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Abstract

This paper reports the implications, for the effectiveness of monetary and fiscal policies, of treating the determination of long-term interest rates by an explicit supply-demand approach instead of the more familiar unrestricted reduced-form term-structure approach. In particular, the new research tool applied in this paper is an altered version of the MIT-Penn-SSRC econometric model from which the usual single term-structure equation has been deleted and into which a supply-demand model of the bond market has been substituted in its place.

Since long-term asset yields and prices are a key part of the bearing of financial market developments on nonfinancial economic activity, simulation experiments based on the altered model suggest interesting implications for monetary and fiscal policies. Simulation results indicate that, in the short to intermediate run, fiscal policy may have somewhat larger real-sector effects and monetary policy somewhat smaller real-sector effects than conventional U.S. macroeconometric models have shown. The results also indicate that these differences (for both fiscal and monetary policies) are more pronounced when the Federal Reserve System implements monetary policy by setting the monetary growth rate than when it does so by setting interest rate levels.

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The yields and prices of long-term assets play an important role in the complex interrelationships that connect financial and nonfinancial behavior in an economy like the United States. Long-term interest rates are a major component of the cost of financial capital to corporate borrowers and, consequently, a key determinant of physical capital formation through business investment in new plant and equipment. Long-term interest rates may also affect other typically debt-financed physical investments like residential construction, although the evidence there is less straightforward. Equity yields constitute another large component of the cost of corporate financial capital, and hence another determinant of business investment. Movements in equity prices (and, to a lesser extent, bond prices) also account for much of the variation in households' overall wealth positions and thereby importantly influence consumer spending. In sum, long-term asset yields and prices are a large part of the story of how what happens in the financial markets — including monetary policy and the financial aspects of fiscal policy — affects the nonfinancial economy.

In light of the importance of long-term asset yields and prices even in a nonfinancial context, the meager treatment of the determination of these yields and prices in most present-day macroeconometric models is both surprising and disconcerting. Moreover, the skeleton-like treatment accorded long-term assets in such models often contrasts sharply with the rich development of the determination of short-term yields (via a market-clearing approach to the demand for and supply of either money or bank reserves) or the effects of long-term asset yields on investment (via the "putty-clay" neoclassical investment function) and consumption (via the "life cycle" model). Instead, after carefully modeling short-term interest rates, most such models determine one long-term interest rate by a simple term-structure relation to short-term rates and then determine other long-term yields (including equity yields, and hence equity prices) by analogous single equations, before proceeding to use these long-term asset yields and prices as inputs to the again more fully modeled nonfinancial blocks. Even in models that contain substantial quantity detail relating to long-term asset markets, such detail is often merely peripheral, and the actual determination of long-term yields and prices takes place independently along roughly these lines.

In principle, of course, simplicity is a virtue in economic modeling, and there is nothing <u>necessarily</u> wrong with handling the key middle step between short-term yields and nonfinancial behavior by a spare single-equation approach. The issue, instead, is whether the standard single term-structure equation does or does not adequately represent the main features of long-term interest rate determination. In particular, while such equations could in principle capture effects due to shifts in relative asset demands (say, because of weak cash flows at major bond-buying institutions) or relative asset supplies (say, because of strong business capital expenditures in comparison to profits), in practice they do not. Experience indicates that single term-structure equations are simply incapable of representing such influences on long-term interest rate determination.[1] To the extent that such influences matter, therefore, these single equations inadequately represent long-term yield behavior, and macro models based on these equations may give a misleading picture of important financial effects on nonfinancial economic behavior.

The object of this paper is to bring to bear on financial-nonfinancial interactions a richer approach to modeling the determination of long-term interest rates. In a series of previous papers,[2] I have developed an alternative model based explicitly on the truism that any factor affecting long-term bond yields does so by (and only by) influencing some borrower's supply of bonds and/or some lender's demand for bonds. Rather than model the bond yield directly, as in the single-equation term-structure approach, this work instead models the supply of and the demand for bonds, and determines the bond yield at the level necessary to equate resulting total supply and demand.[3] The specific bond supplies and demands modeled in this work are those in the U.S. market for corporate bonds; this market is the primary source of long-term external funds to finance business fixed investment, and the corporate bond yield is also the long-term interest rate most frequently used in single-equation models of term-structure relationships.[4]

