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# DEBT MANAGEMENT POLICY, INTEREST RATES, AND ECONOMIC ACTIVITY

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## Abstract

The maturity structure of the U.S. government's outstanding debt has undergone large changes over time, at least in part because of shifts in the Treasury's debt management policy. During most of the post World War II period, an emphasis on short-term issues rapidly reduced the debt's average maturity. In the early 1960's and again since 1975, however, the opposite policy just as rapidly lengthened (and is now lengthening) the average maturity. Such changes in debt management policy in general affect the structure of relative asset yields as well as nonfinancial economic activity.

The evidence presented in this paper indicates that debt management actions of a magnitude comparable to the recent changes in U.S. debt management policy have sizeable effects both in the financial markets and more broadly. In particular, a shift from long-term to short-term government debt — that is, a shift opposite to the Treasury's recent policy — lowers yields on long-term assets, raises yields on short-term assets, and in the short run stimulates output and spending. Moreover, the stimulus to spending is disproportionately concentrated in fixed investment, so that debt management actions shortening the maturity of the government debt not only increase the economy's output but also shift the composition of output toward increased capital formation.

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At the end of World War II, the U.S. Treasury's outstanding debt was mostly long-term: $54 billion of bonds maturing in ten years or more, $66 billion of notes and bonds maturing in one to ten years, and only $47 billion of bills and other securities due in less than one year, amounting to an overall mean maturity of 116 months. By contrast, in financing new deficits and refinancing maturing issues during the subsequent three and half decades, the Treasury has usually relied on shorter-term borrowing, thereby substantially reducing the outstanding debt's average term to maturity. This pattern of debt management has no doubt resulted in part from the statutory limitations (occasionally relaxed) on issuing bonds bearing coupons greater than 4 1/4%, but to some extent it has also reflected discretionary Treasury policy.

During several specific episodes, however, the Treasury's management of its debt has taken the opposite tack (see Table 1).[1] One such episode occurred during the early 1960s, when an emphasis on longer-term issues extended the overall mean maturity from 53 months in January, 1960, to 69 months in June, 1965. Another is currently in progress. The mean maturity of the Treasury's outstanding debt reached 28 months, its shortest post-war level, in January, 1976. Since then reliance on regular medium-term note issues and several new thirty-year bonds has extended the mean maturity to 47 months as of midyear 1981. Hence the result of the Treasury's debt management policy since 1976 has been to lengthen the debt just as rapidly

TABLE 1

MATURITY STRUCTURE OF PRIVATELY HELD U.S. TREASURY DEBT

| Yearend | Total | Within 1 Year | 1 to 5 Years | 5 to 10 Years | 10 to 20 Years | 20 Years and Over | Mean Maturity |
|---|---|---|---|---|---|---|---|
| 1945 | $167.5 | 28.1% | 20.5% | 19.1% | 19.2% | 13.1% | 116 m |
| 1950 | 126.3 | 33.2 | 25.3 | 12.7 | 28.9 | 0.0 | 100 |
| 1955 | 134.2 | 34.0 | 29.8 | 25.7 | 7.5 | 3.0 | 71 |
| 1960 | 153.5 | 38.2 | 37.5 | 10.4 | 7.5 | 6.4 | 58 |
| 1965 | 160.4 | 41.9 | 27.0 | 18.8 | 3.9 | 8.4 | 63 |
| 1970 | 168.5 | 49.9 | 33.9 | 7.5 | 3.9 | 4.8 | 41 |
| 1975 | 255.9 | 58.7 | 29.2 | 6.5 | 3.3 | 2.3 | 29 |
| 1980 | 492.3 | 48.7 | 32.4 | 8.4 | 5.5 | 5.0 | 45 |

Notes: Totals in billions of dollars, distribution in percentages, mean maturity in months.
Callable securities classified by date of first call for 1945-1955, by final maturity for 1960-1980.
Source: U.S. Department of the Treasury (Treasury Bulletin, Office of the Secretary of the Treasury, Office of Government Financing).

as the average policy prevailing during the prior thirty years shortened it.

Do changes in Treasury debt management affect the economy? Although many economists assumed so in the first half of the post-war period, a series of empirical investigations beginning in the 1960s provided either weak evidence for such effects or none at all. More recently, however, researchers using structural models of interest rate determination (that is, explicit supply and demand models) have provided partial-equilibrium evidence of sufficiently imperfect asset substitutabilities in private-sector portfolios to suggest substantial effects associated with major debt management actions. Still, the effects of such actions on economic activity in a general equilibrium context remain unexplored.

The object of this paper is to provide a quantitative assessment of the economic effects of debt management policy. The principal research tool employed here for this purpose is a hybrid model combining the familiar MIT-Penn-SSRC (henceforth MPS) econometric model of the United States, a structural model developed in Friedman [ 9, 12] representing the determination of interest rates and financing volume in the U.S. corporate bond market, and a structural model developed in Roley [27, 28] representing the determination of interest rates in four separate maturity sub-markets of the U.S. government securities market. The basis of the two interest rate models is the requirement that, in each asset market, the amount of securities demanded by investors must equal the amount supplied by borrowers — including either private-sector borrowers or the government. Hence changes in the pattern of government debt management can directly affect the market-clearing structure of yields. The MPS model (minus its term-structure equation, which is unnecessary in the presence of the structural interest rate models), in turn develops the implications of these yield movements for other aspects of financial as well as nonfinancial economic activity. Moreover, because the combined model is fully simultaneous, the general equilibrium solution that it determines allows for a rich set of feedbacks in both directions between financial and nonfinancial aspects of economic behavior.

Section I reviews the underlying theory relating the structure of asset yields generally, and the volumes of inside assets supplied and demanded, to the supplies of outside assets. Section II describes the combined MPS and structural interest rate model used for the empirical analysis. Section III reports simulation experiments assessing the effects of two different debt management actions — one a sustained change in the pattern of new financing, and the other a larger change in the maturity structure effected within one year. To anticipate, the results of these experiments indicate that such debt management actions, in plausible magnitudes, would have significant effects not only on the structure of asset yields and prices but also on both the amount and the composition of nonfinancial economic activity. Section IV briefly summarizes the paper's principal conclusions.

I. Debt Management, Interest Rates, and Asset Prices

When asset markets are in equilibrium, the market-clearing structure of yields depends in a straightforward way on the quantities of outside assets supplied.

