and in the process change private security yields.[1/] The conditions that determine the effectiveness of Federal debt management policy in this literature are twofold. First, different maturities of Treasury securities must be imperfect substitutes. Second, private and Treasury securities must to some degree be either substitutes or complements in investors' demands.[2/]

Despite the theoretical plausibility of significant relative asset supply effects on security yields, virtually all empirical research has been unsuccessful in isolating these effects. However, the single-equation methodology used in previous studies—based on either appended versions of the "expectations hypothesis" or unrestricted reduced-form equations—is not capable of directly representing asset substitutability in investors' portfolios.[3/] For this reason Friedman [15,16], Hendershott [20], and Backus, Brainard, Smith, and Tobin [1] among others have advocated the use of disaggregated market-clearing structural models of interest rate determination to examine the effects of shifts in both supply and demand factors.[4/] Friedman [15] in particular has demonstrated the usefulness of this approach in his study of the yield curve effects associated with shifting wealth ownership among disaggregated categories of investors.

Instead of the relative asset demand effects considered by Friedman [15], the purpose of this paper is to determine the effects of changes in the relative supplies of different maturities of Treasury securities on both the Treasury yield curve and long-term private security yields. Because of the previous lack of empirical support concerning Federal debt-management effects on the Treasury yield curve, the further question as to whether changes in the maturity composition of Treasury debt have differential effects on yields on distinct categories of private securities—notably corporate bonds and equities—has not been examined. To investigate all of these potential Federal debt-management effects, a disaggregated structural model of Treasury and private security markets is employed. The model consists of estimated equations representing the demands for corporate bonds, equities, and four different maturity classes of Treasury securities by disaggregated categories of investors corresponding to the Federal Reserve's flow-of-funds accounts [4]. By adding six market-clearing identities equating market demands with exogenous security supplies, the six security yields are simultaneously determined within the model.

Based on the results from a less comprehensive precursor of this model, changes in the maturity composition of Federal debt appear to significantly affect relative Treasury security yields.[5/] Given this result, the differential impacts on corporate bond and equity yields depend on the relative substitutability of different maturities of Treasury securities with these categories of private securities. In this respect the ultimate impact on all types of security yields depends not only on the substitutability of different types of securities in investors' portfolios, but also on the substitutability among different maturities of private debt and equity on the supply side of the market.[6/] The net result of a Federal debt-management operation could in fact be an unchanged structure of financial yields with a significant change in the composition of corporate financing. In this case, if the goal of Federal debt management policy is to increase private long-term debt and equity financing, the policy will be successful if measured by the amount of new issues in these markets but not if measured by relative security yields.[7/] In any event, the necessary first step is that the demands for different types of private securities and different maturities of Treasury securities shift in response to changes in the maturity composition of Federal debt, and it is this demand-side effect that is examined below.

In the first section of this paper, the conditions for the effectiveness of Federal debt management in changing security yields are explicitly developed in a simple theoretical framework that is analogous to the specification of the empirical model. The importance of adequate maturity class disaggregation of Treasury securities is also discussed. The specification and estimation of the disaggregated structural model are presented in the second section. In the third section, the substitutability of Treasury and private securities in the context of the disaggregated demands is empirically examined. The results from simulation experiments are presented in the fourth section to evaluate the consequences of selected Federal debt-management policies. The principal findings of this study are summarized in the final section.

I. Aspects of Federal Debt Management Policy

A basic theoretical model of financial markets is sufficient to show the possible effects of changes in the maturity composition of Federal debt. Although the empirical results reported in later sections are obtained from a disaggregated structural model including 51 behavioral equations, the empirical model in its aggregated form closely corresponds to the theoretical framework presented below. Following Friedman [13], market demands for financial assets may be represented as[8/]

$$\underline{A} = \underline{\beta r} + \underline{\delta}Y + \underline{\gamma}W \qquad (1)$$

where $\underline{A}$ = N x 1 vector of financial asset demands

$\underline{r}$ = N x 1 vector of yields

Y = total spending

W = financial wealth ($\underline{1}'\underline{A} = W$)

β, $\underline{\delta}$, $\underline{\gamma}$ = N x N matrix and N x 1 vectors of coefficients, respectively.

The balance-sheet constraint implies $\underline{1}'\beta = \underline{0}$, $\underline{1}'\underline{\delta} = 0$, $\underline{1}'\underline{\gamma} = 1$.

In this simplified framework as in the empirical model, only the financial effects of Federal debt-management operations are considered. Thus, income is exogenous and the financial effects examined are those analogous to shifts in the LM curve in traditional IS-LM analysis.[9/] To further simplify the analysis, Federal debt-management operations are also assumed to leave the total value of financial assets W unchanged. Because Federal debt-management operations are defined here as changes in the composition of a given dollar amount of outstanding Treasury securities held by private investors, this merely abstracts from changes in wealth due to capital gains and losses on different categories of securities which are likely to at least partially offset each other.[10/]

The five-asset version of this model—including money (M), short-term Treasury debt (S), long-term Treasury debt (L), corporate bonds (B), and equity (E)—determines four endogenous security yields. With the nominal rate of return on money assumed to equal zero and with endogenous security demands set to equal exogenous security supplies ($\underline{A}^0$), the impact of a Federal debt-management operation ($dS^0 + dL^0 = 0$) on security yields may be represented as

$$\begin{bmatrix} d\ r_S \\ d\ r_L \\ d\ r_B \\ d\ r_E \end{bmatrix} = \left[\begin{array}{cc|cc} \beta_{SS} & \beta_{SL} & \beta_{SB} & \beta_{SE} \\ \beta_{LS} & \beta_{LL} & \beta_{LB} & \beta_{LE} \\ \hline \beta_{BS} & \beta_{BL} & \beta_{BB} & \beta_{BE} \\ \beta_{ES} & \beta_{EL} & \beta_{EB} & \beta_{EE} \end{array}\right]^{-1} \cdot \begin{bmatrix} d\ S^0 \\ d\ L^0 \\ 0 \\ 0 \end{bmatrix} \tag{2}$$