This paper reports the implications of this supply-demand model of long-term interest rate determination for the effectiveness of monetary and fiscal policies, as modeled in all <u>other</u> respects by the MIT-Penn-SSRC (henceforth MPS) econometric model of the United States. The new research tool applied in this paper is therefore an <u>altered</u> MPS model from which the usual single term-structure equation has been removed and into which a supply-demand model of the bond market has been substituted in its place. The only difference between this altered MPS model and the familiar MPS model therefore lies in the determination of long-term asset yields and prices. Since these long-term yields and prices are such an important part of the overall bearing of financial market developments on nonfinancial behavior, however, the altered model exhibits interesting implications for monetary and fiscal policies.

Section I describes the supply-demand model of the bond market, contrasting it to the standard single-equation term-structure approach, and notes some of the key influences on long-term interest rate determination that the MPS model's term-structure equation overlooks but that the supply-demand model of the bond market incorporates. Section II briefly recalls the important channels by which long-term asset yields and prices (however determined) affect nonfinancial behavior in the MPS model. Sections III and IV focus on fiscal policy and monetary policy, respectively, highlighting the differences that emerge in the analysis of these policies according to the approach adopted for long-term interest rate determination. Section V offers some general conclusions drawn from these results, and suggests some opportunities for further research along these lines.

I. The Determination of Long-Term Interest Rates[5]

A. The Concept of the Demand-Supply Model

Since the concept of price determination by the market-clearing intersection of demand and supply is so central to the analysis of economic behavior, it seems at first only natural to approach the determination of financial asset prices and yields from an explicit demand-supply perspective. The total market demand for any given asset, A^D, is presumably some function of the asset's yield, r, and of other factors (such as yields on competing assets, variances and covariances, etc.),

$$A^D = f^D(\ldots,r,\ldots), \qquad f^{D'} \geq 0 \tag{1}$$

while the total market supply of the asset is an analogous function[6]

$$A^S = f^S(\ldots,r,\ldots), \qquad f^{S'} \leq 0. \tag{2}$$

The requirement of market clearing,

$$A^D = A^S, \tag{3}$$

closes the system and permits the model to determine not only the asset quantity A $(= A^D = A^S)$ but also the asset yield r. Any factor which influences the demand for or supply of an asset will also, ceteris paribus, influence the asset's yield (and price). Conversely, any factor which influences an asset's yield does so, ceteris paribus, only by influencing the relevant market demand or supply (or both).

In addition to its appeal from the general standpoint of economic theory, there are two further reasons why the explicit demand-supply perspective seems particularly appropriate for modeling asset prices and yields. First, the highly efficient markets for many actively traded financial assets should be cases for which, in comparison with many product and factor markets, the assumption of market clearing as in (3) requires relatively little sacrifice of realism. Second, a long tradition of economic analysis of portfolio behavior has provided a rich development of economic theory deriving the pertinent asset demand and supply relations, as in (1) and (2), from the constrained utility-maximizing behavior of market participants under a variety of assumptions about the specification of the utility function and the nature of the associated constraints.

At the empirical level, however, economists modeling the determination of long-term interest rates — that is, the yields on fixed-income assets of long duration — have traditionally avoided the explicit demand-supply apparatus and instead related long-term interest rates directly to short-term interest rates and/or various other factors assumed to influence the demand for and/or the supply of long-term bonds. The dominant empirical methodology associated with this approach has been a model consisting of a single unrestricted reduced-form equation with the value of the (nominal) long-term interest rate as the dependent variable. Familiar explanatory variables used in such unrestricted reduced-form long-term interest rate equations include proxy representations of expected future short-term interest rates and expected future price inflation, a monetary policy variable, a proxy for liquidity considerations, etc. Indeed, the literature of the subject has typically — and properly — considered any variable which might influence the demand for and/or supply of bonds to be an appropriate argument of the unrestricted reduced-form equation determining the long-term interest rate.

Since the explicit demand-supply model of (1)-(3) also implies an equation for the long-term interest rate, this structural model constitutes a valid alternative to the single-equation unrestricted reduced-form model. The demand-supply model's implied expression for r is itself a reduced-form equation (except for any nonlinearities introduced by functional forms f^D and f^S) which is equivalent to the conventional equation except that it is restricted by the underlying structural demand and supply equations.