If investors' preferences exhibit constant relative risk aversion, and if their assessments of the returns on the available assets are normally (or joint normally) distributed, in the absence of transactions costs their optimal single-period portfolio allocation will be of the form

$$\underline{A}_t^D = W_t \cdot (B_t \underline{r}_t^e + \underline{\pi}_t) \qquad (1)$$

where $\underline{A}^D$ is a vector of asset demands satisfying $\underline{A}^{D'}\underline{1} = W$, W is total portfolio wealth, $\underline{r}^e$ is a vector of means of the joint asset return distribution corresponding to $\underline{A}^D$, B and $\underline{\pi}$ are respectively a matrix and a vector of coefficients determined by the coefficient of relative risk aversion and the variance-covariance matrix of the asset return distribution,[2] and t denotes the t-th time period. Because $\underline{A}^D$ is proportional to W and linear in $\underline{r}^e$, (1) is both the optimal allocation for a single investor when W is that one investor's wealth and also the economy-wide optimal allocation when W is aggregate wealth and all investors have identical preferences and assessments. The economy-wide optimal allocation is still of the form (1) even if investors exhibit heterogeneous preferences or hold diverse assessments, and the aggregate B and $\underline{\pi}$ in this case are combinations of the B and $\underline{\pi}$ appropriate for the underlying individuals, weighted by their respective individual wealth totals.[3]

The partial equilibrium of the asset markets is equivalent to the market-clearing condition

$$\underline{A}_t^D = \underline{A}_t^S \tag{2}$$

where $\underline{A}^S$ is a vector of given net asset supplies including nonzero values for all existing outside assets and zero values for all inside assets. Substitution from (1) then yields the determination of expected asset returns according to[4]

$$\underline{r}^e = B_t^{-1} \left(\frac{1}{W_t}\underline{A}^S - \underline{\pi}_t\right). \tag{3}$$

For given wealth, and given preferences and variance-covariance assessments (so that B and $\underline{\pi}$ are fixed), variations in outside asset supplies clearly affect the market-clearing structure of yields. The role of government debt management policy in this context is, in the first instance, to achieve just such effects.

For example, consider the case of a model with no inside assets and only four outside assets: money (M), short-term government debt (S), long-term government debt (L), and capital (K). The structure of the asset markets in this case is just the linear form

$$\begin{vmatrix} M/W \\ S/W \\ L/W \\ K/W \end{vmatrix}^D = \begin{vmatrix} \pi_m \\ \pi_s \\ \pi_\ell \\ \pi_k \end{vmatrix} + \begin{vmatrix} b_{mm} & b_{ms} & b_{m\ell} & b_{mk} \\ b_{sm} & b_{ss} & b_{s\ell} & b_{sk} \\ b_{\ell m} & b_{\ell s} & b_{\ell\ell} & b_{\ell k} \\ b_{km} & b_{ks} & b_{k\ell} & b_{kk} \end{vmatrix} \begin{vmatrix} r_m \\ r_s \\ r_\ell \\ r_k \end{vmatrix}^e = \begin{vmatrix} M/W \\ S/W \\ L/W \\ K/W \end{vmatrix}^S \tag{4}$$

where, for covenience, both supplies and demands are divided by total wealth defined as W = M+S+L+K, and the time subscript is suppressed.[5] From the implications of the balance-sheet constraint ($\sum_i \pi_i = 1$; $\sum_i b_{ij} = 0$, all j), it is possible to simplify the system further by expressing it in terms of only three coefficients in each column vector. Moreover, if the

Jacobian is symmetric,[6] it is possible to eliminate an additional six coefficients. Applying the balance-sheet and symmetry constraints so as to retain explicitly the six off-diagonal Jacobian coefficients indicating the four assets' respective pairwise substitutabilities yields

$$\begin{vmatrix} 1-\pi_s-\pi_\ell-\pi_k \\ \pi_s \\ \pi_\ell \\ \pi_k \end{vmatrix} + \begin{vmatrix} -b_{ms}-b_{m\ell}-b_{mk} & b_{ms} & b_{m\ell} & b_{mk} \\ b_{ms} & -b_{ms}-b_{s\ell}-b_{sk} & b_{s\ell} & b_{sk} \\ b_{m\ell} & b_{s\ell} & -b_{m\ell}-b_{s\ell}-b_{\ell k} & b_{\ell k} \\ b_{mk} & b_{sk} & b_{\ell k} & -b_{mk}-b_{sk}-b_{\ell k} \end{vmatrix} \begin{vmatrix} r_m \\ r_s \\ r_\ell \\ r_k \end{vmatrix}^e = \begin{vmatrix} M/W \\ S/W \\ L/W \\ K/W \end{vmatrix} . \quad (5)$$

Debt management actions in this simple model consist of offsetting changes in the supplies of short- and long-term bonds which, at least to a first approximation,[7] leave total wealth fixed — in other words, $dS = -dL$.

What effect will such actions have on the resulting structure of asset yields? The form of the asset demand system in (5), which explicitly incorporates the balance-sheet constraint, makes clear that only three of the four equations are independent, so that the system can determine only three of the four asset yields. With $r_m$ fixed, for example, any three equations of the system can determine $r_s$, $r_\ell$ and $r_k$. Moreover, although the absolute levels of these three yields will depend on the $\pi_i$ coefficients and on the fixed level of $r_m$, because of the system's linear form the marginal effect of any $dS = -dL$ on these three yields will depend only on the Jacobian B — which, as (5) shows, can be expressed completely in terms of the relevant asset substitutabilities. Solution of (5), for W, M, K and $r_m$ held fixed, yields these marginal effects as

$$\frac{dr_s}{dS} = \frac{b_{m\ell}(b_{mk}+b_{sk}+b_{\ell k}) + b_{mk}b_{\ell k}}{W \cdot \Delta}$$

$$\frac{dr_\ell}{dS} = -\frac{b_{ms}(b_{mk}+b_{sk}+b_{\ell k}) + b_{sk}b_{\ell k}}{W \cdot \Delta} \qquad (6)$$

$$\frac{dr_k}{dS} = \frac{b_{m\ell}b_{sk} - b_{ms}b_{\ell k}}{W \cdot \Delta}$$

where W is again total wealth, and $\Delta$ is the determinant of the subsystem of the Jacobean in (5) formed by eliminating the first column (since $r_m$ is fixed) and any one row chosen arbitrarily.

Although the derivatives in (6) remain unsigned in the absence of any restrictions at all on B, the assumption that the four assets are gross substitutes[8] — that is, that each of the six off-diagonal $b_{ij}$ coefficients shown explicitly in (5) is negative — renders the determinant unambiguously positive and therefore yields the intuitively plausible result

$$\frac{dr_s}{dS} > 0$$

$$\frac{dr_\ell}{dS} < 0 \qquad (7)$$

$$\frac{dr_k}{dS} \gtrless 0.$$

Hence a simultaneous sale of short-term bonds and purchase of long-term bonds increases the yield on the former and reduces that on the latter, while still leaving ambiguous the effect on the asset with supply held constant. From (6) however, it is clear that a further intuitive assumption about the ordering of relative substitutabilities among asset pairs is sufficient to sign the effect on $r_k$ also. If investors perceive an asset hierarchy (in terms of safety, liquidity, etc.) extending in order from money to short-term bonds to long-term bonds to capital, such that they regard assets which are adjacent in this ordering as better substitutes than more distant assets, then $b_{ms}$ and $b_{\ell k}$ will be large (in absolute value) in comparison to $b_{m\ell}$ and $b_{sk}$, and the effect of a debt management action on the required yield on capital will be

$$\frac{dr_k}{dS} < 0. \tag{7'}$$

Although the simple analysis in (1) - (7) sets forth the central idea behind the role of debt management policy in affecting asset yields, two generalizations of this analysis are important for the effects of debt management more broadly as investigated in Section III below.