In this framework, a Federal debt-management operation will in general affect private security yields if: (i) short- and long-term Treasury debt are not perfect substitutes implying the absence of a single representative Treasury security supply measure and Treasury security yield; and (ii) the 2 x 2 matrix in the third quadrant of the partitioned coefficient matrix in (2) does not equal the zero matrix. This latter condition requires some degree of substitutability (or complementarity) between Treasury and private securities, and such a relationship has often been hypothesized. For example, Treasury and corporate bonds may be close substitutes in some investors' portfolios because both are long-term nominal debt.[11/] Alternatively, if investors determine the relationships among securities solely on the basis of length of life or duration, then Treasury bonds, corporate bonds, and equities all may be close substitutes.[12/] In the absence of empirical evidence, however, it is difficult to make qualitative not to mention quantitative appraisals of the elements in the coefficient matrix.

Although the concepts reviewed in the context of the aggregated model (2) are applicable to the estimated model reported in the next section, the empirical model nevertheless differs in one important area. In particular, instead of the two maturity classes, Treasury securities are disaggregated into four separate maturity classes. Inadequate disaggregation schemes may have obscured the effects of changes in the maturity composition of Federal debt in previous studies. For example, a shift in the relative supplies of 5-year notes and 20-year bonds may cause the respective yields to change, but a long-term maturity class including both of these securities would indicate no change in supply. As a result, the supply variable would be unable to capture any of this variation in Treasury security yields. Similarly, disaggregation schemes that combine Treasury and private debt in short- and long-term maturity classes—e.g., Hendershott [20] and Backus, Brainard, Smith, and Tobin [1]—or those that combine all long-term debt with equity—e.g., Hendershott [20]—potentially obscure the effects of relative asset shifts between Treasury and private securities. To avoid these potential pitfalls, the model specified and estimated in the next section includes four separate maturity classes of Treasury securities along with separate asset categories for corporate bonds and equities. The substitutability of these six categories of securities is examined in the third section to judge the appropriateness of this disaggregation scheme.

II. Specification and Estimation of the Model

The methodology used here to specify the financial asset demands of individual categories of investors is to consider the allocation of existing portfolio wealth together with a given net wealth flow within a one-period investment horizon. This approach is implemented through the use of portfolio adjustment models that form short-run asset demands from expressions representing desired long-run proportional asset holdings:[13/]

$$\underline{\alpha}_t^* = \underline{A}_t^*/W_t = \underline{b} + B_1 \underline{\mu}_t + B_2 \underline{\sigma}_t \tag{3}$$

where $\underline{\alpha}_t^*$ = N x 1 vector of the investor's desired proportional holdings of assets at time period t $(\underline{\alpha}_t^{*\prime} \underline{1} = 1)$

$\underline{A}_t^*$ = N x 1 vector of the investor's desired holdings of assets at time period t $(\underline{A}_t^{*\prime} \underline{1} = W_t)$

W_t = the investor's total portfolio size (wealth) at the end of time period t

$\underline{\mu}_t$ = N x 1 vector of expected holding-period yields at time t

$\underline{\sigma}_t$ = N x 1 vector of variances of holding-period yields at time t

$\underline{b}$, B_1, B_2 = N x 1 vector and N x N matrices of coefficients, respectively.

The usual "adding-up" properties imply $\underline{1}' \underline{b} = 1$, $\underline{1}' B_1 = \underline{0}$, and $\underline{1}' B_2 = \underline{0}$. In addition, most derivations of desired asset holdings consistent with (3) imply non-negative coefficients on expected own-yields and coefficients on competing asset yields with signs that are unknown *a priori*.[14/]

Short-Run Portfolio Adjustment Models. Portfolio adjustment models are used to specify the less than instantaneous adjustment to desired asset proportions due to transactions costs. Because of the diverse institutional and behavioral characteristics of the categories of investors included in the disaggregated structural model, several versions of a general portfolio adjustment model are applied. The most general form of the adjustment model includes four properties that are additional to the standard stock adjustment model: (i) new investable financial flows have distinct effects on portfolio adjustment; (ii) effects from new investment financial flows are dependent on the holding-period yields of the endogenous assets in the portfolio; (iii) new investable financial flows affect the reallocation of assets already in the portfolio; and (iv) positive and negative new investable financial flows have asymmetric effects.[15/] With one exception, all of the adjustment models utilized for the investor categories included in the disaggregated structural model may be classified by a subset of these properties.[16/] In addition, each adjustment model includes properties (i) and (ii).

The model in its most general form, incorporating all four of the properties listed above, may be written as

$$\Delta A_{it} = \sum_{k}^{N} \Theta_{ik}(\alpha^*_{kt}W_{t-1} - A_{k,t-1}) + \sum_{k}^{N} \psi'_{ik}(\Delta W'_t/W_{t-1})(\alpha^*_{kt}W_{t-1} - A_{k,t-1})$$

$$+ \sum_{k}^{N} \psi''_{ik}(\Delta W''_t/W_{t-1})(\gamma^*_{kt}W_{t-1} - A_{k,t-1}) + \alpha^*_{it}\Delta W'_t + \gamma^*_{it}\Delta W''_t,$$

$$i = 1\ldots,N, \qquad (4)$$

where ΔA_{it} represents net purchases of the i^{th} asset; the indices i and k ($i, k = 1,\ldots,N$) are associated with endogenous assets; Θ_{ik}, ψ'_{ik}, and ψ''_{ik} are fixed coefficients of adjustment; and α^*_{kt} and γ^*_{kt} are desired proportional holdings of assets conditional on positive and negative investable financial flows, respectively.[17/] In addition, the positive and negative investable financial flows are written as

$$\Delta W'_t = \begin{cases} \Delta W_t, \text{ if } \Delta W_t > 0 \\ 0, \text{ otherwise,} \end{cases}$$

$$\Delta W_t'' = \begin{cases} \Delta W_t, \text{ if } \Delta W_t < 0 \\ 0, \text{ otherwise.} \end{cases}$$

The portfolio wealth constraint implies $\sum_i^N \Theta_{ik} = \overline{\Theta}$, $\sum_i^N \psi_{ik}' = \overline{\psi}'$, and $\sum_i^N \psi_{ik}'' = \overline{\psi}''$, for all k.

