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ASSET SUBSTITUTABILITY AND THE IMPACT OF FEDERAL DEFICITS

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ABSTRACT

In this paper, the role of asset substitutability in determining the impact of debt-financed federal deficits is examined. The issues are first discussed in the context of a simple analytical model in which financial assets are disaggregated into money, federal debt, and corporate bonds. In this model, it is shown that depending on the degree of substitutability among financial assets, a range of possible outcomes associated with a change in the federal deficit is possible. Next, the issue of asset substitutability is examined empirically in a disaggregated structural model of the Treasury security, corporate bond, and equity markets. Using this model, the implications of larger debt-financed federal deficits are then examined in a series of simulation experiments.

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ASSET SUBSTITUTABILITY AND THE IMPACT OF FEDERAL DEFICITS

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The large federal deficits since 1975, and the prospect of their further rapid expansion through the mid-1980s, have caused greater attention to be focused on the economic consequences of federal deficits. Much of the discussion has centered on the issue of whether a rise in the deficit crowds out interest-sensitive private spending. This discussion is properly directed, as a vast majority of deficits since the late 1960s have been debt financed. In particular, while marketable Treasury securities net of Federal Reserve holdings actually declined during the 1964-69 period, private investors have purchased about 85 percent of the cumulative rise in federal debt since 1969. Moreover, during 1980 and 1981, private investors purchased over 90 percent of the rise in outstanding federal debt.[1/]

Any of several conditions have been shown to imply situations in which a debt-financed increase in the federal deficit due to a rise in government expenditures crowds out an equal amount of private expenditures, even in the short run.[2/] One unambiguous case emerges when all factors of production are already fully employed [e.g., M. Friedman (1970)]. However, even in the presence of unemployed resources, if households view the tax liability associated with an increase in federal debt as being equal to the value of the debt, then debt-financed increases in government spending would again crowd out private spending [e.g., Bailey (1971), Barro (1974), and Kochin (1974)]. That is, if the Ricardian equivalence theorem holds, systematic fiscal policy cannot affect aggregate demand.[3/]

In the absence of full employment and Ricardian equivalence, Tobin (1961,1963) and subsequent writers have noted that the extent of short-run crowding out depends on the substitutability among assets. If federal debt and private capital are perfect substitutes, for example, complete crowding out is again possible if the demand for money depends on wealth [e.g., Silber (1970) and Meyer (1975)]. However, if money and federal debt are perfect substitutes, a debt-financed increase in the deficit causes total spending to rise. Allowing imperfect substitutability among money, federal debt, and capital, the possible outcomes span these extremes and therefore range from crowding out to crowding in [e.g., B. Friedman ([1978)]. Moreover, even if federal debt and capital are perfect substitutes, Blinder and Solow (1973) have demonstrated that bond-financed deficits may be more stimulative than those that are money-financed in the long run.[4/]

The purpose of this paper is to examine empirically the role asset substitutability plays in determining the impact of federal deficits on interest rates and capital formation. In the first section, the issues are examined in a simple analytical model including three assets: money, federal debt, and corporate bonds. Following B. Friedman (1978), the impact of federal deficits is shown to depend primarily on the relative magnitudes of the interest-rate coefficients in the aggregate demands for these three assets. The empirical model used to evaluate asset substitutability is presented in the second section. The model consists of estimated demands for corporate bonds, equities, and four different maturity classes of Treasury securities by 11 disaggregated investor categories. In the third section, the short-run impact of deficits on interest rates is estimated using simulations in which the supply of each of the four maturity classes of Treasury securities is separately increased in each period. The dynamic effects of deficit shocks are then calculated in this partial equilibrium framework. The general equilibrium effects of deficits on both interest rates and capital formation are considered in the fourth section. These general equilibrium effects are obtained from the model developed by B. Friedman (1981,1982), which in turn is comprised of the disaggregated asset demands estimated by Roley (1980,1982) combined with the MIT-PENN-SSRC (MPS) model. The main conclusions of this paper are summarized in the final section.

ISSUES IN A SIMPLE ANALYTICAL MODEL

In this section, a basic analytical model is presented to consider the role of asset substitutability in determining the impact of a change in the federal deficit on interest rates.[5/] Two permutations of this simple model are also considered. First, the corporate financing decision is endogenized to examine whether substitutability between financing alternatives moderates the impact of deficits on interest rates. Second, similar effects are investigated in the context of financial intermediation. Although the empirical results reported in later sections are obtained from a disaggregated structural model comprised of 51 behavioral equations, the empirical model in its aggregated form is similar to the illustrative models analyzed here.

In each of the models presented below, only the financial effects of an increase in the federal deficit are considered. Thus, income is exogenous and the financial effects examined are analogous to shifts in the LM curve in traditional IS-LM analysis. Using B. Friedman's (1978) terminology, such shifts in the LM curve determine the amount of "portfolio crowding out," which is separate from the amount of "transactions crowding out." This latter effect corresponds to the movement along a given LM curve associated with shifts in the IS curve. As long as the LM curve has a positive slope, some transactions crowding out—and a subsequent rise in interest rates—will occur in response to stimulative fiscal actions. However, if the LM curve is not vertical, transactions crowding out cannot be of sufficient magnitude to inhibit altogether a rise in total spending. Thus, the question of whether crowding out is complete depends also on the sign and magnitude of the portfolio crowding out effect considered below. Moreover, depending on the substitutability among assets, some portion of transactions crowding out could actually be offset resulting in an unambiguous rise in total spending with perhaps only a trivial rise in interest rates.

To investigate these questions, the first model considered is comprised of the aggregate demands for money (M^d), federal debt (T^d), and corporate bonds (B^d):

$$\begin{aligned} M^d &= \beta_{mt} r_t + \beta_{mb} r_b + \gamma_m W + \delta_m Y \\ T^d &= \beta_{tt} r_t + \beta_{tb} r_b + \gamma_t W + \delta_t Y \\ B^d &= \beta_{bt} r_t + \beta_{bb} r_b + \gamma_b W + \delta_b Y \end{aligned} \qquad (1)$$

where

r_t, r_b = yields on Treasury securities and corporate bonds, respectively

W = financial wealth

Y = income

β_{ij}, γ_i, δ_i(i,j=m,b,t) = coefficients.