First, although the general model in (1) - (3) in principle includes inside assets, the model as written says nothing about the determination of their respective quantities, and the special case considered in (4) - (7) excludes inside assets altogether. If all investors are identical, then of course the outstanding amount of each inside asset must be exactly zero on a gross basis as well as the net basis captured in the supply vector $\underline{A}^S$. One investor would not borrow from or lend to another if both shared identical preferences, assessments and endowments. In a world in which preferences, assessments and endowments may differ, however — and in which legal and other institutional restrictions may importantly constrain the behavior of asset market participants — borrowing and lending among individuals and firms in fact constitute much of the financial markets' everyday activity.

An alternative form of (2) that explicitly recognizes this heterogeneity is just

$$\sum_h \underline{A}^D_{ht} = \underline{A}^S_t \tag{8}$$

where h denotes the h-th investor (which may be an individual or an institution), and for the j-th asset the market-clearing condition is correspondingly

$$\sum_h A^D_{hjt} = A^S_{jt}. \tag{9}$$

The special characteristic of an outside asset is that $A^S_j > 0$ (if the asset exists) and $A^D_{hj} \geq 0$ for all h, subject of course to (9). By contrast, the special characteristic of an inside asset is that $A^S_j = 0$ and $A^D_{hj} \gtrless 0$, again subject to (9).

While a fully aggregated asset market model can never identify the gross quantity of an inside asset, a disaggregated model can do so if the disaggregation is such as to distinguish positive from negative $A^D_{hj}$. By far the most familiar such disaggregation in macroeconomic models is that between the banking system and the nonbank public, which permits identification of inside money; but other inside assets may be worth identifying as well. To the extent that gross quantities of inside assets matter in addition to the associated yields, therefore — for example, if the quantity of mortgage credit borrowed and lent affects homebuilding apart from the mortgage rate, or if the level of household indebtedness affects consumer spending apart from the consumer credit rate, or if the volume and pattern of corporate financing affects business investment apart from the rates on bonds and bank loans — an advantage of an appropriately disaggregated model is its ability to identify and determine these quantities, thereby facilitating the representation of their effects on economic activity.

A second important shortcoming of the simplified analysis in (1) - (7) is that it excludes induced asset price effects.[9] Although it is possible to imagine situations in which both the quantity and the price of capital would remain fixed despite movements in the yield on capital, a more plausible treatment would allow for a price response (say, in the short run) or a quantity response (say, in the long run), or both. Under the fixed-quantity variable-price conditions assumed by Tobin [32], for example, the equivalent of (4) is

$$\begin{vmatrix} M/W \\ S/W \\ L/W \\ qK/W \end{vmatrix}^{D} = \underline{\pi} + B\underline{r}^{e} = \begin{vmatrix} M/W \\ S/W \\ L/W \\ qK/W \end{vmatrix}^{S} \tag{10}$$

where K is now the fixed physical quantity of capital and q is its market price in relation to replacement cost, which varies with the associated yield according to

$$q = f(r_k) , \quad f' < 0. \tag{11}$$

Because wealth now depends on the price of capital, which changes whenever $r_k$ changes, the asset market equilibrium described by (10) is richer than that in (4). A fall in $r_k$ as in (7') increases the supply of capital. It therefore increases wealth and hence strictly increases the sum of the demands for all assets including capital itself. If investors are wealth diversifiers (that is, $\pi_i > 0$ for all i), then, under the assumptions that give rise to the effects of a debt management action on $r_S$ and $r_L$ as in (7) and $r_k$ as in (7'), the consequence of a flexible price of capital is a reduction in the absolute magnitude of each yield effect without any change in sign. In a linearized version of (1), the effect of $dS = -dL$ on $r_k$ is

$$\frac{dr_k}{dS} = \frac{b_{m\ell}b_{sk} - b_{ms}b_{\ell k}}{\Delta - Kf'[\pi_s(b_{s\ell}b_{\ell k}+b_{sk}b_{mk}+b_{s\ell}b_{sk}+b_{sk}b_{\ell k}) + \pi_\ell(b_{s\ell}b_{sk}+b_{\ell k}b_{ms}+b_{\ell k}b_{s\ell}+b_{sk}b_{\ell k}) + (1-\pi_k)(b_{ms}b_{m\ell}+b_{ms}b_{s\ell}+b_{ms}b_{\ell k}+b_{s\ell}b_{m\ell} + b_{s\ell}b_{\ell k}+b_{sk}b_{m\ell}+b_{sk}b_{s\ell}+b_{sk}b_{\ell k})]}. \tag{12}$$

This expression differs from the corresponding part of (6) only by the second (long) term in the denominator, which, like the determinant, is unambiguously positive if all assets are gross substitutes and if investors are wealth diversifiers. Hence the effect on $r_k$ is again negative, though smaller in absolute value. By (11) the effect on q is simply

$$\frac{dq}{dS} = f' \frac{dr_k}{dS} > 0. \tag{13}$$

Although generalizing the model to allow for a flexible price of capital does not qualitatively change the effect of debt management on the asset market partial equilibrium, like the generalization to identify gross quantities of inside asset stocks it may have important implications for associated effects beyond the asset markets. Models relating business investment to the ratio of market price to replacement cost, either instead of or in addition to capital and other asset yields per se, are well known. In addition, because ownership of equity claims to capital bulks large in household portfolios, and because the variation over time in equity prices is much greater than that in other asset prices, the flexible price of capital in fact accounts for most of the observed variation in household wealth. To the extent that household wealth in turn affects consumption, as is suggested by the life-cycle model, effects of debt management actions on asset prices again may affect economic activity.

Finally, it is important to recognize that, once debt management affects economic activity, with likely feedback effects on the asset markets, any simple partial equilibrium analysis is no longer adequate. Changes in incomes and spending may affect asset demands and the resulting market-clearing yields directly, as in the presence of a transactions demand for money, or through changes in borrowing that typically accompany certain types of expenditures, or through changes in wealth due to induced saving or dissaving. A model of general equilibrium, incorporating these and other influences in both directions between the financial and nonfinancial markets, is necessary.

## II. A Model of Interest Rates and Economic Activity

Most empirical models of interest rate determination that are familiar today preclude analysis of debt management effects because they rule out such effects at the outset. After first determining some key short-term interest rate from the interaction of monetary policy and the demand for money, most current models then proceed to determine the yield on any other asset, like the interest rate on long-term bonds or the dividend-price yield on equities, from a single reduced-form term-structure equation estimated directly with the yield in question as the dependent variable. Equations of this kind have become standard since the work of Modigliani and Sutch [22] and Modigliani and Shiller [21].

Because such term-structure equations in principle represent partial reduced forms of some (usually unspecified) structure that may resemble (1) - (3) above,[10] there is no a priori reason why they cannot include one or more variables representing outside asset supplies. Indeed, in the mid 1960s several researchers attempted to isolate effects of the then recent "Operation Twist" surrogate debt management policy in just this way. Although a few analyses showed some evidence of effects on the yield structure due to changing asset supplies, most did not and therefore concluded that Operation Twist had been a failure — perhaps not surprisingly since, despite the Federal Reserve System's limited attempt to shorten the average maturity of the privately held government debt via open market purchases, offsetting Treasury financings led instead to a net lengthening (see again Table 1).[11] The finally estimated form of the "preferred habitat" model of Modigliani and Sutch, for example, in fact included no "preferred habitat" terms.