The terms in (4) relate to various sources of portfolio adjustment. The first term describes standard stock adjustment. The second and third terms incorporate the effects of financial flows on the reallocation of assets already in the portfolio dependent on the sign and magnitude of the financial flows. The final two terms involve the marginal allocation of investable financial flows according to desired proportional asset holdings (3), with the inclusion of asymmetric effects from positive and negative flows. The various sub-models—involving zero constraints on the ψ_{ik}' and ψ_{ik}'' parameters—applied to particular investor categories are determined on the basis of statistical tests.

Data and Estimation Techniques.[18/] The investor categories included in the disaggregated structural model are indicated in Table 1. The investor categories with endogenous demands hold 95 per cent of the total amount of outstanding Treasury securities net of Federal Reserve System and foreign holdings, 96 per cent of the total supply of corporate bonds, and 97 per cent of the total supply of equities.[19/] The primary data source of the disaggregated structural model is the Federal Reserve System's flow-of-funds accounts [4]. Quarterly observations are used, with the sample period beginning in 1960:Q1 and ending in 1975:Q4.

The data for Treasury securities consist of four weighted maturity

TABLE 1

TREASURY SECURITIES, CORPORATE BONDS, AND EQUITIES OUTSTANDING AS OF YEAREND 1975

Securities Held By:	Treasury Securities[1]		Corporate Bonds		Equities	
	Amount	Percent	Amount	Percent	Amount	Percent
Federal Reserve System	$ 87.9 b	23.5 %	---	---	---	---
Commercial Banks+	84.6	22.6	8.6	2.7	0.9	0.1
Foreign	66.5	17.8	2.6	0.8	26.7	3.1
Households*	49.0	13.1	65.9	20.8	630.5	73.8
State-Local General Funds+	30.6	8.2	---	---	---	---
Nonfinancial Corporate Businesses+	14.3	3.8	---	---	---	---
Private Pension Funds*	7.9	2.1	37.8	11.9	88.6	10.4
Savings and Loan Associations+	5.4	1.4	---	---	---	---
Credit Unions	5.0	1.3	---	---	---	---
Life Insurance Companies*	4.7	1.3	105.5	33.3	28.1	3.3
Mutual Savings Banks*	4.7	1.3	17.5	5.5	4.4	0.5
Other Insurance Companies*	4.7	1.3	12.2	3.8	14.3	1.7
Sponsored Credit Agencies	3.4	1.0	---	---	---	---
State-Local Retirement Funds*	2.2	0.6	60.9	19.2	25.8	3.0
Security Brokers and Dealers	2.1	0.6	1.4	0.4	1.7	0.2
Investment Companies**	1.1	0.3	4.8	1.5	33.7	3.9
Total	374.1	100.0	317.2	100.0	854.7	100.0

Notes:

Source: Board of Governors of the Federal Reserve System [4]
Amounts are in billions of dollars.
Detail may not add to total because of rounding.
1 Agency issues and non-negotiable savings bonds are excluded.
* Endogenous demands for all three types of securities.
+ Endogenous demands only for Treasury securities.
**Endogenous demand only for equities.

classes of Federal debt that are consistent with the flow-of-funds accounts. (See Taylor and Wood [37].) The data are defined in terms of four "definite" areas and three "borderline" areas. The definite areas include the following maturities: (1) within 1 year (short-term), (2) 2 to 4 years (short-intermediate-term), (3) 6 to 8 years (long-intermediate-term), and (4) over 12 years (long-term). Treasury securities with maturities in the borderline areas are allocated to the definite classifications according to a weighting scheme. In particular, if n is the number of months in a borderline area, then the securities are allocated to the immediately preceding and successive definite maturity classes according to the following pairs of weights:

$$\left[\frac{n}{n+1}, \frac{1}{n+1}\right], \left[\frac{n-1}{n+1}, \frac{2}{n+1}\right], \ldots, \left[\frac{1}{n+1} \quad \frac{n}{n+1}\right],$$

where maturity is increasing from left to right. 20/ The principal advantage of this procedure is that it avoids the otherwise perverse effects that occur when large debt issues cross fixed maturity boundaries.

Financial flow variables corresponding to the individual assets of the 11 investor categories are defined in terms of seasonally adjusted net changes during the quarter. The wealth flow variables are generally defined as quarterly net acquisitions of financial assets, seasonally adjusted. Financial stock variables, including individual asset stocks and total portfolio wealth, are formed by decrementing seasonally adjusted quarterly flows from the value of yearend outstandings in 1975:Q4. This procedure serves to guarantee the mutual consistency of the asset stock and flow data throughout the sample period. When asset stock data contain market valuation changes, these components are included without seasonal adjustment. The endogenous yields correspond to the published series for the 3-month Treasury bill yield, the 3- to 5-year Treasury security yield, the long-term (10-year and over) Treasury security yield, the yield on new issues of corporate bonds (Aa utilities), Standard and Poor's dividend-price ratio, and a weighted average of yields on Treasury securities maturing in 6, 7, and 8 years for the long-intermediate-term yield. When statistically significant, distributed lags on the percentage change of the Standard and Poor's composite common stock price index are also included to represent expected capital gains or losses on equities.[21/]

The estimated demand equations correspond to various sub-models embodied in (4). Because yields on securities are jointly dependent variables along with investors' demands, the use of ordinary least squares estimation would result in inconsistent estimates. Thus, a simultaneous equations estimation technique is used. In particular, the application of an instrumental variables technique described by Brundy and Jorgenson [8] is used to gain consistent estimates of the structural equations. The direct application of 2SLS is not possible in this case because of the undersized sample problem—i.e., more predetermined variables than sample observations.