Throughout this section, it is assumed that own-yield and wealth elasticities of demand are nonnegative such that $\beta_{ii}>0$, $0\leqq\gamma_i\leqq 1$, (i=t,b), and that assets are not gross complements [$\beta_{ij}\leqq 0$, $i\neq j$, (i,j=m,t,b)].[6/] The Brainard-Tobin (1968) portfolio balance conditions place further restrictions on the coefficients, and they may be represented as

$$\beta_{mt} + \beta_{tt} + \beta_{bt} = 0$$

$$\beta_{mb} + \beta_{tb} + \beta_{bb} = 0$$

$$\gamma_m + \gamma_t + \gamma_b = 1$$

$$\delta_m + \delta_t + \delta_b = 0.$$

In this model, the interest-bearing securities are assumed to have variable coupons and fixed market values, and businesses are assumed to finance all capital accumulation with bonds. It is also assumed that the cumulative supply of bonds (B^s) equals the value of the capital stock, K. Thus, total wealth has the usual representation

$$W = M + T + K. \quad (2)$$

Combining the aggregate demands (1) with fixed supplies of money (M^0), Treasury securities (T^0), and capital ($K^0=B^s$), the model determines two endogenous yields, r_t and r_b. Because of its presumed effect on business investment decisions and hence total spending, the impact of bond-financed deficits on the corporate bond rate is examined here. That is, the corporate bond rate is taken as the relevant rate for the IS curve.

Following Christ (1968), Silber (1970), and Meyer (1975), any increases in government expenditures (G) or decreases in taxes (R) are related to increases in federal debt and outside money through the government budget constraint

$$dG - dR = dT + dM. \tag{3}$$

In the case of a bond-financed increase in the deficit, dM=0 and dT=dW>0, the impact on the corporate bond rate may be expressed as

$$\frac{\partial r_b}{\partial T} = \frac{-(1-\gamma_t)\beta_{bt} - \gamma_b\beta_{tt}}{\beta_{tt}\beta_{bb} - \beta_{tb}\beta_{bt}} \tag{4}$$

where the denominator is positive if all assets are gross substitutes. Thus, the presence of portfolio crowding out or crowding in depends on the numerator. In turn, the sign and magnitude of the numerator depends on the degree of asset substitutability and the effect of wealth on the individual demands.

With the above assumptions, it can be shown that if wealth does not affect money demand (γ_m=0), then a rise in the deficit unambiguously reduces the corporate bond rate and therefore leads to crowding in. In this case, the wealth effects on the demands for interest-bearing securities more than offset the impact of the rise in the supply of Treasury securities. Alternatively, if the demands for Treasury securities and corporate bonds are not functions of wealth (γ_m=1), a bond-financed increase in the deficit unambiguously leads to crowding out. Interest rates must rise in this case to offset the increased demand for money due to the rise in wealth.

The interest-rate coefficients in the demands—which relate directly to asset substitutability—are equally important in determining the impact of larger deficits on the corporate bond rate. As others have previously noted, if money and Treasury securities are close substitutes, implying that β_{bt} is near zero, then bond-financed increases in the deficit cause the corporate bond yield to fall. Alternatively, if Treasury securities and corporate bonds are close substitutes, leading to a value of $-\beta_{bt}$ near β_{tt}, crowding out is the result.[7/] For asset substitutability between these extremes, the outcome could be either crowding out or crowding in.

Corporate Financing Decision

In the model examined above, businesses are assumed to finance capital accumulation solely by selling bonds. This assumption is now relaxed in perhaps the simplest manner by allowing corporations to either sell bonds or reduce their money holdings to finance investment spending. As is shown below, the extent of crowding out or crowding in is reduced if corporations view alternative funding sources as substitutes.

In this extended model, corporations are assumed to demand money and supply bonds according to

$$\begin{aligned} M^c &= b_{mb} r_b + b_m K + b_{my} Y \\ B^s &= b_{bb} r_b + b_b K + b_{by} Y \end{aligned} \qquad (5)$$

where the coefficients b_{ij}, b_i, b_{iy} (i,j=m,b) satisfy

$$b_{bb} \leq 0,\ 0 \leq b_b, b_m \leq 1,\ 0 \leq b_{by}, b_{bm} \leq 1$$

as well as the portfolio-balance constraints

$$b_{bb} - b_{mb} = 0,\ b_b - b_m = 1,\ b_{by} - b_{my} = 0. \qquad (6)$$

Implicit in equation (6) is the constraint $K = B^s - M^c$. The aggregate demands for assets by households (1) are assumed to remain unchanged, but equilibrium in the money market is now described by the market-clearing identity

$$M^d + M^c = M^0.$$

Combining equations (1) and (5), the impact of a bond-financed increase in the deficit on the corporate bond rate may be determined as before. In this case, it may be shown that the impact is

$$\frac{\partial r_b}{\partial T} = \frac{-(1-\gamma_t)\beta_{bt}-\gamma_b\beta_{tt}}{\beta_{tt}(\beta_{bb}-b_{bb})-\beta_{tb}\beta_{bt}} . \qquad (7)$$

Under the reasonable assumption that the supply of bonds is negatively related to the corporate bond rate ($b_{bb}<0$), the impact on this rate (7) is unambiguously less in absolute value than that in the previous case (4). Not surprisingly, then, allowing some substitutability among corporate financing decisions moderates the effect of increased deficits on the corporate bond rate. The importance of substitutability in the corporate-financing decision is empirically examined in the third section.

Financial Intermediation

If the portfolio behavior of financial intermediaries such as banks, insurance companies, and pension funds is different from that of households due to regulation or other institutional features, and if households do not view intermediaries simply as mutual funds and adjust their own portfolio behavior accordingly, then financial intermediation may modify the impact of increased deficits on interest rates. Indeed, Hansen (1973) and Meyer and Hart (1975) have examined such effects in a model similar to that employed here, and found that the addition of financial intermediaries alters the crowding-out effect in a nontrivial way. Because financial intermediaries are explicitly represented in the empirical model discussed in subsequent sections, it may be useful to examine their impact in the context of the illustrative framework presented above.