Subsequent work on interest rates within the single-equation directly estimated reduced-form framework has largely followed the same path. Through most of the post World War II period, either there was too little variation (around trend) in the relative supplies of short- versus long-term outside bonds, or investors regarded debts of different maturity as too closely substitutable, for the standard term-structure equation to detect any asset supply effects. Analogous work based on more recent data has shown some evidence for such effects, but to date the extent of variation present in the data apparently still precludes drawing sharp conclusions from such imprecise methods.[12]

By contrast, structural models of interest rate determination constructed explicitly in the form of (1) - (3) above provide a way of extracting more information from the available data, in that the underlying market-clearing structure constrains the way in which asset quantity variables enter the analysis. In the most general terms, the structural model facilitates using the theory of portfolio behavior to restrict the model's implied equations for relative interest rates, while imposing on the researcher the discipline of acknowledging explicitly that any factor hypothesized to affect relative interest rates can do so only by affecting some investor's asset demands (or some borrower's asset supplies).[13] The asset demand equations in models of the U.S. corporate and government bond markets, constructed in this way by Friedman [9 , 12] and Roley [27, 28], respectively, indicate that investors (and private-sector borrowers) regard assets of different maturity as less than perfect substitutes. Moreover, partial equilibrium simulations of these models indicate that, because of this imperfect substitutability, changes in asset supplies have sizeable effects on the structure of asset yields.

For at least two reasons, however, it is useful to go beyond such partial equilibrium analysis. First, debt-management effects within the asset markets only are of limited interest. What presumably matters for policy purposes is the effects such actions have on nonfinancial economic activity. Second, partial equilibrium analysis of the asset markets necessarily holds fixed all aspects of nonfinancial activity, including those aspects that debt-management actions may affect. Allowing for the associated set of feedbacks requires instead an analysis of the resulting general equilibrium.

The model employed here for this purpose consists of an altered MPS model (1978 version), from which the familiar single term-structure equation determining the corporate bond yield has been removed and into which a structural model of interest rate determination in the corporate and government bond markets has been substituted. The corporate bond yield is by far the most important asset yield in the MPS model from the perspective of implications for nonfinancial economic behavior. In the first instance, the corporate bond yield exerts a major influence on business fixed investment in the model through its role in determining the user cost of capital. It also exerts an analogous influence on residential investment at only one step removed; in this case the relevant user cost depends on the mortgage yield, which in turn follows from the corporate bond yield via a simple term-structure-like relationship. In addition, the corporate bond yield influences both durable and nondurable consumer spending. The motivation underlying the determination of expenditures on consumer durables is again analogous to that for business and residential investment, although in this case the model actually uses a simplified function relating these expenditures directly to the corporate bond yield. The primary determinant of nondurable consumption is households' wealth, which consists in large part of equities;[14] the model determines the market value of equities as the quotient of dividend payments, in turn determined by a function in which the corporate bond yield is one direct argument among several, and the dividend-price yield, which also follows from the corporate bond yield via another simple term-structure-like relationship. Finally, within the model's representation of the financial markets, the corporate bond yield is a direct argument of the functions determining numerous other yield and quantity variables that in turn also exercise diverse influences on nonfinancial behavior.[15]

The corporate bond market model consists of eight equations representing the respective net purchases of corporate bonds by six categories of bond investors (life insurance companies, other insurance companies, private pension funds, state and local government retirement funds, mutual savings banks and households) and net sales of corporate bonds by two categories of bond issuers (domestic nonfinancial business corporations and finance companies).[16] The model's ninth, and final, equation is a market-clearing equilibrium condition analogous to (2), which requires the algebraic sum of the net purchases and sales by all categories of bond investors and bond issuers to sum to zero, and hence permits the model to determine the corporate bond yield as in (3).[17]

The government bond market model has four parts, corresponding to sub-markets for four separate maturity classes of U.S. Treasury securities. These four maturity classes are defined in terms of four distinct ranges (within 1 year, 2-4 years, 6-8 years and over 12 years), with securities in the three remaining indeterminate areas allocated to the respective preceding and succeeding ranges according to a weighting scheme designed to avoid anomalous effects that would otherwise occur when large individual debt issues cross arbitrary classification boundaries. The model for each maturity sub-market consists of a set of demand equations representing the respective net purchases of Treasury securities in that maturity class by either nine or ten categories of investors (the six listed above as corporate bond investors plus commercial banks, savings and loan associations, state and local government general funds, and, for the two shorter maturity ranges only, domestic nonfinancial business corporations).[18] The supply of securities in each maturity sub-market is exogenous to the model, and in each case a market-clearing equilibrium condition analogous to (2) determines the associated yield as in (3).[19]

The specification of each investor group's respective demand for either corporate bonds or any maturity class of government securities combines the asset demand system (1) for given wealth, generalized to allow for influences on desired portfolio allocations due to factors other than expected yields (for example, expected price inflation), with an optimal marginal adjustment model that represents in a tractable way the effect of differential transactions costs which render the allocation of new investable cash flows more sensitive to expected yields (and other influences) than the re-allocation of existing holdings.[20] The specification of the two private borrower groups' respective supplies of corporate bonds follows from an analogous treatment of the optimal choice of liabilities to finance a given cumulated external deficit. For consistency with the MPS model, all equations are estimated using quarterly data through 1976.

With the addition of the structural models of the corporate and government bond markets, the altered MPS model includes an explicit representation, as in (1) - (3) above, of the markets for six assets: money (or reserves, depending on the representation of monetary policy), four maturity classes of government securities, and corporate bonds. This system of six asset market equilibrium conditions is sufficient to determine the yields on five assets, given that of the sixth. With the yield on money (or reserves) fixed at zero, therefore, the model determines the yields on the remaining five assets that are interest-bearing in the conventional sense.[21] The yields on other assets that appear in the MPS model follow in the usual way from the original model's term-structure-like equations linking each to one of the five structurally determined yields. The Treasury bill rate, for example, directly determines the commercial paper rate, while the corporate bond rate directly determines the mortgage rate and the dividend-price yield.[22]

In all other respects, the model underlying the simulations reported in Section III is identical to the familiar MPS model. Because of the richer treatment of the determination of relative interest rates, however, the altered model (unlike the original) admits analysis of the effects of debt management policy.

## III. Empirical Assessment of the Effects of Debt Management Policies

Table 2 summarizes the results of simulations of the combined MPS-corporate-government-bond-market model for two different debt management actions: first, a sustained shift in Treasury financing to emphasize new issues of short- instead of long-term securities and, second, a one-year program to shorten the maturity structure of the outstanding Treasury debt by issuing short- and repurchasing long-term securities.[23] (The simulated effects of debt management actions in the model are sufficiently symmetrical that there is no need to show results of analogous actions to lengthen the debt.) The simulation period in both cases is the ten-quarter interval spanning 1974:IV - 1977:I.[24]

In a partial equilibrium analysis of the asset markets like that in Section I, specifying changes in policy-determined supplies of outside assets ($dS = -dL$, for example) is straightforward. By contrast, in a general equilibrium context both fiscal and monetary policy have direct implications for the supply of government securities. For example, if a change in relative asset yields due to a debt management action stimulates overall economic activity, it will also raise tax revenues and reduce transfers, and, in the absence of offsetting increases in government purchases, reduce the government deficit (or increase the surplus). As time passes, therefore, the total amount of government securities outstanding will be less than it would have been otherwise, and it is necessary to make some ahistorical assumption about the composition of Treasury financing. The simulations reported in Table 2 are based on the assumption that real government purchases are fixed and that, in this situation, the induced reduction of debt in each maturity class is proportional to the share of that class in the total Treasury debt outstanding; that is, after the deliberate debt management policy action, the Treasury finances changes from the historical total outstanding debt so as not to