Empirical Results. In total, 51 behavioral equations representing the demands for four maturity classes of Treasury securities, corporate bonds, and equities are estimated over 64 quarterly observations beginning in 1960:Q1 and ending in 1975:Q4. Summary statistics for the estimated equations are presented in Table 2. The estimation results provide support for the short-run portfolio selection model specified above. As indicated by the multiple correlations ($\bar{R}^2$), these equations explain much of the variation of the net purchases of

TABLE 2

SUMMARY OF ESTIMATION RESULTS (Sample Period: 1960:Q1-1975:Q4)

	Net Purchases of:											
	US1		US2		US3		US4		CB		EQ	
Investor Category	$\bar{R}^2$	SE	$\bar{R}^2$	SE	$\bar{R}^2$	SE	$\bar{R}^2$	SE	$\bar{R}^2$	SE	$\bar{R}^2$	SE
Commercial Banks	.75	1190	.57	841	.87	366	.64	136	---	---	---	---
Households	.76	978	.76	426	.66	318	.71	154	.69	660	.61	637
Investment Companies	---	---	---	---	---	---	---	---	---	---	.53	325
Life Insurance Companies	.85	45	.83	21	.96	30	.93	39	.87	238	.88	120
Mutual Savings Banks	.55	74	.67	50	.72	57	.71	52	.82	187	.84	21
Nonfinancial Corporate Businesses	.65	665	.77	169	---	---	---	---	---	---	---	---
Other Insurance Companies	.44	71	.53	57	.81	35	.64	24	.77	108	.78	110
Private Pension Funds	.55	90	.77	45	.85	35	.80	38	.64	262	.85	217
Savings and Loan Associations	.52	172	.59	158	.61	103	.66	53	---	---	---	---
State-Local General Funds	.62	515	.43	186	.35	122	.52	108	---	---	---	---
State-Local Retirement Funds	.60	98	.37	26	.58	32	.57	117	.80	197	.91	104

Notes:

US1 = short-term Treasury securities
US2 = short-intermediate-term Treasury securities
US3 = long-intermediate-term Treasury securities
US4 = long-term Treasury securities
CB = corporate bonds
EQ = equities
$\bar{R}^2$ = adjusted multiple correlation coefficient
SE = standard error in millions of dollars

the six types of securities. The multiple correlations range from .53 to .91 for equities, .64 to .87 for corporate bonds, and .35 to .93 for the much more volatile net purchases of Treasury securities. Comparing the individual categories of investors using this criterion, the modeling of the short-run demands of life insurance companies is the most successful with multiple correlations ranging from .83 to .96. Within individual investor categories, the statistics reported in Table 2 also indicate that the net purchases of each type of security are modeled with approximately equal success. The standard errors of the estimated equations are additionally reported to indicate the accuracy of the estimated equations in dollar amounts.

Individual parameter estimates also support the short-run portfolio selection model. The estimation results of two key sets of parameters—coefficients on lagged own-stocks (Θ_{ii}) and coefficients on the products of own-yields and wealth flows (β_{ii})—are reported in Table 3. For six categories of investors—life insurance companies, mutual savings banks, other insurance companies, private pension funds, savings and loan associations, and state and local government retirement funds—the ψ'_{ik} and ψ''_{ik} parameters in (4) take zero values allowing the identification of parameters in the expressions for desired proportional asset holdings $\alpha^*_{it.}$ [22/] In this case, the estimated coefficients β indicate the equilibrium response resulting from a one percentage point increase in the respective own-yields. A one percentage point increase in the Treasury bill yield, for example, causes life insurance companies to increase their equilibrium proportional holdings of short-term Treasury securities by 1.1 per cent. With the exception of the equilibrium response reported for the demand for corporate bonds by mutual savings banks,