In the model, banks are taken as the representative intermediaries and they are assumed to hold required reserves (RR), excess reserves (ER), and corporate bonds (B^b). The sum of their asset holdings equals total money liabilities (M) and net worth (NW). The behavior of these intermediaries is described by the following set of equations

$$\begin{aligned} H &= RR + ER \\ RR &= \alpha M \\ ER &= c_{eb} r_b + c_e (NW+M-RR) \\ B^b &= c_{bb} r_b + c_b (NW+M-RR) \end{aligned} \tag{8}$$

where H represents outside money and the coefficients satisfy

$$0 \leqq \alpha \leqq 1, \quad 0 \leqq c_{bb} \leqq 1, \quad 0 \leqq c_e, c_b \leqq 1$$

as well as the portfolio adding-up restrictions

$$c_{eb} + c_{bb} = 0, \quad c_e + c_b = 1. \tag{9}$$

Thus, for a given required reserve ratio (α), banks determine their allocation of assets between excess reserves and bonds. In addition, the market-clearing condition for bonds now becomes

$$B^d + B^b = B^s$$

and household wealth may be expressed as[8/]

$$W = H + T + K.$$

Combining equation (8) with equations (1) and (5), the impact of a bond-financed increase in the deficit on the corporate bond rate may be shown to equal

$$\frac{\partial r_b}{\partial T} = \frac{[-(1-\gamma_t)\beta_{bt}-\gamma_b\beta_{tt}]-(1-\gamma_t)c_b(1-\alpha)\beta_{mt}-\gamma_m c_b(1-\alpha)\beta_{tt}}{[\beta_{tt}(\beta_{bb}-b_{bb})-\beta_{bt}\beta_{tb}]+\beta_{tt}[c_{bb}+c_b(1-\alpha)(\beta_{mb}+b_{mb})]-c_b(1-\alpha)\beta_{mt}\beta_{tb}} . \quad (10)$$

The effects of financial intermediation may be illustrated by several special cases. First, if the required reserve ratio equals one ($\alpha=1$), then the impact of an increased deficit (10) is unambiguously smaller in absolute value than before if banks exhibit some interest elasticity in their allocation of net worth between excess reserves and bond holdings. Second, this same result follows if banks' demand for bonds has zero elasticity with respect to the value of total discretionary asset holdings ($c_b=0$). Finally, in comparison to equation (7), changes in the interest sensitivity in banks' portfolio allocation (c_{bb}) have ambiguous effects. As a whole, the presence of financial intermediation may accentuate or diminish any crowding-out or crowding-in effect.

To summarize, simple extensions to the illustrative model considered at the outset can significantly alter the portfolio crowding-out effect. Before turning to the empirical investigation of the crowding-out effect, the empirical analogue of the analytical model discussed in this section is presented.

SPECIFICATION AND ESTIMATION OF THE MODEL

Various aspects of the empirical model used to estimate the impact of bond-financed deficits on interest rates are discussed in this section.[9/] The model consists of disaggregated demands for Treasury securities, corporate bonds, and equities by 11 categories of investors. The yields on these securities are determined from market-clearing identities which equate aggregate demands with supplies for each type of security. As such, the reduced-form expressions for security yields implicit in the model are restricted by the underlying portfolio behavior of the different categories of investors.[10/] Thus, as was the case in the illustrative model considered in the previous section, the substitutability among assets in the individual asset demands is a primary determinant of the impact of bond-financed deficits on interest rates.

Specification

The approach used to specify the financial asset demands attempts to capture the basic determinants of investors' short-run portfolio allocation. One such determinant is surely the risk-return trade-off associated with different attainable portfolios. This trade-off may be modeled formally using the mean-variance portfolio selection model, which serves to identify investors' desired portfolios in terms of their risk aversion and the risk and return characteristics of individual securities. Following Friedman and Roley (1979b), the mean-variance model may be shown to be consistent with the following linear homogenous demands:

$$\alpha^*_{it} = A^*_{it}/W_t = a_{i0} + \sum_j b_{ij} r^e_{jt} + \sum_k c_{ik} \sigma_{kt}, \quad i=1,\ldots,N \qquad (11)$$

where the α^*_{it} are desired portfolio shares, the A^*_{it} are desired asset holdings in dollars, $W(=\sum_i A^*_{it})$ is total portfolio wealth, the r^e_{jt} are expected asset yields, and the σ_{kt} are variances associated with these yields. These latter terms are added to the asset demands obtained from utility maximization to represent the possible nonstationarity of yield variances—i.e., changes in the riskiness of different types of securities over time. The a_{i0}, b_{ij}, and c_{ik} are fixed coefficients that satisfy the usual adding-up constraints

$$\sum_i b_{ij} = \sum_i c_{ik} = 0, \text{ for all } j \text{ and } k,$$

and $$\sum_i a_{i0} = 1.$$

Although, investors desire to hold the portfolio shares described in equation (11), actual short-run portfolios are often thought to be different from those desired due to transactions costs. Because of this important role of transactions costs, their effects should be represented with some care. In this respect, the general portfolio adjustment model used here distinguishes among the costs associated with reallocating the securities currently held by the investor, the smaller costs associated with purchasing securities from new investable wealth flows, and the possible asymmetric costs in buying and selling securities.[11/] Analytically, all of these features are represented in the model

$$\Delta A_{it} = \sum_k^N \pi_{ikt}(\alpha^*_{kt}W_{t-1} - A_{k,t-1}) + \delta_{it} \cdot \Delta W_t, \quad i=1,\ldots,N \qquad (12)$$

where ΔA_{it} represents net purchases of asset i; the indices i and k (i,k=1,...,N) are associated with endogenous assets; δ_{it} describes the marginal allocation of new investable wealth flows ΔW_t; and the π_{ikt} are flexible portfolio adjustment parameters.