TABLE 2

SIMULATED EFFECTS OF TWO DEBT MANAGEMENT POLICIES

| | | $250 Million Shift from Long to Short, All Ten Quarters | | $1 Billion Shift from Long to Short, First Four Quarters Only | |
|---|---|---|---|---|---|
| Variable | (1) Historical Mean | (2) Simulated Mean | (3) Difference from Historical | (4) Simulated Mean | (5) Difference from Historical |
| $r_{TB}$ | 5.50 | 5.68 | 0.18 | 6.17 | 0.67 |
| $r_{35}$ | 7.22 | 7.29 | 0.07 | 7.60 | 0.38 |
| $r_{68}$ | 7.59 | 7.38 | -0.21 | 7.05 | -0.55 |
| $r_{TL}$ | 6.90 | 6.66 | -0.25 | 6.35 | -0.55 |
| $r_{CB}$ | 8.61 | 8.49 | -0.12 | 8.41 | -0.20 |
| $r_{DP}$ | 4.18 | 4.13 | -0.05 | 4.06 | -0.11 |
| X | 1241.8 | 1246.3 | 4.6 | 1255.7 | 13.9 |
| IP | 37.0 | 37.4 | 0.3 | 38.1 | 1.0 |
| IE | 79.6 | 80.2 | 0.6 | 81.6 | 2.0 |
| IH | 43.8 | 45.0 | 1.1 | 46.9 | 3.1 |
| C | 798.9 | 801.1 | 2.2 | 805.5 | 6.6 |
| CUR | 75.2 | 75.3 | 0.1 | 75.4 | 0.2 |
| RNB | 34.7 | 34.5 | -0.2 | 37.0 | -0.7 |
| DF | 57.5 | 55.4 | -2.1 | 51.0 | -6.5 |
| S | 954.8 | 973.6 | 18.8 | 997.9 | 43.1 |
| PRO | 111.2 | 113.2 | 1.9 | 116.5 | 5.3 |

(Table 2 continued on the following page)

(TABLE 2 continued)

Variable Symbols:

| | | |
|---|---|---|
| $r_{TB}$ | = | 3-month Treasury bill yield (%) |
| $r_{35}$ | = | 3-5-year Treasury security yield (%) |
| $r_{68}$ | = | 6-8-year Treasury security yield (%) |
| $r_{TL}$ | = | 10-year-and-over Treasury security yield (%) |
| $r_{CB}$ | = | corporate bond yield (%) |
| $r_{DP}$ | = | dividend-price yield (%) |
| X | = | real gross national product (1972 $ billion) |
| IP | = | real investment in plant (1972 $ billion) |
| IE | = | real investment in equipment (1972 $ billion) |
| IH | = | real residential investment (1972 $ billion) |
| C | = | real consumer expenditures (1972 $ billion) |
| CUR | = | currency outside banks ($ billion) |
| RNB | = | nonborrowed reserves ($ billion) |
| DF | = | federal government deficit ($ billion) |
| S | = | market value of common stock ($ billion) |
| PRO | = | corporate profits ($ billion) |

change the maturity structure still further.[25]

Similarly, if monetary policy fixes the growth rate of either bank reserves or any given monetary aggregate, the total amount of government securities held by all private investors will decline over time as the central bank conducts the open market operations needed to accommodate the public's greater demand for currency associated with a greater level of economic activity. If monetary policy fixes the growth rate of a monetary aggregate, then yet further induced changes in the central bank's holdings will also follow as it accommodates the banking system's changing demand for nonborrowed reserves due to the public's shifting preferences for different kinds of deposits bearing different reserve requirements, as well as to any changes in banks' aggregate net free reserve position. Hence some ahistorical assumption about the composition of the central bank's portfolio is also necessary. The simulations reported in Table 2 are based on the assumption that the Federal Reserve System fixes the growth rate of the money stock (M1), that it buys or sells the amount of Treasury bills required to render consistent the values of the Treasury bill rate determined in the money market and in the shortest maturity sub-market of the government securities market model, and that, for the incremental induced changes in the size of its portfolio, it buys or sells the other three maturity classes of government securities together in proportion to their respective total amounts outstanding (so that in this respect it acts analogously to the Treasury's financing of incremental induced deficits or surpluses).[26]

Apart from the assumed changes in debt management policy that are their primary focus of attention, augmented by these additional technical assumptions about the securities transactions associated with fiscal and monetary policies, the simulations reported in Table 2 rely on historical values of all exogenous variables. Moreover, each equation in the model is adjusted by adding back the historical single-equation residuals so that, given the historical values for all exogenous variables (including supplies of each maturity class of Treasury securities), the model would exactly reproduce the historical values shown in column (1) of the table. The differences between these historical values and the simulated values shown in the table's remaining columns are therefore attributable entirely to the effect of the specified debt management actions, rather than to any underlying inability of the model to reproduce the observed historical record.

Columns (2) and (3) of Table 2 summarize the results of a simulation of the model in which, in each quarter, the Treasury issues \$250 million more short- and \$250 million less long-term securities (before adjustment for induced changes in the federal deficit). The historical amounts of short- and long-term Treasury securities outstanding as of March 31, 1977, were \$144.5 billion and \$20.1 billion, respectively, so that a change of this magnitude in debt management, even cumulated over ten quarters, is small in comparison with the former but substantial in comparison with the latter. Because of the Treasury's policy shift to lengthening the debt after 1975, in conjunction with the huge federal deficit in the wake of the 1973-75 recession, the historical amount of long-term Treasury securities outstanding increased by \$7.3 billion during these ten quarters. In the simulation the increase is only \$4.5 billion.[27] Column (2) shows ten-quarter simulated means for selected financial and nonfinancial variables, and column (3) shows the respective differences between these simulated means and the historical means shown in column (1).

The simultated effect of this change in outside asset supplies on the Treasury yield curve, shown in the first four lines of the table, corresponds to presumptions based on the theory of portfolio behavior and interest rate determination outlined in Section I. The Treasury bill rate rises and the long-term bond rate falls, in comparison to the historical values, and the relative movements in the rates on the two intermediate maturity classes lie between the two extremes.[28] Similarly, the effects on private asset yields correspond to familiar notions of relative asset substitutabilities. The average relative yield decline for corporate bonds is only half that for long-term government bonds, while the relative decline for the equity yield is smaller still.