The two key advantages of the demand-supply model are its ability to use the theory of portfolio behavior to restrict the implied equation for the long-term interest rate, and the facility which it provides for directly investigating hypotheses about portfolio behavior. In return, this structural approach imposes upon the researcher the discipline of explicitly acknowledging that, since financial asset yields (that is, asset prices) are proximately determined in a market in which assets are bought and sold, any factor hypothesized to influence the long-term interest rate can do so only by — and only by — influencing some issuer's supply of bonds or some investor's demand for bonds, or both. To the extent that expectations of future short-term yields are relevant via substitution effects which enforce the familiar term-structure relationship, or that less-than-infinite elasticities of substitution create "preferred habitats" which render quantity variables relevant, or that less-than-infinite adjustment speeds render quantity flow variables relevant as well as quantity stock variables, all these factors affect the determination of long-term interest rates by, and only by, influencing the portfolio behavior of borrowers and lenders.

B. Methodological Issues

Several methodological aspects of the demand-supply approach to modeling long-term interest rate determination merit explicit comment.

First, since the long-term interest rate is clearly a jointly determined variable in the structural model of (1)-(3), it is necessary to use an estimation technique which avoids the inconsistency to which the model's simultaneity would subject ordinary least-squares procedures. A variety of instrumental-variables procedures is readily available for this purpose.

Second, the demand-supply approach largely avoids the problem of spurious correlations inherent in unrestricted estimation of interest rate relationships. This point is especially relevant in the case of flexible distributed lags on past interest rates, which are typically the heart of interest rate models based on the expectations theory of the term structure. In a structural model any such distributed lags simply appear as arguments of the individual demand and supply equations, where spurious correlation is both less likely and less harmful.

Third, it follows by construction of least-squares estimators that the single-equation unrestricted reduced-form model of long-term interest rate determination will always "fit" historical interest rate data at least as well as the restricted expression estimated implicitly within any corresponding explicit demand-supply model. Hence it is possible that the structural model may buy its key associated advantages — its ability to use and test explicit behavioral hypotheses — at great cost in terms of performance as measured by within-sample fit. The key methodological finding documented in Friedman [17,19], however, is that a fully dynamic simulation of the structural bond market model tracks the historical long-term interest rate with a root-mean-square error no larger (and sometimes smaller) than the comparable standard errors reported by researchers using the unrestricted single-equation term-structure methodology. Hence the portfolio-theoretic restrictions placed on the structural model's demand and supply equations apparently "pay their freight" in terms of enriching the model's ability to draw general behavioral implications without substantially eroding even its within-sample "predictive" performance.

C. The Equations in the Bond Market Model

The demand side of the corporate bond market model consists of six equations separately representing the net purchases of corporate bonds by life insurance companies, other insurance companies, private pension funds, state and local government retirement funds, mutual savings banks and households; these investors together hold approximately 95% of all corporate bonds issued in the United States. The supply side of the model consists of two equations separately representing the net new issues of corporate bonds by domestic non-financial business corporations and finance companies, which together account for over 90% of all corporate bonds issued in the United States. A ninth equation determines the net of the bond purchasing and bond issuing activity of the remaining categories of market participants.

The model's tenth, and final, equation is a market-clearing equilibrium condition analogous to (3), that enables the structural model to determine the nominal long-term interest rate (that is, the own-rate) which is an argument of each structural bond demand or bond supply equation. The particular long-term interest rate used as the own-rate in this model is the observed new-issue yield on long-term bonds issued by utility companies rated Aa by Moody's Investors Service, Inc.