One way this model (12) differs from the standard stock adjustment model is that it allows wealth flows to affect the reallocation of assets already held in investors' portfolios. In particular, the parameter describing the adjustment of last period's assets $A_{k,t-1}$ to those desired $\alpha^*_{kt}W_{t-1}$ is not constant. Instead, this parameter is defined as

$$\pi_{ikt} = \Theta_{ik} + \psi'_{ik}(\Delta W'_t/W_{t-1}) + \psi''_{ik}(\Delta W''_t/W_{t-1}) \tag{13}$$

where Θ_{ik}, ψ'_{ik}, and ψ''_{ik} are fixed coefficients satisfying the constraints $\sum_i^N \psi_{ik} = \bar{\Theta}$, $\sum_i^N \psi'_{ik} = \bar{\psi}'$, and $\sum_i^N \psi''_{ik} = \bar{\psi}''$, for all k; and $\Delta W'_t$ and $\Delta W''_t$ are positive and negative wealth flows, respectively. For positive wealth flows, for example, $\Delta W''_t$ equals zero, and the larger the magnitude of the flow, the less an investor will reallocate currently held assets. In this case movement toward desired portfolio composition may be achieved with less cost by simply investing the wealth flow according to desired portfolio composition.

The final term in the model (12) reflects this less costly investment strategy. This term describes the marginal allocation of new investable wealth flows. For positive wealth flows, it is defined to equal α^*_{it}, investors' desired long-run portfolio composition. For negative wealth flows, investors may not sell assets according to desired portfolio composition for a variety of reasons—including differential transactions costs and a possible aversion to realizing capital losses—implying that a separate term may be needed to represent portfolio behavior in this case. Thus, the coefficient determining marginal purchases or sales is defined as

$$\delta_{it} = \begin{cases} \alpha^*_{it}, \text{ for } \Delta W_t > 0 \\ \gamma^*_{it}, \text{ for } \Delta W_t < 0 \end{cases} \tag{14}$$

where γ^*_{it} depends on the same factors as α^*_{it} in equation (11), but it is not constrained to imply identical responses by investors to positive and negative wealth flows.

All of the terms that are additional to the standard stock adjustment model are tested to judge their relevance. As might be expected because of the diverse institutional and behavioral characteristics of the categories of investors included in the structural model, several sub-cases of the general portfolio adjustment model (12) are actually applied. Statistical tests involving zero constraints on the ψ'_{ik} and ψ''_{ik} parameters and equality constraints on the α^*_{it} and γ^*_{it} terms are used to determine which sub-model is appropriate for each investor category.

Data and Estimation Techniques

The investor categories included in the disaggregated structural model are indicated in Table 1. As of yearend 1981, the investor

TABLE 1 about here

categories with endogenous demands held 96 percent of the total amount of outstanding Treasury securities net of the Federal Reserve System and foreign holdings, 98 percent of the total supply of corporate bonds, and 96 percent of the total supply of equities. The primary data source of the disaggregated structural model is the Federal Reserve System's flow-of-funds accounts (1975). 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 classes of federal debt that are consistent with the flow-of-funds accounts. The data are defined in terms of four "definite" areas and three "borderline" areas. The definite areas include the

TABLE 1

TREASURY SECURITIES, CORPORATE BONDS, AND EQUITIES OUTSTANDING AS OF YEAREND 1981

Securities Held By:	Treasury Securities[1]		Corporate Bonds		Equities	
	Amount	Percent	Amount	Percent	Amount	Percent
Households*	$162.0b	22.0%	76.5	14.5	1,084.2	72.5
Foreign	141.4	19.2	22.0	4.2	64.1	4.3
Federal Reserve System	131.0	17.8	--	--	--	--
Commercial Banks†	113.1	15.4	7.6	1.4	0.1	0.0
State-Local General Funds†	60.7	8.3	--	--	--	--
Private Pension Funds*	30.6	4.2	61.7	11.7	167.1	11.2
State-Local Retirement Funds*	27.3	3.7	102.8	19.4	47.8	3.2
Other Insurance Companies*	18.2	2.5	30.8	5.8	31.0	2.1
Credit Unions	14.1	1.9	--	--	--	--
Life Insurance Companies*	8.6	1.2	187.9	35.5	49.7	3.3
Nonfinancial Corporate Businesses†	8.0	1.1	--	--	--	--
Savings and Loan Associations†	8.0	1.1	--	--	--	--
Mutual Savings Banks*	5.4	0.7	20.2	3.8	3.2	0.2
Sponsored Credit Agencies	2.9	0.4	--	--	--	--
Investment Companies‡	2.8	0.4	10.1	1.9	37.4	2.5
Security Brokers and Dealers	1.0	0.1	9.1	1.7	11.7	0.8
Total	735.1	100.0	528.7	100.0	1,496.4	100.0

Notes:

Source: Board of Governors of the Federal Reserve System (1975) and subsequent issues.
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 demands only for equities.

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. 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.[12/] Variances of holding-period yields are represented by lagged four- or eight-quarter moving-average variances of the sum of the coupon return and the capital gain (or loss) on the respective securities.

The estimated demand equations correspond to various sub-models embodied in equation (12). For the simplest case—involving the constraints $\psi'_{ik} = \psi''_{ik} = 0$ and $\gamma^*_{it} = \alpha^*_{it}$—expansion of equation (12) implies that net purchases of a security depend on lagged stocks of assets, products of expected yields with wealth flows and stocks, and products of variances with wealth flows and stocks. The set of lagged asset stocks consists not only of the six securities modeled here, but also such assets as commercial paper, state and local bonds, mortgages, and components of the monetary aggregates. Similarly, yields and variances of yields are included for all of these categories of assets.

The structure of the supply-demand model necessitates the use of a simultaneous equations estimation technique. This is the case because yields on securities are jointly dependent variables along with investors' demands. Thus, ordinary least squares estimation results in inconsistent estimates. Because the direct application of 2SLS is not possible due to the undersized sample problem—i.e., more predetermined variables than sample observations—the application of an instrumental variables technique described by Brundy and Jorgenson (1971) is used to gain consistent estimates for the structural equations.