TABLE 3

ESTIMATED OWN-YIELD AND OWN-STOCK ADJUSTMENT COEFFICIENTS

	Net purchases of:											
	US1		US2		US3		US4		CB		EQ	
Investor Category	β	θ	β	θ	β	θ	β	θ	β	θ	β	θ
Commercial Banks	.0889 (4.4)	-.1558 (-4.3)	.0775 (1.8)	-.1987 (-5.8)	.0116 (1.8)	-.2136 (-1.7)	.0037 (2.2)	-.2558 (-3.8)	--	--	--	--
Households	.0928 (3.1)	-.3111 (-4.6)	.0183 (3.5)	-.3335 (-6.0)	.0578 (4.0)	-.3600 (-4.8)	.0501 (5.1)	-.6459 (-8.8)	.0579 (2.6)	-.1004 (-2.8)	.0633 (2.0)	-.0693 (-4.4)
Investment Companies	--	--	--	--	--	--	--	--	--	--	.3086 (3.0)	-.0052 (-1.1)
Life Insurance Companies	.0110 (2.4)	-.6492 (-5.8)	.0274 (4.7)	-.1430 (-2.4)	.0144 (2.0)	-.0670 (-2.6)	.0145 (4.3)	-.2067 (-4.1)	.0862 (3.1)	-.1184 (-3.3)	.0245 (1.5)	-.0451 (-2.5)
Mutual Savings Banks	.2615 (4.1)	-.3082 (-3.6)	.0823 (2.7)	-.2408 (-5.2)	.0252 (2.7)	-.2219 (-5.5)	.0042 (1.7)	-.4210 (-6.3)	.2528 (3.1)	-.0740 (-2.6)	.0102 (4.4)	-.1780 (-4.5)
Nonfinancial Corporate Businesses	.0898 (2.8)	-.0306 (-1.3)	.1153 (3.8)	-.1927 (-4.1)	--	--	--	--	--	--	--	--
Other Insurance Companies	.0570 (2.0)	-.1175 (-3.0)	.0964 (3.7)	-.1880 (-4.8)	.0626 (3.0)	-.1205 (-6.9)	.0162 (1.6)	-.3157 (-4.5)	.0898 (3.0)	-.0438 (-1.9)	.1051 (2.7)	-.2153 (-2.9)
Private Pension Funds	.0225 (2.4)	-.1600 (-2.7)	.0256 (2.7)	-.1225 (-1.5)	.0234 (1.9)	-.0855 (-1.9)	.0153 (2.9)	-.3129 (-4.5)	.0920 (7.5)	-.3513 (-2.7)	.1582 (1.4)	-.1201 (-1.7)
Savings and Loan Associations	.1864 (2.5)	-.1977 (-3.4)	.0600 (2.4)	-.5804 (-6.7)	.1394 (1.5)	-.1662 (-3.0)	.0022 (1.6)	-.5391 (-6.2)	--	--	--	--
State-Local General Funds	.0752 (1.5)	-.3106 (-3.3)	.0603 (4.4)	-.1822 (-3.9)	.1493 (2.2)	-.2228 (-2.6)	.0243 (1.4)	-.0546 (-2.2)	--	--	--	--
State-Local Retirement Funds	.0255 (3.5)	-.5110 (-4.7)	.0063 (1.8)	-.1205 (-2.9)	.0071 (1.9)	-.0570 (-2.6)	.1663 (3.4)	-.1021 (-1.9)	.0275 (1.8)	-.0245 (-1.8)	.1156 (3.2)	-.3782 (-7.3)

Notes:

(See Table 2)
t-statistics in parentheses.
β = estimated coefficient on the product of the own-yield and wealth flow.
θ = estimated coefficient on the lagged own-stock.
For commercial banks, the reported β estimates are for the coefficient on the product of the own-yield and positive demand deposit flows.

all of these identifiable own-yield equilibrium responses appear to be reasonable. The estimation results for categories of investors without identifiable equilibrium responses also indicate the statistical significance of multiplicative terms involving investable flows and own-yields.[23/]

The second group of individual parameter estimates reported in Table 3 consists of estimated coefficients on lagged own-stocks. Virtually all of these estimated coefficients are highly statistically significant with the expected sign. In several instances, however, the estimated coefficients suggest extremely slow rates of own-stock adjustment.

By combining the 51 estimated equations with six market-clearing identities that place aggregate demands equal to the exogenous supplies of the four maturity classes of Treasury securities, corporate bonds, and equities, the yields on these six classifications of securities may be simultaneously determined.[24/] The results of the dynamic simulation of this supply-demand model are reported as the control simulation in Table 5. For Treasury security yields, the root-mean-square errors (RMSE) monotonically decrease from 69 basis points for the Treasury bill yield to 21 basis points for the long-term Treasury security yield. Thus, as expected, this measure increases as maturity becomes shorter because of the greater volatility of shorter term yields. The root-mean-square errors of the corporate bond yield and the dividend-price ratio are both 37 basis points which is less than that of the long-intermediate-term Treasury security yield but greater than that of the long-term Treasury security yield. On the whole, the disaggregated structural model explains yields remarkably well with only small biases evident in the reported results.

III. The Substitutability of Treasury and Private Securities

Additional empirical results are examined in this section to determine the degree of substitutability among different securities. Of these results, the most important concerns the competing security yields included in each of the estimated demand equations.

In this respect, the t-statistics for coefficients on competing endogenous asset yields entering into the estimated demands are presented in Table 4.[25] These coefficients are analogous to the off-diagonal elements of the coefficient matrix in (2). The individual values in Table 4 are labeled by investor category, and represent the t-statistics on multiplicative variables consisting of yields and either wealth flows or wealth stocks. In the case of commercial banks, where wealth flows are disaggregated into exogenous balance sheet items, all variables consisting of the product of competing yields and disaggregated wealth flows are reported. Several aspects of these results are of interest. First, the presence of the statistically significant negative off-diagonal elements indicates at least some degree of substitutability among different maturities of Treasury securities and between private and Treasury securities. Second, even on the basis of the summary statistics in Table 4, it is apparent that the coefficient matrix of the aggregate demands is not symmetric.[26] Finally, the estimation results for some categories of investors exhibit particularly significant asset substitutability in their portfolios. For example, the demands for different maturity classes of Treasury securities by commercial banks include a variety of statistically significant competing Treasury security yields, and all of the Treasury security demands of private

TABLE 4

t-STATISTICS FOR ESTIMATED COEFFICIENTS ON COMPETING YIELDS

Net Purchases of:	Yields					
	R1	R2	R3	R4	RC	RE
US1	--	0	SG(-2.5)	BK(-1.7)	0	OI(-1.4);PF(-2.8)
US2	BK(-2.7)(-3.3) (-2.2)(-1.9); SL(-2.2)	--	0	LI(-3.9);MB(-1.7)	OI(-3.2);PF(-3.8)	PF(-3.3)
US3	MB(-1.7);PF(-3.6); SR(-2.5)	BK(-6.1);LI(-2.5); OI(-3.8);SL(-1.3); SG(-2.4)	--	BK(-4.3)(-5.3); HH(-5.1)	PF(-2.0)	PF(-2.7)
US4	BK(-1.1);PF(-3.6); SG(-2.2)	SR(-2.7)	0	--	LI(-4.2)	PF(-3.7)
CB	0	MB(-2.0)	0	HH(-4.5)	--	MB(-4.4);SR(-7.2)
EQ	0	0	PF(-3.5)	0	MB(-2.8);OI(-2.1); SR(-3.7)	--

Notes:

(See Table 2).