The specification of the respective sectors' bond demand equations combines the familiar linear homogeneous model of desired portfolio selection,

$$\alpha^*_{it} \equiv \frac{A^*_{it}}{W_t} = \sum_k^N \beta_{ik} r^e_{kt} + \sum_h^M \gamma_{ih} x_{ht} + \pi_i, \qquad i = 1,\ldots,N, \tag{4}$$

with the optimal-marginal-adjustment model of portfolio adjustment in the presence of transactions costs,

$$\Delta A_{it} = \sum_k^N \theta_{ik} (\alpha^*_{kt} W_{t-1} - A_{k,t-1}) + \alpha^*_{it} \Delta W_t, \qquad i = 1,\ldots,N, \tag{5}$$

where the α_i are (percentage) portfolio shares, the A_i are (dollar amount) asset holdings, W is total portfolio size, the r_k^e are expected yields, the x_h are other influences on portfolio selection (including variances and covariances), the ΔA_i are net asset purchases, ΔW is total investable cash flow, an asterisk indicates a desired value, and the β_{ik}, γ_{ih}, π_i and θ_{ik} are fixed behavioral parameters. The specification of the respective sectors' bond supply equations is analogous to that of the model's bond demand equations, combining the linear homogeneous selection of desired liabilities to finance a given cumulated external deficit and again the optimal-marginal-adjustment model.

The primary rationale motivating the use of the linear homogeneous portfolio selection model is, as usual, simply its convenience and tractability.[7] Some adjustment model is always necessary to render a desired portfolio allocation model operational in the presence of transactions costs. The principal advantage motivating the use of the optimal-marginal-adjustment model is that it captures, in a tractable way, the effect of differential transactions costs which render the allocation of the new investable cash flow more sensitive to expected yields (and variances, etc.) than the reallocation of the asset holdings already in the portfolio.

The primary data source for the stock and flow quantities used in this model is the Federal Reserve System's flow-of-funds accounts. The respective bond demand and supply equations are estimated using the instrumental-variables procedure of Bundy and Jorgenson [8].

D. Influences on the Long-Term Interest Rate

Since a key determinant of market participants' demands for and supplies of bonds as modeled in (4) is the comparison of the expected yield on bonds versus the yield on short-term assets, short-term yields play a large role in determining long-term yields in the demand-supply model just as they do in a single-equation term-structure model. Expectations of price inflation, proxied by current and recent observed inflation, also play an analogous role here and in the conventional term-structure equation. If these variables were the only arguments of the demand and supply equations, then the sole contribution of the structural model would be the imposition of some restrictions on the estimation of an otherwise standard long-term interest rate equation.

In fact, however, the respective bond demand and supply equations as modeled in (4) and (5) include a rich set of arguments other than just short-term yields and price inflation, and the structural model's basic requirement that total demand equal total supply likewise determines the long-term interest rate in a way that depends on these additional market forces. Allowing for these additional factors changes the process determining long-term interest rates (and long-term asset yields and prices more generally) and consequently alters the way in which the financial markets affect nonfinancial economic behavior in the overall macroeconometric model.

Substituting the corporate bond market model for the MPS model's term-structure equation therefore brings to bear on long-term interest rate determination a host of aspects of financial market behavior that are already modeled elsewhere in the MPS model but that are ordinarily excluded by the MPS model's term-structure equation from affecting long-term yields. Although the interactions among these forces are sufficiently complex to preclude a full enumeration, since the results presented in Sections III and IV below show that their overall implications for the financial-nonfinancial behavioral linkage are substantial, it is useful to highlight separately several of the more important ones:

1. business borrowing effects: The MPS model determines the business sector's after-tax profits and depreciation allowances, as well as key uses of funds such as capital expenditures, inventory accumulation and dividend payments. Hence the model also approximately determines the business sector's external borrowing requirements. In the bond market model, the external deficit of the business sector is a key determinant of the supply of bonds.[8] Stronger fixed investment, or weaker profits (or both together) imply a larger external deficit, hence greater bond supply, hence a higher market-clearing long-term interest rate ceteris paribus.

2. investable cash flow effects: The MPS model determines the incomes and expenditures, and hence the net accumulations of financial assets, for most of the major categories of bond market investors.[9] In the bond market model, each investing sector's investable cash flow is a key determinant of its demand for bonds. Stronger personal income flows, or additional payments into pension funds, or stronger demand for life insurance products (or all three together) implies a larger investable cash flow, hence greater bond demand, hence a lower market-clearing long-term interest rate ceteris paribus.