The particular instrumental variables procedure used involves replacing current values of dependent variables appearing in the right-hand side of the structural equations with fitted values obtained from a first-stage regression. The first-stage regression for an individual structural equation has right-hand side variables consisting of a subset of the principal components of the entire set of predetermined variables in the system of equations, augmented by the set of predetermined variables appearing in the structural equation. In addition, since the dependent variables being instrumented appear as products with either wealth flows or stocks, the proper procedure of forming an instrument for the entire multiplicative term is followed here.

Empirical Results

In total, 51 behavioral equations representing the net purchases of 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. As indicated by the multiple

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TABLE 2 about here

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correlations ($\bar{R}^2$), these equations explain much of the variation of the net purchases of the six types of securities. The multiple correlations range from 0.53 to 0.91 for equities, 0.64 to 0.87 for corporate bonds, and 0.35 to 0.93 for the much more volatile net purchases of Treasury securities. Comparing the individual categories of investors using this criterion, the short-run demands of life insurance companies are explained the most successfully with multiple correlations ranging from 0.83 to 0.96. Within individual investor categories, the

TABLE 2

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

Investor Category	Net Purchases of: US1 $\bar{R}^2$	US1 SE	US2 $\bar{R}^2$	US2 SE	US3 $\bar{R}^2$	US3 SE	US4 $\bar{R}^2$	US4 SE	CB $\bar{R}^2$	CB SE	EQ $\bar{R}^2$	EQ SE
Commercial Banks	.75	1,190	.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

Yield	Simulation Results (in percent): One Period ME	One Period RMSE	Dynamic ME	Dynamic RMSE
Short-Term Treasury (r_T)	.02	.66	.06	.69
Short-Intermediate-Term Treasury (r_2)	.03	.40	.06	.47
Long-Intermediate-Term Treasury (r_3)	.01	.32	-.11	.43
Long-Term Treasury (r_4)	.00	.19	.02	.21
Corporate Bond (r_C)	-.01	.31	.04	.37
Equity (r_E)	.00	.34	.01	.37

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
ME = mean error
RMSE = root-mean-square error

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. As reported by Roley (1980,1982), all coefficients on own-yields and own-asset stocks have the anticipated sign, and virtually all are statistically significant. Moreover, in the set of 51 estimated demands, there is evidence that at least some asset substitutability exists as 45 statistically significant cross-yield terms are included.

By combining the 51 estimated equations with six market-clearing identities that place aggregate demands equal to exogenous supplies (net of exogenous demands) of the four maturity classes of Treasury securities, corporate bonds, and equities, the yields on these six types of securities along with the 51 endogenous security demands may be simultaneously determined. The endogenous variables are determined in this framework using both one-period and dynamic simulations beginning in 1960:Q1 and ending in 1975:Q4. The dynamic simulation differs from the one-period (or static) simulation in that the former uses simulated values for all lagged endogenous variables.

The results from these simulations are summarized for the six endogenous yields in the lower half of Table 2. In both simulations, the root-mean-square errors (RMSE) monotonically decrease for Treasury security yields as the maturity becomes longer, reflecting the greater volatility of shorter term yields. Moreover, for long-term yields, the root-mean-square errors range from only 19 basis points for the long-term Treasury yield in the one-period simulation to 37 basis points for the corporate bond and equity yields in the dynamic simulation. Thus, the disaggregated structural model explains yields remarkably well with only small biases evident in the reported results.

FINANCIAL EFFECTS OF AN INCREASE IN THE FEDERAL DEFICIT

In this section, the disaggregated structural model of the Treasury security, corporate bond, and equity markets is used to examine empirically the effect of an increase in the federal deficit on interest rates. In particular, two sets of simulation experiments are performed. First, the initial impacts of increases in each of the four maturities of Treasury securities on the six endogenous yields are considered. Second, the longer run effects of deficit shocks—financed according to the historical maturity distribution of the outstanding federal debt—are investigated. Since these experiments involve only the financial sector, the results correspond to the portfolio crowding-out effects reviewed in the first section.

Initial Effects of an Increase in the Deficit

To examine the short-run impact of debt-financed increases in the deficit on interest rates, simulations involving 1 percent increases in the stocks of the four different maturity classes of Treasury securities are performed, with all other predetermined variables taking historical values in each period. These experiments are not only suggestive in indicating the initial financial effects of increased debt-financed deficits, but they may also be used to examine whether alternative financing schemes involving the four maturities of

Treasury securities have different consequences. Indeed, in a previous study [Roley (1982)], this model was shown to imply that debt-management operations involving changes in the maturity composition of the federal debt significantly affect corporate bond and equity yields. In the expanded model employed in the next section, B. Friedman (1981) found similar effects.

As is discussed in more detail in the next subsection, the 1 percent changes in the different maturity classes of Treasury securities are quite small in comparison to the historical innovations in the respective net supplies. Thus, in the context of actual deficit financing policy which occurred during the sample period, the changes in asset stocks used in the simulation experiments may be thought of as innovations in the time-series processes which generated these asset stocks, and not as shifts in policy regimes which may render the model inadequate [e.g., Mishkin (1979) and Sims (1982)]. In addition, in all of the experiments performed in this section, the total financial asset holdings of households are increased by the amount of the change in the deficit. Thus, the experiments correspond to "bond rains" on households. As a consequence, the possibility of additional effects from shifts in relative total asset holdings of different categories of investors is ignored at this stage. As shown by B. Friedman (1980), such effects may significantly affect relative yields if different investors have different "preferred habitats."