The next five lines of the table indicate the effects of this debt management action on both the amount and the composition of real economic activity. Real output is greater than the historical by nearly one-half percent on average. Moreover, because of the sensitivity of investment to cost-of-capital factors, fixed capital formation accounts for a disproportionate amount of the increase. The three categories of fixed investment, which together comprised only one-eighth of total spending, account for nearly one-half of the simulated increase over the historical. Hence the results support the suggestion that a shift away from the Treasury's recent debt management policy would enhance the U.S. economy's rate of capital formation.[29]

The bottom five lines of the table present values for additional financial variables that are useful for understanding the structure of the simulation. The induced effects on the Federal Reserve's portfolio are small, given the assumption that it fixes the M1 money stock. Small open market purchases are necessary to accommodate the public's increased demand for currency, but slightly larger open market sales are necessary to accommodate member banks' reduced demand for nonborrowed reserves due to smaller holdings of demand deposits and larger discount window borrowings.[30]

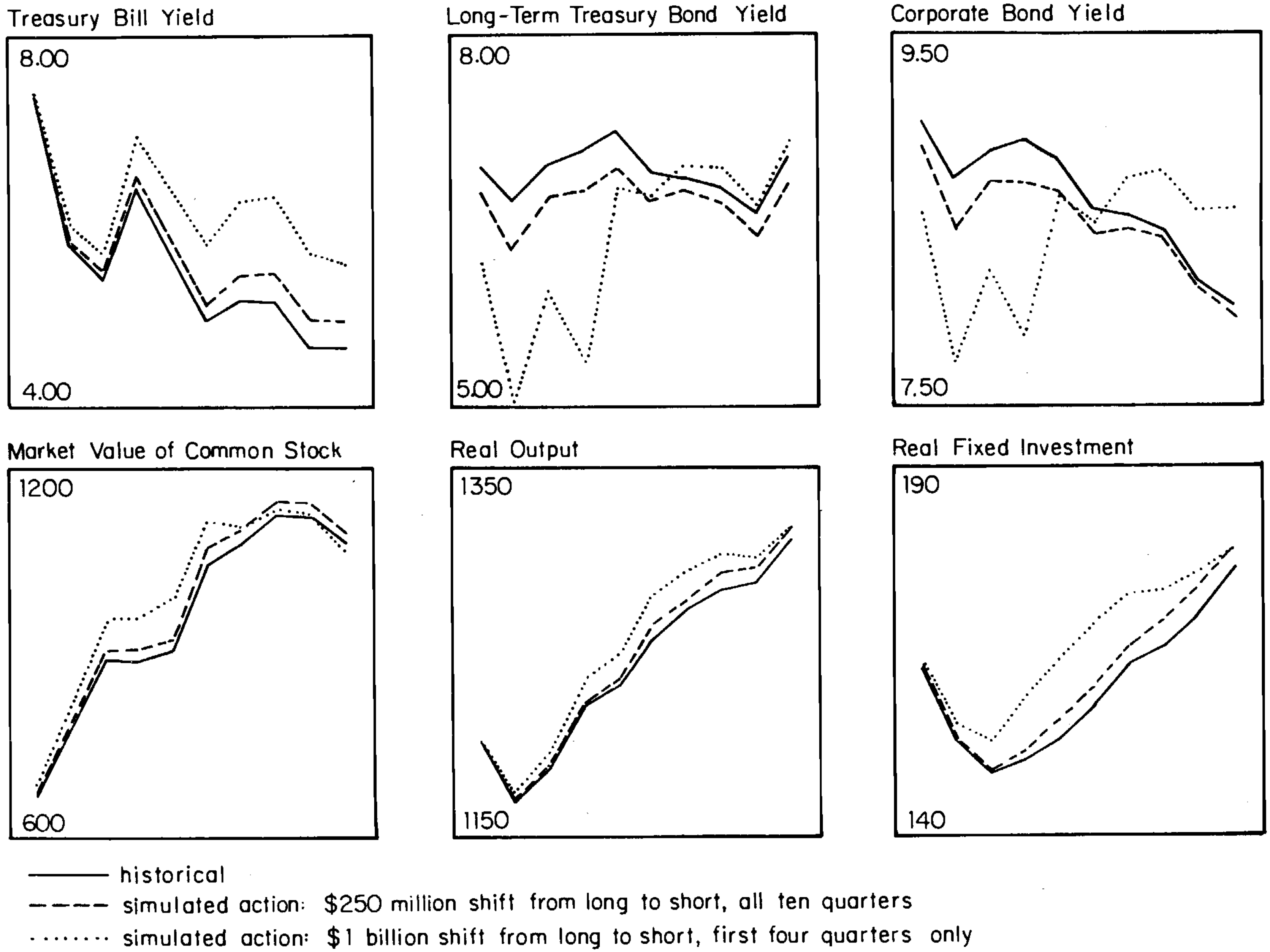
By contrast, the induced effects on the total amount of Treasury securities outstanding are more substantial. A large increase in tax revenues and a small decline in transfer payments reduce the federal deficit and hence reduce the required volume of Treasury financing.[31] Finally, an apparent puzzle in the simulation is that the increase in consumer spending is surprisingly large in comparison to the small fall in the dividend-price yield, given the underlying MPS model's reliance on the life-cycle model of consumption. The explanation, as shown in the table, is that equity prices do rise substantially, in large part because of an increase in corporate profits (which in turn raises dividends).

Figure 1 provides further information about these results by plotting the historical (solid) and simulated (broken) paths, quarter by quarter for all ten quarters, for six key variables. The increase in the Treasury bill rate, in comparison to the historical, takes place gradually. By contrast, the relative decline in the long-term Treasury bond rate occurs within two quarters, while the relative decline in the corporate bond rate also occurs within two quarters but then almost disappears after another six. The relative increase in equity prices reaches its peak after six quarters. The stimulative effect of these financial developments on real output is near its peak by the sixth quarter, but in fact continues to build through the ninth quarter and then declines only trivially in the tenth. The stimulative effect on real capital formation follows a roughly similar path, with a peak in the eighth quarter and a negligible decline thereafter.

Columns (4) and (5) of the table summarize the results of a simulation of the model in which, in each of the first four quarters, the Treasury issues $1 billion more short-term securities and repurchases enough long-term securities to reduce the net flow supply of the latter by $1 billion

FIGURE 1

SIMULATED EFFECTS OF TWO DEBT MANAGEMENT ACTIONS




Note: The simulation period plotted is 1974:IV - 1977:I.

relative to the historical (before adjustment for changes in the federal deficit). For the remaining six quarters of the simulation, debt issues follow the historical proportions. Such a one-year bill-bond swap program would represent a major debt management operation, especially in the context of the limited size of the long-term Treasury bond market. From $12.7 billion as of September 30, 1974, the outstanding amount of long-term Treasury securities in the simulation falls to $10.3 billion a year later, in contrast to the historical rise to $14.5 billion.[32] Column (4) shows the simulated ten-quarter means, and column (5) shows the respective differences between these simulated means and the historical means in column (1).

The average effects of this one-year swap on the structure of asset yields are analogous to, but for each yield greater than, the average effects of the sustained change in the maturity of new issues studied in the first simulation. Within the Treasury yield curve, once again the bill rate rises and the long-term rate falls in comparison to the corresponding historical levels. The rate for the second maturity class again moves in the same direction as that for the first, and again by about half as much, while this time the rate for the third maturity class moves exactly as much as that for the fourth. The relative declines in the corporate bond yield and the dividend-price yield are of about the same proportion, when compared to the relative decline in the long-term Treasury yield, as in the first simulation.