3. disintermediation effects: The MPS model devotes particularly detailed attention to the determination of the cash flows of institutions that, at times of high short-term market yields, experience cash outflows because of deposit interest rate ceilings or an equivalent. The two such institutions also included explicitly in the bond market model are life insurance companies, which must meet policy loan demand at predetermined rates, and mutual savings banks, which face the familiar Regulation Q ceilings. In either case higher short-term market yields imply a smaller investable cash flow, hence smaller bond demand, hence a higher market-clearing long-term interest rate ceteris paribus.

4. portfolio diversification effects: The MPS model determines the movement of equity prices, and hence the value of the equity portion of investors' portfolios. In the bond market model, each investing sector seeks to diversify its total portfolio in the context of changing asset values, of which the most volatile by far are equity prices.[10] Higher equity prices imply a greater value of equities in investors' portfolios, hence greater bond demand, hence a lower market-clearing long-term interest rate citeris paribus.

5. perceived risk effects: The MPS model determines the yields on short-term financial assets like commerical paper and Treasury bills, as well as (here in conjunction with the bond market model) the yields and prices of long-term assets like bonds and equities. In the bond market model, each investing sector selects its portfolio on the basis of not only the expected yields on the available assets but also the variances associated with those yields. Greater variability of equity prices implies greater bond demand, hence a lower market-clearing long-term interest rate, while greater variability of bond prices implies smaller bond demand, hence a higher market-clearing long-term interest rate ceteris paribus.[11]

II. Influences of the Long-Term Interest Rate on Nonfinancial Behavior in the MPS Model[12]

In the MPS model the long-term interest rate, once determined, exerts in turn a variety of influences on nonfinancial economic behavior.

Perhaps the most familiar of these influences, following Jorgenson [28] and Bischoff [5], is the effect on business fixed investment via the role of the long-term interest rate in determining the user cost of capital. The cost of capital in the model is a weighted average (appropriately adjusted for tax factors) of the corporate bond yield and the dividend-price equity yield, where the equity yield depends on the bond yield via a simple term-structure-like relation. The user cost of capital is in turn a principal determinant of the unit rental rate on physical capital, which depends also on depreciation factors, additional tax factors, and the price of capital goods. The rental rate together with the price of business output then determines the equilibrium capital-output ratio, the desired capital stock is a function of current and lagged values of both output and the equilibrium capital-output ratio, and investment expenditures finally follow from an adjustment process that gradually brings the actual capital stock into alignment with the corresponding desired level.

The MPS model applies this causal chain, with the corporate bond yield at its inception, to determine separately expenditures on producers' structures and on producers' durable goods. In addition, the MPS model applies an analogous causal chain beginning from the mortgage yield (which, like the equity yield, depends on the corporate bond yield via a simple relationship) to determine separately expenditures on 1-2 family houses and on 3-and-more family houses. The motivation underlying the MPS model's determination of expenditures of consumer durables is again analogous, although in this case the model actually uses a simplified function relating consumer durable expenditures directly to the corporate bond yield.

In addition to these direct influences, in the MPS model the corporate bond yield also exerts one further important influence on nonfinancial behavior at only one step removed. The MPS model solves for the market value of outstanding corporate equities as the quotient of dividend payments (determined by a function in which the corporate bond yield is one direct argument among several) and the dividend-price yield (determined by a function in which the corporate bond yield is the principal direct argument). Equities in turn account for a large part of the average value of households' total wealth and, given the relative volatility of equity prices, an even larger part of the variation over time in households' total wealth. Since households' wealth is the primary determinant of nondurable consumption in the "life cycle" model developed by Modigliani, Brumberg and Ando [29,31,32], the value of corporate equity — and hence its key determinant, the corporate bond yield — emerges as the major driving force behind consumption spending.

In light of its direct influence on business fixed investment, residential construction and durable consumption, and its only thinly indirect influence on nondurable consumption, the corporate bond yield emerges as one of the most important variables in the MPS model's relation of nonfinancial behavior to the financial markets. Moreover, within the model's representation of the financial markets themselves, the corporate bond yield is a direct argument of the functions determining numerous yield variables (including the yields on equities, mortgages, municipal bonds, commercial loans, mutual savings bank deposits, and savings and loan shares) as well as quantity variables (for example, corporate dividends, commercial loan demand, new mortgage commitments, and thrift institution deposits);

and these financial variables also exert diverse influences on nonfinancial economic behavior in the model.[13]

Changing the MPS model's method of determining the corporate bond yield, by substituting the supply-demand model of the bond market outlined in Section I in place of the MPS model's single term-structure equation, can therefore have substantial implications for the model's overall behavior. If the bond market model successfully captures central features of long-term interest rate determination omitted by the term-structure equation, then the description provided by the combined MPS and bond market model will provide a better guide to the working of the economy.