R1 = yield on short-term Treasury securities
R2 = yield on short-intermediate-term Treasury securities
R3 = yield on long-intermediate-term Treasury securities
R4 = yield on long-term Treasury securities
RC = yield on corporate bonds
RE = yield on equities

BK = commercial banks
HH = households
LI = life insurance companies
MB = mutual savings banks
OI = other insurance companies
PF = private pension funds

SG = state-local general funds
SL = savings and loan associations
SR = state-local retirement funds

pension funds include the equity yield.

Further tests were performed to provide evidence concerning the substitutability of Treasury and private securities. In particular, the demand equations were respecified by switching sets of predetermined variables between different types of securities. For example, the demand for short-term Treasury securities was estimated using the specification for short-intermediate-term Treasury securities with the own-yield and lagged own-stock replaced to correspond to the dependent variable, and vice versa. Although this procedure is not subject to formal statistical hypothesis testing, it does allow a judgmental interpretation of the appropriateness of applying the same specification, without any constraints on the coefficients, to any two types of securities within an individual investor category. If investors view different types of securities as perfect or even close substitutes, then the separate demands should have similar subsets of predetermined variables. Thus, under this hypothesis, there should be little loss of fit from switching specifications between securities. This respecification procedure was applied to adjacent maturity classes of Treasury securities and to pairs of Treasury and private securities. The results of these tests generally indicate a substantial loss of fit from switching specifications. For example, applying this procedure to long-term Treasury security and corporate bond demands led to an average increase of 58.7 per cent in the estimated standard errors. Similar results followed from other pairs of respecified equations.

The combined results of this section suggest that some degree of substitutability exists among different maturities of Treasury securities, corporate bonds, and equities, but not perfect substitutability. This result implies that Federal debt-management operations may be effective in changing both relative Treasury and private security yields. To determine the impact of Federal debt management operations, the results of simulation experiments are considered below.

IV. Simulation Experiments

Six simulation experiments are performed to evaluate the effects of Federal debt-management operations on Treasury and private security yields. These six simulations consist of two basic types of debt-management operations initiated at the beginning of three different years. Different time periods are necessary to evaluate the effects of maturity composition changes of Federal debt because of the nonlinearity of the model—e.g., all yields enter multiplicatively with either wealth flows or wealth stocks implying non-stationary yield elasticities. The results from the simulation experiments are presented in Table 5, where the reported values are differences from the control simulation levels. Both the impacts and average effects are reported. The impacts correspond to the changes in security yields during the quarter that the experiment is initiated. The average effects are defined as the average changes in security yields over the five-year period beginning with the quarter that the experiment is initiated.

The first type of Federal debt-management operation involves a permanent 10 per cent increase in the supply of long-term Treasury securities, with the other maturities of Treasury securities declining by equal dollar amounts. This change in the maturity composition of Federal debt is initiated separately in 1960:Q1, 1966:Q1, and 1971:Q1, with the amount of long-term

TABLE 5

DYNAMIC SIMULATION RESULTS

	Control		Simulation Experiments (Difference from Control in Percentage Points)											
			10% Increase in US4[1]						2.5% Increase in US1[1]					
			1960:Q1		1966:Q1		1971:Q1		1960:Q1		1966:Q1		1971:Q1	
Yield	ME	RMSE	Impact	Average	Impact	Average	Impact	Average	Impact	Average	Impact	Average	Impact	Average
R1	0.06%	0.69%	-.34%	-.59%	-.38%	-.53%	-.29%	-.11%	.83	.54	.30	.21	.02%	.28%
R2	0.06	0.47	-.58	-.40	-.37	-.42	-.35	-.08	-.38	.17	-.34	.00	-.31	.05
R3	-0.11	0.43	-.26	-.08	.52	.16	.79	.28	-.27	-.20	-1.18	-.13	-.21	.02
R4	0.02	0.21	.39	.61	1.52	.39	.77	.05	-.07	-.23	- .40	-.15	-.22	-.17
RC	0.04	0.37	.31	.54	1.11	.18	.41	.05	-.06	-.16	- .56	-.29	-.37	-.13
RE	0.01	0.37	.00	.35	.06	.07	.33	.13	-.05	-.03	-.36	-.15	.13	.15

Notes:

(See Tables 2 and 4).

ME = mean error

RMSE = root-mean-square error

Impact = change in security yields during the quarter that the experiment is initiated (1960:Q1, 1966:Q1, or 1971:Q1).

Average= average change in security yields during the first five years after the experiment is initiated.

[1] Other maturities of Treasury securities are decreased by equal dollar amounts.

Treasury securities increasing by $2.3 b, $2.0 b, and $1.6 b, respectively. The reported impacts indicate that the short (R1)- and short-intermediate-term (R2) Treasury security yields decline in response to the reduction in the corresponding supplies, and the long-term Treasury security yield (R4) rises from the increase in the supply of long-term Treasury securities. However, the long-intermediate-term Treasury security yield (R3) actually increases by 52 basis points in 1966:Q1 and 79 basis points in 1971:Q1 despite the reduction in the supply of securities in this maturity class. In this case, the increase in the supply of long-term Treasury securities is three times larger than the fall in the supply of long-intermediate-term securities, and the subsequent rise in the long-term Treasury security yield (as well as the yields on corporate bonds and equities) causes the demand for long-intermediate-term securities to decrease more than their supply. The simulation results also show disproportionate impacts on corporate bond (RC) and equity (RE) yields. The corporate bond yield follows the long-term Treasury security yield much more closely than does the equity yield. The equity yield remains unchanged in 1960:Q1 and only increases by 6 basis points in 1966:Q1 in response to this type of Federal debt-management operation. Depending on the short-run responsiveness on the supply side of private securities markets, the changes in relative bond and equity yields may significantly alter the composition of corporate financing.