One-period simulations utilizing the model exactly as outlined in the previous section are reported on the top half of Table 3. For

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TABLE 3 about here

TABLE 3

INITIAL EFFECTS OF FEDERAL DEBT SHOCKS

Impact With Respect to (Corporate Bond Supply Exogenous):[1/]

Yields	US1			US2			US3			US4		
	1966:Q1	1971:Q1	Average	1966:Q1	1971:Q1	Average	1966:Q1	1971:Q1	Average	1966:Q1	1971:Q1	Average
r_T	.32%	.19%	.32%	-.00%	.02%	-.01%	-.01%	.00%	-.01%	.05%	.03%	.01%
r_2	.03	.09	.11	.18	.13	.17	-.01	.00	-.00	.01	.02	.01
r_3	.02	.07	.07	.07	.08	.08	.21	.07	.12	.18	.09	.12
r_4	.02	.02	.04	.02	.01	.02	.00	.00	.01	.18	.09	.14
r_C	.05	.02	.04	.01	.02	.02	-.00	-.00	.01	.16	.07	.12
r_E	.04	-.01	-.03	.03	-.00	-.02	.04	.00	.01	.05	.01	.01
(Corporate Bond Supply Endogenous)												
r_T	.32	.19	.32	-.00	.02	-.01	-.01	.00	-.01	.05	.02	.01
r_2	.03	.09	.11	.18	.13	.17	-.01	.00	-.00	.01	.02	.01
r_3	.03	.07	.07	.07	.08	.08	.22	.07	.12	.18	.09	.11
r_4	.02	.01	.04	.02	.01	.02	.00	.00	.01	.18	.09	.14
r_C	.02	.02	.03	.01	.02	.02	-.00	.00	.00	.14	.06	.09
r_E	.04	-.04	-.03	.03	-.01	-.02	.05	.00	.01	.05	.01	.01
Supply:CB	-$5m	-$15m	-$17m	-$3m	-$17m	-$10m	$0m	$1m	-$1m	-$41m	-$55m	-$53m

Notes:

US1 = supply of short-term Treasury securities
US2 = supply of short-intermediate-term Treasury securities
US3 = supply of long-intermediate-term Treasury securities
US4 = supply of long-term Treasury securities
CB = supply of corporate bonds
r_T = 3-month Treasury bill yield
r_2 = 3- to 5-year Treasury security yield
r_3 = 6- to 8-year Treasury security yield
r_4 = long-term (10-year and over) Treasury security yield
r_C = yield on new issues of corporate bonds (Aa utilities)
r_E = Standard and Poor's dividend-price ratio
Average = average impact over the entire sample period (1960:Q1-1975:Q4)

[1/] Difference from control simulation values.

short-term Treasury securities (US1), for example, the results indicate that a 1 percent rise in the amount outstanding causes the bill yield (r_T) to rise 32 basis points above its value in the control simulation in 1966:Q1, 19 basis points in 1971:Q1, and an average of 32 basis points in one-period simulations over the entire sample period. Similarly, 1 percent increases in outstanding short-term Treasury securities results in an average rise in the corporate bond rate of 4 basis points, and a decline in the equity yield of 3 basis points.

As a whole, the results from these simulations are somewhat mixed. However, in comparing short- and long-term debt financing, the model suggests that the former is less likely to result in crowding out. In particular, under long-term debt financing, the average impacts on the corporate bond and equity yields are 12 and 1 basis points, respectively, or about 8 and 4 basis points higher than those calculated under short-term debt financing. This difference occurs despite the fact that the average increase in short-term Treasury securities is over three times larger than the rise in long-term Treasury securities.

In the next set of simulations, the supply of corporate bonds is made endogenous by adding B. Friedman's (1979) corporate bond supply equation to the model.[13/] This specification is particularly well suited for the experiments conducted here as it emphasizes the substitutability between long- and short-term debt financing. In this expanded model, the same simulations as before are performed, and the impacts of increased Treasury security supplies on both yields and the supply of corporate bonds are reported on the bottom half of Table 3.

In terms of the impacts on yields, the simulation results are virtually the same as those reported on the top half of the table. The average impact on the corporate bond yield is, however, reduced slightly in the experiments concerning increases in long-term Treasury securities. With respect to quantity effects, the substitution away from corporate bond financing is quite small in three of the four sets of experiments. The average reductions in net issues of corporate bonds are \$17m, \$10m, \$1m, and \$53m for 1 percent increases in US1, US2, US3, and US4, respectively, where average increases in these four maturities of Treasury securities are \$118m, \$52m, \$66m, and \$31m. The results therefore indicate a high degree of substitutability between long-term federal debt and corporate bonds, as a \$31 million average increase in long-term Treasury securities results in an average reduction of \$53 million in corporate bonds.

Dynamic Effects of an Increase in the Deficit

The longer run financial effects of an increase in the deficit are considered in two sets of dynamic simulations. In these experiments, the innovation technique suggested by Mishkin (1979) is employed. This approach is implemented by first estimating an equation representing the time-series process of the cumulative debt-financed deficit over the 1960:Q1 to 1975:Q4 sample period.[14/] Using the Box-Jenkins (1970) identification procedures, the time-series model ultimately obtained is[15/]

$$\Delta Debt_t = \underset{(4.6)}{.5734}\ \Delta Debt_{t-1} + \underset{(2.6)}{.3850}\ \Delta Debt_{t-2} + \varepsilon_t \qquad (15)$$

$$R^2 = .90 \qquad SE = \$3479m \qquad Q(26) = 10.48$$

where

$Debt_t$ = cumulative debt-financed federal deficit at time t

ε_t = serially uncorrelated random error.

This estimated equation (15) is then shocked by \$3.5 billion, or about one standard error, and the dynamic cumulative changes in the federal debt are computed. The increases in the cumulative deficit which result are financed according to the historical proportions of the amount outstanding in each of the maturity classes of Treasury securities to the total privately-held federal debt in each quarter. It may be verified from (15) that the \$3.5 billion shock cumulates to \$26.1 billion after 12 quarters, and averages \$15.3 billion over the same period.