The associated effects on real economic activity are also similar, though larger throughout. Real output is greater by about one percent on average, with fixed capital formation again accounting for nearly one-half of the increase. The Federal Reserve's holdings of Treasury securities decline more substantially in comparison to the first simulation, almost entirely as a result of the reduced demand for nonborrowed reserves associated with greater discount window borrowings,[33] and the decline in the total amount of Treasury securities outstanding is also more substantial as a result of the stimulation of additional tax revenues. The combination of a steeper relative decline in the dividend-price yield and a greater rise in corporate profits (and hence dividends) leads to a much larger rise in equity prices than in the earlier simulation.

Although comparison of the ten-quarter means shown in Table 2 suggests that the economic effects of the one-year swap are just an enlarged mirror of the effects of the sustained change in new issue design, the quarter-by-quarter time paths plotted in Figure 1 (the dotted lines) make clear that this is not so. The most immediate contrast is in the effects on the long-term asset markets — including the long-term Treasury bond yield, the corporate bond yield, and the price of equities. These effects in each case build irregularly during the four quarters in which the debt management action is in progress, but then decline rapidly thereafter and even change sign during the latter part of the simulation.

The increase in real output in comparison to the historical reaches a peak, equal to nearly two percent of the corresponding historical output, in the sixth quarter. Thereafter it too erodes rapidly, so that by the tenth quarter the respective output paths for the two simulations converge. The peak effect on fixed investment also occurs in the sixth quarter, after which the increase erodes especially rapidly because of the effects of high short-term interest rates on residential construction (which falls below the historical by the end of the simulation period).

The Treasury bill rate is the one variable for which the time path resulting from the one-year swap most nearly resembles that from the sustained debt management change. The increase in the bill rate in comparison with the historical continues to build almost until the end of the simulation period, when the effect on real income has largely eroded.

The contrasts between these two simulations indicate that, in addition to the magnitude, the timing of a debt management action affects its impact on the economy. This result is not surprising in light of the basic model of portfolio adjustment underlying both the corporate and the government bond market models. Because the adjustment model distinguishes between investors' allocation of new cash flows and re-allocation of existing holdings (and draws an analogous distinction between private borrowers' financing of new external deficits and refinancing of existing liabilities), in the short run financial flow variables matter in addition to stock variables.[34] Hence the size of a debt management action in relation to other flows in the financial system is a key determinant of its effects.

More importantly, however, despite their contrasts the two sets of results both indicate that debt management actions have effects, on interest rates as well as nonfinancial economic activity, which not only are in accordance with familiar theory but also are of a size deserving attention.

## IV. Summary of Conclusions

The maturity structure of the U.S. government's outstanding debt has undergone large changes over time, at least in part because of shifts in the Treasury's debt management policy. During most of the post World War II period, an emphasis on short-term issues rapidly reduced the debt's average maturity. In the early 1960s and again since 1975, however, the opposite policy just as rapidly lengthened (and is now lengthening) the average maturity.

Debt management actions do not leave other aspects of economic activity unaffected. In the financial markets changes in the relative supplies of outside assets in general alter the structure of expected yields on all assets whether outside or inside, raising the relative yield on the asset with supply increased and on assets closely substitutable for it, and lowering the relative yield on the asset with supply decreased and on its close substitutes. In a general equilibrium context the resulting realignment of asset yields and prices also affects nonfinancial economic activity.

Simulation experiments indicate that debt management actions of a magnitude comparable to observed changes in U.S. debt management policy have sizeable effects both in the financial markets and more broadly. In particular, a shift from long- to short-term government debt lowers yields on long-term assets (and raises their prices), raises yields on short-term assets, and in the short run stimulates output and spending. Moreover, the stimulus to spending is disproportionately concentrated in fixed investment, so that debt management actions shortening the maturity of the government debt not only increase the economy's output but also shift the composition of output toward increased capital formation.

## Footnotes

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1. The distribution data in Table 1 slightly understate the shift to shorter maturities because of the switch from a first-call classification for 1945-55 to a final-maturity classification for 1960-80. (The first-call breakdown for 1960, corresponding to that shown in the table, is 43.0%, 39.7%, 9.6%, 2.4%, 5.2%). The mean maturity computation is based on final maturity and is consistent throughout.

2. The specific form of (1), if all assets are risky, is $B = -\frac{1}{\rho}[\Omega^{-1} - (\underline{1}'\Omega^{-1}\underline{1})^{-1}\Omega^{-1}\underline{1}\,\underline{1}'\Omega^{-1}]$ and $\underline{\pi} = (\underline{1}'\Omega^{-1}\underline{1})^{-1}\Omega^{-1}\underline{1}$, where $\rho$ is the coefficient of relative risk aversion and $\Omega$ is the variance-covariance matrix. Here B is singular, so that the asset demand system will be capable of determining all relative yields and all but one absolute yield. Alternatively, in the presence of a risk-free (certain return) asset the full $\Omega$ matrix is singular, so that it is necessary to partition the set of demands; the resulting asset demand system, in which $\underline{A}^D$, $\underline{r}^e$ and $\Omega$ refer to the risky assets only, is then just $\underline{A}^D = W \cdot (B\underline{r}^e)$ where $B = \frac{1}{\rho}\Omega^{-1}$, and the optimal portfolio demand for the risk-free asset is simply $(W - \underline{A}^{D'}\underline{1})$. See Friedman and Roley [16] for a proof that constant relative risk aversion and joint normal asset return assessments imply asset demand functions that are homogeneous in wealth and linear in expected returns, and Roley [25] for a thorough treatment of the distinction between the cases with and without a risk-free asset. (The combination of constant relative risk aversion and normal distributions is only an approximation, in that the underlying utility function is undefined for negative wealth values.)

3. See Lintner [20] and Friedman [13] for explicit treatments of the case of heterogeneous investors.

4. Because the full B matrix is singular (see again footnote 2), the expression in (3) actually has dimension reduced by one and therefore represents the determination of relative yields against an arbitrary fixed benchmark in the case of all risky assets or against the certain yield in the presence of a risk-free asset. An isomorphic interpretation of (3) is that relative asset returns depend on shares in the market portfolio relative to shares in the minimum-variance portfolio.

5. Including an additional term to represent the dependence of the demand for money (and hence at least one other asset) on income, in accordance with standard transactions-inventory models, would not alter the analysis here; see Friedman [11].

6. See Roley [25] on the implications of a symmetric Jacobian.

7. The condition $dS = -dL$ holds exactly in a timeless abstraction in which, with no prior history of assets outstanding, the government distributes one kind of bond or the other, or both. In a more realistic context however, wealth does change because of valuation changes on the outstanding long-term bonds. For example, to anticipate the analysis that follows, suppose that the government issues short-term bonds and uses exactly the entire proceeds to buy back some of its outstanding long-term bonds. If that action reduces the yield on the long-term bonds still outstanding, the associated rise in these bonds' price will raise total wealth. The reasoning is analogous to that argued below for the case of valuation of capital. See Roley [26] for a theoretical discussion emphasizing changes in bond prices resulting from debt management actions.

8. See Blanchard and Plantes [ 2 ] for a statement of necessary and sufficient conditions for gross substitutability. The covariance matrices reported in Bodie [ 3 ] suggest that, for broad asset categories like those under consideration here, at least the necessary conditions are met in practice.