In the longer run, the simulation results suggest that the permanent 10 per cent increase in the supply of long-term Treasury securities may permanently change relative security yields, at least for the experiments initiated in 1960:Q1 and 1966:Q1. For the experiments initiated during these two periods, there is also an interesting effect on the Treasury yield curve. In particular, despite the differences in percentage supply decreases, the Treasury yield curve is systematically tilted beginning with the largest decline being registered by the short-term yield and ending with the long-term yield recording the largest increase. This result reflects the substitutability between adjacent maturities of Treasury securities. Again for the 1960:Q1 and 1966:Q1 experiments, the average effect on the corporate bond yield is larger than that on the equity yield.

The last set of simulation results in Table 5 reports the effects from a 2.5 per cent increase in the supply of short-term Treasury securities, with all other maturities of Treasury securities declining by equal dollar amounts. The increases in the supply of short-term Treasury securities are $1.5 b, $1.6 b, and $1.9 b for 1960:Q1, 1966:Q1, and 1971:Q1, respectively. In each case, the impact on the short-term Treasury security yield is positive, but it initially rises by only 2 basis points in the 1971:Q1 experiment. In response to this type of debt management operation all other Treasury security yields fall. The corporate bond yield again declines by about the same order of magnitude as the long-term Treasury security yield. The equity yield, however, actually rises in the 1971:Q1 experiment despite the declines in other long-term security yields. In a debt-management experiment considered by Backus, Brainard, Smith, and Tobin [1], the equity yield responds in a similar manner during several time periods. As these authors suggest, the imperfect substitutability of bonds and capital apparently account for this result.

The average effects from Federal debt management operations with 10 per cent increases in the supply of short-term Treasury securities are quite different from the impacts. In the longer run, the rise in the short-term

Treasury security yield leads to excess supply in the short-intermediate-term market for two of the three time periods. This causes the short-intermediate-term yield to rise above control simulation levels. For the 1971:Q1 experiment, the long-intermediate-term yield also rises slightly above its control simulation level. Nevertheless, in each case a systematic change in the Treasury yield curve occurs with the short-term yield exhibiting the largest increase and the long-term yield experiencing the largest decline. This type of Federal debt-management operation also disproportionately affects corporate bond and equity yields. The average decline in the corporate bond yield relative to the equity yield ranges from 13 basis points for the 1960:Q1 experiment to 28 basis points for the 1971:Q1 experiment.

To summarize, in the short run Federal debt management operations appear to significantly affect relative Treasury and private security yields. In addition, the corporate bond yield follows the long-term Treasury security yield quite closely while the equity yield generally exhibits smaller absolute changes in response to Federal debt-management operations. In the longer run, the effects on security yields are often smaller than the initial impacts despite the permanent nature of the maturity composition shifts considered here. Nevertheless, the results generally indicate that lengthening the average maturity of the Federal debt reduces the incentives for both bond and equity corporate financing, and vice versa.

V. Summary of Conclusions

The disaggregated structural model of Treasury and private security markets developed here has allowed a more explicit analysis of the empirical issues surrounding Federal debt-management policy than previous studies based on single-equation models of interest rate determination. The disaggregated structural modeling framework enables the explicit investigation of asset substitutability which is crucial in determining the potential effectiveness of Federal debt-management operations. Single-equation models may obscure the consequences of Federal debt-management operations by combining both demand and supply effects which may result in only small changes in relative Treasury and private security yields, but significant changes in the composition of corporate financing.

The empirical results of this study indicate that different maturities of Treasury securities are imperfect substitutes, and some degree of substitutability exists among Treasury securities, corporate bonds, and equities. Given these results, simulation experiments were performed and they indicated that changes in the maturity composition of the Federal debt significantly affect Treasury and private security markets, at least in the short run. Depending on the supply-side response of corporate financial policy, the simulation experiments suggest that Federal debt-management policy can affect private security markets by either changing relative yields or relative supplies.

Footnotes

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1. This result is also implicit in the analyses presented by Keynes [22] and Leijonhufvud [23] who aggregate securities on the basis of an asset's length of life. Apart from changing relative yields, a Federal debt management operation may also have an impact on both financial and nonfinancial sectors from subsequent changes in liquidity. For a discussion of possible liquidity effects, see Smith [36].

2. Although Federal debt management policy is also potentially effective if different maturities of Treasury securities are complements, discussions in the remainder of the paper focus on the more plausible case of substitutability.

3. Researchers who find only insignificant relative asset supply effects using single-equation models of the long-term Treasury security yield include Okun [27], Modigliani and Sutch [25, 26], and Hamburger and Silber [19].

4. Although Fair and Malkiel [11] use the reduced-form approach to investigate relative asset supply effects, they also suggest that a more complete study would include the direct estimation of security demands.

5. See Roley [28, 30].

6. For evidence on the substitutability of short- and long-term debt in the financing of corporate external deficits, see Friedman [14].

7. Modigliani and Sutch [26], for example, suggest that changes in the supplies of private securities may account for the insigificance of relative Treasury security supply effects on the long-term Treasury security yield in their study.

8. The set of asset demands (1) is also consistent with linearized versions of the models presented by Brainard and Tobin [6] and Tobin [40].