As before, simulations are performed both with and without an endogenously determined supply of corporate bonds. In the case of an exogenously determined supply, dynamic simulations beginning in 1966:Q1 and 1971:Q1 are reported on the top half of Table 4. In each

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TABLE 4 about here

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case, the dynamic simulations span 12 quarters. In comparison to the results in Table 3, each of the simulations exhibit much larger impacts in the initial quarter reflecting the significantly larger magnitude of the federal debt shock. In the experiment initiated in 1966:Q1, the corporate bond yield rises throughout the 12 quarters, while the equity yield reaches a peak and then declines to 21 basis points above its value in the control simulation. In contrast, in the dynamic simulation initiated in 1971:Q1, both private security

TABLE 4

DYNAMIC SIMULATION RESULTS

(Corporate Bond Supply Exogenous)

Yields	Deficit Shock of \$3.5b in 1966:Q1 [1/]			Deficit Shock of \$3.5b in 1971:Q1 [1/]		
	1966:Q1	1968:Q4	Average	1971:Q1	1973:Q4	Average
r_T	.92%	.17%	.17%	.47%	-.19%	.09%
r_2	.67	-.06	.31	.65	.00	.13
r_3	1.27	-.04	.98	.81	-.13	.22
r_4	.52	.66	.63	.28	.02	.18
r_C	.46	.80	.74	.32	-.08	.17
r_E	.22	.21	.34	.12	-.14	-.05

(Corporate Bond Supply Endogenous)

Yields	1966:Q1	1968:Q4	Average	1971:Q1	1973:Q4	Average
r_T	.93	-.09	.01	.47	-.41	-.04
r_2	.67	-.43	.14	.63	-.15	.04
r_3	1.27	.03	1.01	.79	-.10	.21
r_4	.52	.71	.66	.28	.00	.16
r_C	.40	.12	.43	.24	-.19	.03
r_E	.22	.29	.36	.11	-.04	-.02
Supply:CB	-\$117m	-\$7,671m	-\$2,784m	-\$234m	-\$4,854m	-\$2,212m

Notes:

For variable definitions, see Table 3.

Average = average change over the first 12 quarters after the experiment is initiated (1966:Q1 or 1971:Q1)

1/ Differences from control simulation values.

yields actually fall below their control simulation values after 12 quarters.

With an endogenously determined supply of corporate bonds, the yields exhibit similar patterns, as is apparent on the bottom half of Table 4. In this case, however, several of the initial impacts of the deficit shocks are somewhat smaller. Moreover, after 12 quarters, the corporate bond yield is significantly lower in comparison to the exogenous supply case. The declines in net issues of corporate bonds are also fairly small relative to the increase in the cumulative deficit. After 12 quarters, outstanding corporate bonds fall by about $7.7 and $4.9 billion in the experiments initiated in 1966:Q1 and 1971:Q1, respectively, while the cumulative change in federal debt equals $26.1 billion in each simulation. However, to the extent that the quantity of as well as the yield on corporate bonds influences business investment decisions, these results could be consistent with some crowding out of investment expenditures. These general equilibrium effects are examined in the next section.

DEFICITS, CAPITAL FORMATION, AND ECONOMIC ACTIVITY

In this section, both the nonfinancial and financial effects of an increase in the federal deficit are examined in a model developed by B. Friedman (1981,1982). The model consists of B. Friedman's (1977,1979) structural model of the corporate bond market, the structural model of the Treasury securities market discussed in preceding sections, and the MPS model. The principal differences between this model (hereafter MPS-CGB) and the MPS model are that yields are determined in an explicit supply-demand market-clearing framework, and that the government budget constraint is explicitly imposed.

Deficits are increased in the simulation experiments by adding \$10 billion to government expenditures in each quarter.[16/] The money stock is held at its control simulation path, thereby allowing virtually all of the rise in the deficit to be reflected in net sales of federal debt to the public. In implementing the simulation experiments, the Treasury bill yield is determined in the money market as in the unaltered MPS model, and the quantity of Treasury bills (US1) is then proximately determined in the short-term Treasury securities market. The remainder of the deficit that must be financed is allocated to the other three maturities of Treasury securities according to their historical proportions to total privately-held federal debt.

The results of two dynamic simulations are reported in Table 5.

TABLE 5 about here

As before, the simulations begin in 1966:Q1 and 1971:Q1. The experiments consist of increasing real government expenditures by \$10 billion in each of four quarters. In terms of interest rates, the pattern is similar to that found in the partial-equilibrium financial model, although the long-intermediate-term yield appears to be somewhat unstable. Nevertheless, all yields initially rise above control simulation levels in response to the increase in debt-financed government expenditures, while the longer run effects on the long-term yields are ambiguous.[17/] The impact on the supply of outstanding corporate bonds is on average smaller than before, reflecting a larger amount of

TABLE 5

SIMULATION RESULTS IN THE MPS-CGB MODEL

	Increase in G of $10b in 1966:Q1[1/]			Increase in G of $10b in 1971:Q1[1/]		
Yields	1966:Q1	1966:Q4	Average	1971:Q1	1971:Q4	Average
r_T	.36%	.46%	.43%	.21%	.25%	.28%
r_2	.59	.37	.89	.79	.46	.75
r_3	1.83	1.44	3.62	1.23	1.74	1.81
r_4	.77	-.08	1.31	.54	.78	.84
r_C	.48	-.02	.79	.36	.56	.60
r_E	.03	.28	.27	.03	.27	.18
Bond Supply						
CB	-$320m	$111m	-$67m	-$373m	-$276m	-$379m
Real Expenditures						
G	$10b	$10b	$10b	$10b	$10b	$10b
Y	12.6	3.8	6.5	10.7	2.7	6.9
IPE	0.6	-0.4	0.4	0.4	0.3	0.6
Deficit						
DEF	5.3	8.2	7.4	6.4	8.8	7.5

Notes:

For variable definitions, see Table 3.
G = real federal government purchases ($1972 billion)
Y = real gross national product ($1972 billion)
IPE = real investment in plant and equipment ($1972 billion)
DEF = federal government deficit ($billion)
Average = average change over the first four quarters after the experiment is initiated (1966:Q1 or 1971:Q1)

[1/] Differences from control simulation values.

total corporate external financing resulting from the cumulative rise in investment spending.

The effect of this debt-financed fiscal policy action on economic activity is much smaller in the MPS-CGB model than would be expected in the unaltered MPS model. In the MPS-CGB model, real GNP rises by slightly more than the increase in government expenditures in the initial quarter, but by the end of four quarters real spending equals about one-third of the rise. Real business fixed investment exhibits a small initial rise due to accelerator effects, but in the 1966:Q4 experiment, some real investment is crowded out after four quarters. Moreover, the nominal federal deficit rises over the four quarters, and since prices remain virtually unchanged from their control simulation levels, the rise mainly reflects gains in real deficits.