III. Analysis of Fiscal Policy Effects

A. Fiscal Policy with Nonaccommodative Monetary Policy

The magnitude and timing of the economic effects of fiscal policy actions constitute one of the most widely investigated phenomena in the literature of empirical macroeconomics. A "pure" fiscal action in this context has come to mean deficit spending (or tax reduction, or the reverse of either one) with the money stock held unchanged so that, in effect, the government finances its deficit not by money creation but by selling interest-paying debt instruments to the public.[14] A now familiar feature of such "bond-financed" fiscal actions is that the stimulative effect on total economic activity is only temporary, with the additional government spending "crowding out" some or all forms of private spending after some time.

Table 1 summarizes the results of two simulations of the MPS model designed to investigate the economic effect of a sizeable increase in the federal government's purchases of goods and services. The first simulation uses the conventional MPS model in which the key linkage determining the long-term corporate bond yield (the Aaa seasoned bond index) is the standard single term-structure equation. The second simulation uses instead the altered MPS model, in which the conventional model (less the term-structure equation) is combined with the demand-supply model of the corporate bond market. Since the corporate bond market model determines the Aa new-issue utility yield, an additional equation then determines the Aaa seasoned corporate yield via a simple direct relationship, and the Aaa seasoned yield remains the yield variable used on the right-hand side of the many other MPS equations noted in Section II.[15]

In all respects other than the substitution of the demand-supply corporate bond market model for the single term-structure equation as the means of

TABLE 1

COMPARISON OF SIMULATED FISCAL POLICY EFFECTS (NONACCOMMODATIVE MONETARY POLICY)

Variable	1967:I - 1969:II Mean Values			Values in 1968:I		
	Historical	MPS Model Alone	Combined Model	Historical	MPS Model Alone	Combined Model
G	95.0	105.0	105.0	96.2	106.2	106.2
M	193.2	193.2	193.2	190.4	190.4	190.4
r_{TB}	5.09	6.64	7.21	5.05	6.78	7.09
r_{CP}	5.82	7.56	8.18	5.58	7.49	7.81
r_{Aaa}	6.03	6.53	6.11	6.13	6.60	6.16
S	729.6	672.1	693.2	695.1	680.2	713.7
X	1039.3	1048.0	1053.9	1031.4	1047.9	1052.9
IP	41.9	42.5	42.9	42.2	43.4	43.7
IE	65.5	66.7	67.3	64.7	67.0	67.4
P	81.73	82.87	83.06	81.18	82.22	82.31
GNP	850.1	869.1	876.2	837.3	861.6	866.6
DN	31.8	—	31.2	28.6	—	26.7
WH	66.6	—	71.0	68.1	—	73.5
B	14.0	—	15.4	11.3	—	10.8
r_{Aa}	6.56	—	6.63	6.54	—	6.45

(table continued on next page)

TABLE 1 (continued)

Variable Symbols:

G	=	real federal government purchases (1972 $ billions)
M	=	demand deposits plus currency ($ billions)
r_{TB}	=	Treasury bill yield (%)
r_{CP}	=	commercial paper yield (%)
r_{Aaa}	=	seasoned Aaa corporate bond yield (%)
S	=	market value of common stock ($ billions)
X	=	real gross national product (1972 $ billions)
IP	=	real investment in plant (1972 $ billions)
IE	=	real investment in equipment (1972 $ billions)
P	=	implicit price deflator (index, 1972 = 100)
GNP	=	gross national product ($ billions)
DN	=	nonfinancial corporations' net external deficit ($ billions)
WH	=	households' net accumulation of financial assets ($ billions)
B	=	total net new issues and purchases of corporate bonds ($ billions)
r_{Aa}	=	new-issue Aa utility bond yield (%)

determining long-term interest rates, the two simulations are identical. The period of attention in both is the ten-quarter interval spanning 1967:I - 1969:II — perhaps the last time that the U.S. economy was neither in recession, nor in the immediate recovery from a recession, nor under price controls, nor adjusting to sharp energy price changes. In both simulations the model is adjusted by adding back the historical single-equation residuals so that, given the historical values for all of its exogenous variables, the model would exactly reproduce the historical paths for its endogenous variables. Hence whatever differences emerge between the simulated and historical values of the endogenous variables, when any exogenous variable differs from its historical path, are attributable entirely to the effect of that exogenous variable in the model rather than to any underlying failure of the model's ability to reproduce the observed historical record.