9. In this case, however, the use of a single security yield in the IS-LM framework would be misleading if fixed investment is responsive to both corporate bond and equity yields. To remedy this situation, a weighted average of the corporate bond and equity yields could perhaps be used to reflect the cost of capital. For a recent example of this approach in a study of business fixed investment, see Clark [10].

10. Federal debt-management operations as defined here differ from Federal deficit financing where the amount of outstanding Treasury securities actually increases. In the case of debt-financed deficits, wealth effects are important determinants of both the magnitude and sign of the ultimate "crowding-out" effect. For analyses of Federal deficit financing, see Blinder and Solow [3], Tobin and Buiter [41], and Friedman [13].

11. The distinction between nominal and real claims is made by Tobin [38] in his discussion of asset substitutability. Treasury and corporate bonds are not likely to be perfect substitutes, however, because of a variety of distinguishing attributes. See Fair and Malkiel [11].

12. See, for example, Leijonhuvfud [23].

13. Linear homogeneous asset demands follow from expected utility maximization when either the argument of the utility function is portfolio rate of return or investors exhibit constant relative risk aversion. For derivations of the latter case in both continuous- and discrete-time models, see Friedman and Roley [18]. The expression for desired proportional asset holdings (3) follows from the linearization of asset demands derived from these expected utility maximization models.

14. Again interpreting the desired proportional asset holdings (3) as linearizations of asset demand equations derived from expected utility maximization, Blanchard and Plantes [2] show that positive covariances for all pairs of security yields are necessary but not sufficient for gross substitutability. Furthermore, Roley [31] shows that symmetry of the B_1 matrix implies a particular type of risk averse behavior which does not generally hold for all classes of utility functions.

15. The portfolio adjustment models used by Brainard and Tobin [6], Modigliani [24], and Bosworth and Duesenberry [5] exhibit the first property. Friedman [12] developed and implemented a model with properties (i) and (ii).

16. The portfolio adjustment model applied to commercial banks is the one exception. This adjustment model considers the allocation of individual exogenous components of the new investable financial flow in addition to properties (i) through (iv). Because this adjustment model has been examined in detail elsewhere, it will not be further considered here. See Roley [32].

17. The γ^*_{kt} differ from the α^*_{kt} in that the former explicitly represent desired short-run portfolio holdings conditional on negative financial flows. That is, the γ^*_{kt} are included to allow for possible asymmetric effects of expected holding-period yields and variances of holding-period yields associated with positive and negative financial flows. These asymmetric effects may result from different transactions costs associated with purchasing and selling assets, and from different behavior regarding unrealized capital gains and losses on existing assets in the portfolio. Furthermore, the $\underline{\gamma}^*$ vector is analogous to (3) except that expected holding-period yields enter as reciprocals—e.g., $1/\mu_i$. For the own-yield on asset $i(\mu_i)$, for example, this implies that for negative financial flows, the <u>higher</u> the own-yield, the <u>less</u> the

amount of asset i sold. Alternatively, if the own-yield was not entered in reciprocal form, then the higher the own-yield, the greater the amount of asset i sold.

18. For detailed discussions of the data and estimation techniques used in forming the disaggregated structural model, as well as a detailed listing of the estimation and simulation results associated with the model, see Roley [33].

19. The modeling of foreign purchases of U.S. Treasury securities involves areas well outside the scope of the study. Therefore, foreign purchases are taken as exogenous. The supply of U.S. Treasury securities is determined by fiscal policy and the government budget constraint; and monetary policy determines the Federal Reserve System's total holdings. This results in the net amount of U.S. Treasury securities to be purchased by private investors. For a discussion of fiscal policy and the government budget constraint, see Christ [9] and Silber [35].

20. This procedure is applied by the Federal Reserve System to monthly data. Quarterly observations are formed by taking the arithmetic means of seasonally adjusted monthly data.

21. In a test of rational, unitary, and autoregressive models of expectations in the context of a disaggregated structural model of the corporate bond market, the autoregressive model used here to represent expected capital gains on equities dominates the other expectations models. See Friedman and Roley [17]. Jones [21] also uses a similar autoregressive scheme to model expectations is his disaggregated structural model of the U.S. equity market.

22. Furthermore, mutual savings banks and savings and loan associations are the only two categories of investors among these six that occasionally have negative wealth flows. For the other four categories of investors with strictly positive wealth flows, the portfolio adjustment model is identical to the "optimal marginal adjustment" model developed by Friedman [12].

23. For commercial banks, multiplicative terms involving own-yields and positive demand deposit flows are reported. Again, the investable flows of the commercial banking sector are disaggregated into exogenous balance sheet items, with demand deposit flows comprising a significant portion of the total investable flow.

24. In the simulations, the balance sheet constraints for individual categories of investors are not violated because a complete set of asset demands is not estimated. The set of equations for each investor category therefore implicitly includes a residual asset equation—consisting of money, state and local bonds, and commercial paper, for example—that defines the net purchases of the residual assets as the wealth flow minus total net purchases of endogenous assets. The simulation results are not altered by explicitly including these residual asset equations. In addition, Walras' Law implies that the market-clearing identity for these residual assets is redundant.

25. In each demand equation the statistical significance of all competing

security yields on assets in investors' endogenous choice sets was tested. The final specifications of the equations are based on the statistical significance of these coefficients in preliminary OLS regressions.

26. Within individual categories of investors, the results of symmetry tests involving the demands for short-intermediate-term and long-term Treasury securities indicate that in one-half of the cases the null hypothesis of symmetry can be rejected at the 5 per cent level of significance. Furthermore, in each of the cases where symmetry cannot be rejected, the coefficients on competing security yields are insignificantly different from zero. For a detailed discussion of these tests, see Roley [31].

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