As a whole, the results suggest that while a debt-financed increase in government spending provides stimulus over four quarters, the multiplier is less than one after a year. Moreover, the results suggest that capital formation could be adversely affected, although it rises on average in the simulations. One source of these rather pessimistic results is the deficit-financing scheme adopted in the experiments. In particular, as a consequence of the bill yield being determined in the money market, the supply of bills held by the public actually falls by over $1 billion after four quarters in each of the simulations.[18/] Thus, the rise in the deficit in addition to this $1 billion must be financed by issuing longer term debt instruments. In particular, slightly less than one-half of the cumulative rise in the deficit is financed with long-intermediate- and long-term Treasury securities. On the basis of debt-managements experiments using this model [B. Friedman (1981)], a greater emphasis on short-term debt financing would lead to a more expansionary fiscal policy impact on both total spending and capital formation.

SUMMARY OF CONCLUSIONS

Asset substitutability played an explicit role in determining the effects of federal deficits on interest rates and economic activity in this paper. The role of asset substitutability was made explicit by considering the impact of deficits in a disaggregated structural model of the U.S. Treasury securities, corporate bond, and equity markets. In this model, the relationships among yields depend on the substitutability of assets in the portfolios of different categories of investors. As indicated in the simple illustrative model considered at the outset of this paper, the presence of imperfect asset substitutability implies that the possible impact of an increase in the federal deficit may range from crowding out to crowding in.

In simulations which examined both portfolio and total crowding out, the results suggest that the manner in which the deficit is financed affects interest rates. When the increased deficit is financed with short-term Treasury securities, the partial equilibrium experiments indicated that corporate bond and equity yields change only slightly. In contrast, when long-term debt-financing is employed, both yields rise, particularly the corporate bond yield. Simulations in a general equilibrium setting tended to coincide with these results, as an increase in government expenditures financed by new issues of Treasury securities exclusive of Treasury bills was found to be offset significantly, but not completely, by a reduction in private expenditures.

FOOTNOTES

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1. The source of these data are Board of Governors of the Federal Reserve System (1975) and subsequent issues. For purposes of this introductory section, total marketable U.S. Treasury securities are disaggregated into Federal Reserve and non-Federal Reserve holdings.

2. For a reduction in taxes, private spending remains at its initial level implying an unchanged level of total spending in both of the cases considered below.

3. This theory also hinges on operative intergenerational transfers in which the size of bequests varies with the presumed tax liability of future generations. For evidence on the importance of intergenerational transfers as a determinant of private saving, see Kotlikoff and Summers (1981). For arguments and evidence against the Ricardian equivalence view, see Feldstein (1982).

4. For other dynamic long-run analyses of the two-asset model, see, for example, Burmeister and Phelps (1971), Infante and Stein (1976), Tobin and Buiter (1976), and Turnovsky (1978).

5. In this model it is assumed that investors regard federal debt as wealth, that resources are not fully employed, and that the price level is constant.

6. A system of asset demands similar to the set of equations (1) may be derived from expected utility maximization. In the expected-utility maximization models presented by Blanchard and Plantes (1977) and Roley (1979), positive covariances between asset yields are a necessary but not a sufficient condition for gross substitutability. Moreover, Roley (1983) has shown that symmetry in the yield-coefficient matrix implies constant absolute risk aversion, and hence is not a general property of asset demands. Symmetry is not, therefore, imposed in the asset demands (1).

7. For previous studies which examine the consequences of asset substitutability in the three-asset model, see, for example, Tobin (1961,1963), Brunner and Meltzer (1972), B. Friedman (1978), Cohen and McMenamin (1978), and Walsh (1983). In contrast to the other studies listed above and to the illustrative model discussed here, Cohen and McMenamin (1978) consider the dynamic and long-run consequences of asset substitutability in determining the effect of deficits. Also, Walsh (1983) is unique in considering the impact of deficits in models based on explicit utility maximizing behavior and rational expectations.

8. Households are also assumed to regard the net worth of banks (NW) as exogenous and to allocate W-NW among money, federal debt, and

corporate bonds. Thus, W-NW replaces W in equation (1), where $W = M^d + T^d + B^d + NW = H + T + K$.

9. For a more complete description of this model, see Roley (1980).

10. For a discussion of alternative models of interest-rate determination, see Friedman and Roley (1980). For a comparison of a version of this disaggregated structural model to the "efficient markets" model as advanced, for example, by Pesando (1978) and Mishkin (1978), see Roley (1981).

11. The portfolio adjustment models specified by Brainard and Tobin (1968), Modigliani (1972), Bosworth and Duesenberry (1973), and B. Friedman (1977) exhibit some, but not all, of these properties.

12. 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 (1979a).

13. This corporate bond supply equation was re-estimated through 1975:Q4. The estimated coefficients remained basically unchanged from those reported by B. Friedman (1979).

14. To conform with the simulation experiments in the next section, the aggregated debt variable—as opposed to the stocks of the individual maturity classes of Treasury securities—is used to evaluate the impact of deficit shocks. These deficit data should correspond to those used by Barro (1980). However, in calculating deficit shocks, Barro does not use an ARIMA model.

15. This model was estimated using Chase Econometrics' automated

Box-Jenkins program. The Q(26) statistic is distributed as $\chi^2(24)$, and is not significantly different from zero at the 5 percent significance level, indicating that the null hypothesis of white noise residuals cannot be rejected.

16. While this procedure departs from the innovation technique implemented in the previous section, the numerical values are not drastically different. In particular, an ARIMA model was estimated for the five exogenous categories of government expenditures in the MPS-CGB model, and the combined standard error was about $6 billion. Over the next three quarters, a one standard error shock yielded values of $7.5, $7.3, and $8.1 billion. In the current version of the program used to simulate the MPS-CGB model, only constant changes in government expenditures may be used.

17. In a reduced-form model, Makin (1982) estimates the impact of deficit shocks to be less than one-third of the magnitude reported here for the Treasury bill yield. In representing deficit shocks, Makin employs a demand shock involving exports instead of the government expenditures variable used in Table 5.

18. In the simulations, the increase in the demand for Treasury bills resulting from the rise in the Treasury bill yield is more than offset as a result of rises in other yields, particularly r_2 and r_3.

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