The three left-hand columns of Table 1 report sets of mean values for several key economic variables over the ten quarters of the simulation period: first the historical means, next the means from the fiscal policy simulation based on the MPS model alone, and then the means from the analogous simulation based on the combined MPS and corporate bond market model.

The behavior of two key exogenous variables defines the economic policy content of the simulations. In both simulations fiscal policy is more expansionary than it was historically, to the extent of an additional $10 billion (in 1972 dollars) annual rate of federal government spending on goods and services — that is, an additional $25 billion spent over the ten quarters. Monetary policy is nonaccommodative in both simulations, in that the money stock is unchanged from its historical path despite the additional government spending.

A comparison of the first and second columns of the table shows the familiar story of how debt-financed fiscal policy works in the MPS model. No additional supply of money is available to accommodate the greater demand for money due to the induced increase in economic activity, and so short-term interest rates must rise by about 1 1/2% to clear the money and bank reserves markets. The model's term-structure equation translates this increase in short-term interest rates into an increase of 1/2% in the corporate bond yield, and related equations generate a decline of $58 billion (nearly 8%) in equity values. Because of the effect of higher short- and long-term interest rates and lower equity values, operating through the channels enumerated in Section II, the average effect on real income associated with the additional $10 billion of government spending is only $8.7 billion. (In other words, the ten-quarter average multiplier is 0.87.) It is interesting to note, however, that the overall average effect of the fiscal policy action on business capital formation is slightly positive, with fixed investment marginally greater for both plant and equipment, indicating that in the model the positive effects of a higher operating rate outweigh the negative effects of a higher cost of capital. Hence the burden of "crowding out" represented by the less-than-unit multiplier value falls entirely on consumption and residential construction. Finally, prices are higher by about 1 1/2%, because of the greater real economic activity, so that the average nominal income for the ten quarters is greater by $19 billion.

The third column of Table 1, which gives the corresponding ten-quarter mean values for the analogous simulation using the combined MPS and corporate bond market model, gives a somewhat different — in particular, a more expansionary — account of the working of fiscal policy. Average real income is greater than the historical not by $8.7 billion but by $14.6 billion (a ten-quarter multiplier of 1.46), and both components of business capital formation are slightly stronger than in the simulation based on the MPS model alone. With prices marginally higher also, the average nominal income is greater than the historical by $25 billion. As is to be expected, this stronger nominal income growth increases the demand for money yet further, in comparison with the first simulation, so that the increase in short-term interest rates is about 2 1/4%. Despite this sharp increase in short-term interest rates, however, the corporate bond yield rises hardly at all, and the related decline in equity values is only $36 billion.

Since the small increase in the corporate bond yield (together with the associated small equity market decline) is the key factor underlying the more expansionary effect of fiscal policy in this alternative model simulation, it is useful to examine some of the variables specific to the bond market model to understand how it comes about. The bottom lines of Table 1 show historical and simulated ten-quarter mean values for four variables that are central to the demand-supply model's treatment of the bond market.[16] On the supply side of the market, it turns out that the average net external deficit of the nonfinancial corporate business sector is marginally smaller than the historical as a result of the fiscal action, as increased after-tax profits (adjusted for inventory valuation) more than offset increased capital expenditures. On the demand side of the market, a number of categories of bond buyers experience a larger than historical investable cash flow; the table reports the average values for the household sector cash flow, which increases by over $4 billion.