9. See again footnote 7.

10. As Feldstein and Chamberlain [ 7 ] have pointed out, however, the presence of the unlagged short-term interest rate as a supposedly independent variable precludes most such equations from being valid reduced forms. In this context see also Sargent's [29] criticism of the interest rate equation suggested by Feldstein and Eckstein [ 8 ], as well as the empirical evidence in Sargent [30].

11. The most comprehensive attempt to find evidence of such effects was that of Modigliani and Sutch [23]. An example of results exhibiting such effects is in Okun [24], but Okun concluded that the effects were small.

12. The term-structure equation estimated in Friedman [10], using Fair's [6 ] method and quarterly data for 1960:I - 1976:II, was

$$r_{\ell t} = \underset{(0.1)}{0.000546} + \underset{(19.0)}{0.902}\, r_{\ell,t-1} + \underset{(4.4)}{0.265}\, r_{st} - \underset{(-2.8)}{0.137}\, r_{s,t-1} + \underset{(1.7)}{0.0535}\, \Delta(L-S)_{t-1}$$

$$\bar{R}^2 = 0.97 \qquad SE = 0.0234 \qquad e = 0.592$$

where $r_\ell$ and $r_s$ are the yields on Baa-rated corporate bonds and 3-month Treasury bills, respectively, L and S are the outstanding amounts of U.S. government securities maturing in more than and less than one year, respectively, all variables are expressed in natural logarithms, and the numbers in parentheses are t-statistics. Estimating the same equation using data through 1980:IV gives essentially similar results (including a coefficient of 0.0550, with t-statistic 1.8, on the debt-management term).

13. See Friedman and Roley [17] for a general discussion of the structural and reduced-form approaches to modeling the determination of interest rates.

14. What matters in this context is the contribution of equities not to the level but rather to the variation of households' wealth. Given the great volatility of equity prices in contrast with the fixed-price nature of deposits, the typical 30% share of equities in households' total wealth greatly understates the role of equities in accounting for the variations of household wealth over time.

15. The most important element of financial quantity variables' effects on nonfinancial behavior in the MPS model is the credit availability effect in the mortgage market; see de Leeuw and Gramlich [ 5 ] and the papers by Gramlich and Hulett, Modigliani, and Jaffee in Gramlich and Jaffee [18].

16. The model takes as exogenous the net bond purchases and sales of all investors and issuers other than those noted above. The explicitly modeled investors and issuers account for about 95% and 90%, respectively, of all corporate bonds issued in the United States.

17. The particular bond rate used in this model is the observed new-issue yield on long-term utility bonds rated Aa by Moody's Investor Service, Inc. An additional equation then determines the Aaa seasoned corporate yield, the bond rate used in the MPS model, as a simple direct function of the Aa new-issue yield and the longest-term government yield. Eliminating the Aaa seasoned yield altogether and using the Aa new-issue yield in its place would require re-estimating each MPS model equation in which the corporate bond rate appears.

18. The model takes as exogenous the net bond purchases of all investors other than those noted above. The explicitly modeled investors account for about 55% of all holdings of U.S. Treasury securities. The Federal Reserve System (24%) and foreign investors (18%) account for most of the remainder.

19. The particular yields corresponding to the four maturity ranges are the Treasury yields on 3-month bills and bonds in the 3-5-year, 6-8-year, and 10-year-and-over groups.

20. See Friedman [9] for the development of the optimal marginal adjustment model used in all of the corporate bond demand and supply equations and most of the government security demand equations, and Roley [28] for the development of a more general alternative used in some of the government security demands (especially those for commercial banks).

21. If the estimation of the six sets of asset demand (and supply) equations imposed the full set of balance sheet constraints for all investors (and private-sector borrowers), solving the model would simply involve deleting the equilibrium condition for any one market chosen arbitrarily. Imposing these constraints, however, would have required also re-estimating the MPS model's aggregate money demand equation. In fact, the constraints are not fully imposed, and hence the model is overdetermined. In the simulations reported in Section III below, the composition of the Federal Reserve's portfolio is adjusted in each period so as to render consistent the Treasury bill rate proximately determined in the money market and the Treasury bill rate proximately determined in the shortest maturity sub-market of the government securities market model (see the discussion in Section III). Analogous simulations, based on an alternative solution procedure in which the Treasury bill rate is proximately determined in the government securities market model and the MPS model's money demand equation is deleted, differ in some specifics but yield the same overall results.

22. At least in principle, a fully comprehensive structural model of all asset markets would be preferable. For efforts along these lines see Bosworth and Duesenberry [4], Hendershott [19] and Backus et al. [1]; none of these models, however, distinguishes between government and corporate bonds and among maturity classes of government securities as in the model used here.

23. Because the U.S. Treasury does not ordinarily repurchase its outstanding long-term bonds, it is perhaps easiest to think of such a one-year program as carried out by Federal Reserve open market operations.

24. Carrying out the investigation under conditions of underutilized resources in the economy is probably best because of familiar concerns about the underlying MPS model's representation of economic behavior near full employment. As is apparent from Figure 1 below, 1974:IV is the quarter immediately preceding the trough of the large 1973-75 recession. This period was also an interesting one in the context of the historical debt management policy; see again Section I.

25. With government purchases fixed in real terms, there is some slight offset to the increased tax revenues due to the rising price level. This effect is small in a ten-quarter simulation, however, so that most of the rise in revenues simply reduces the deficit. It is perhaps useful to note explicitly that this way of treating the financing of the induced reduction in government debt outstanding assumes, as in Tobin [31], that the Treasury is not pursuing a policy of minimizing interest costs (at least at this particular margin).

26. See again footnote 21. Here, too, the assumption is that the Federal Reserve does not act to maximize interest earnings on its portfolio.

27. The outstanding supply of long-term Treasury securities at the end of the ten quarters in the simulation is lower than the historical by \$2.88 billion instead of \$2.50 billion (10 quarters times \$250 million per quarter) because of the smaller total volume of Treasury financing due to the induced rise in tax revenues and fall in transfers.

28. An interesting result is the apparent strong substitutabili y between securities in the third and fourth maturity classes. This result appears even more strongly in the second simulation, reported in columns (4) and (5).

29. See Friedman [14] for a discussion of this proposal. The general result that quantitative actions to alter the supply-demand balance in the credit market have a disproportionate effect on capital formation also holds for the case of shifts in saving flows, analyzed in Friedman [15].

30. The public's shift from demand deposits to currency, within a fixed M1 total, is the conventional result associated with greater real income and higher short-term interest rates. The small increase in borrowed reserves occurs mostly because the simulation holds the discount rate fixed despite the rise in short-term market rates.

31. The reduction of the deficit is surprisingly large for the associated increase in income, even after allowance for the difference between nominal and real magnitudes. (The GNP deflator's historical average during this period was 130.3.)

32. The difference is \$4.22 billion instead of \$4.0 billion (4 quarters times \$1.0 billion per quarter) because of the smaller total volume of Treasury financing due to the induced rise in tax revenues and fall in transfers. By the end of the simulation period the outstanding amount is \$5.19 billion less than the historical.

33. See again footnote 30.

34. See Friedman [ 9 ] for a discussion of the rationale underlying the role of financial flow variables in interest rate determination in the short run. In the long run, only the stocks matter.

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