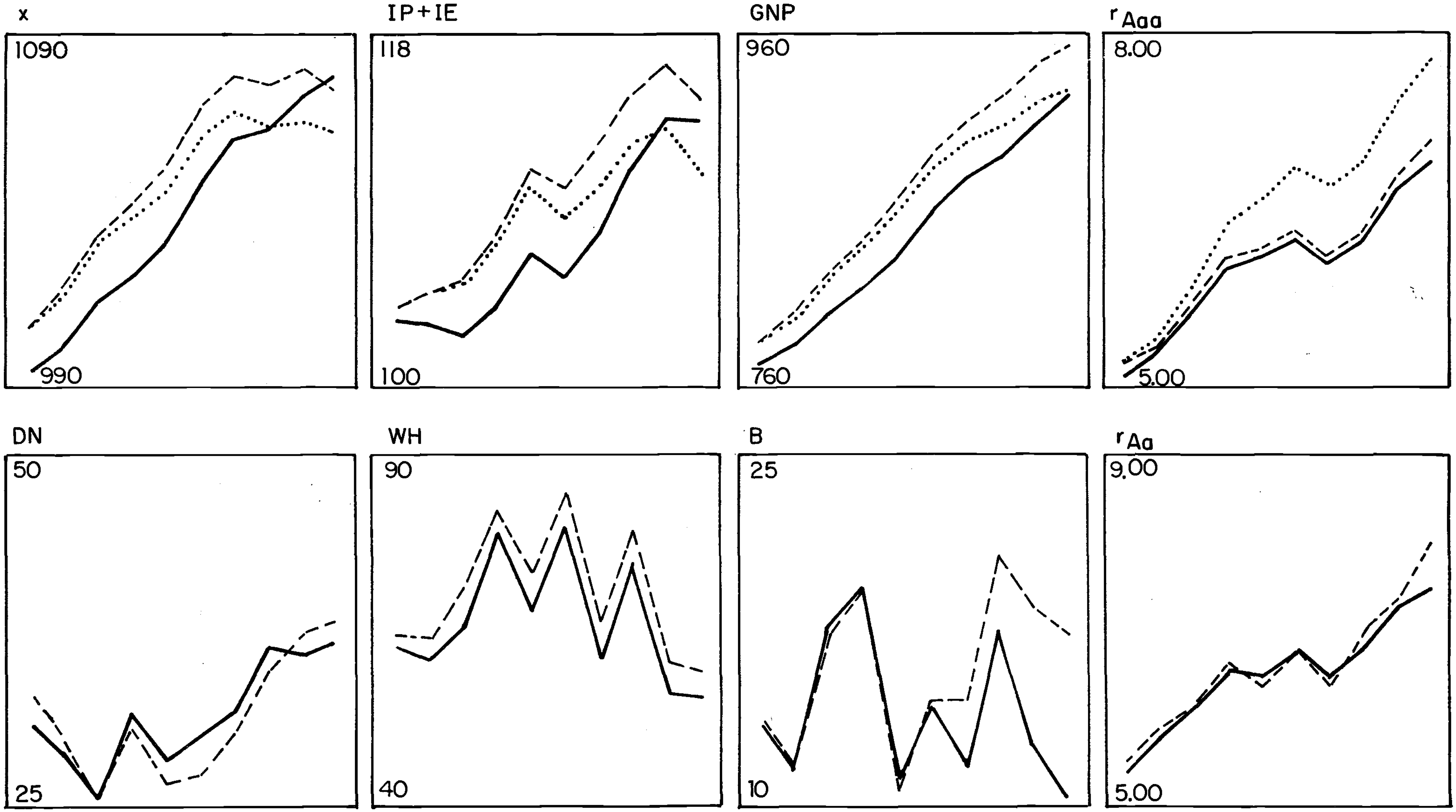
With the sharp rise in short-term interest rates, businesses have an incentive to finance more of their external funds requirements in the bond market. Hence average total bond issues rise by $1.4 billion (or 10%) in comparison to the historical, despite a smaller business deficit. At the same time, even this increase in bond issues is small in comparison with the increase in aggregate investable cash flows. As a result, the substantial shift in corporate financing toward bond issues causes only a slight increase in the corporate bond yield.

Figure 1 provides further information about these two simulations by plotting the quarter-by-quarter historical and simulated paths, for the ten quarters of the simulation period, for several key variables. The dotted paths, corresponding to the simulation of the unaltered MPS model, clearly show the model's "complete crowding out" result. The increase in government spending at first boosts private spending also, but this effect lasts little more than a year. By the tenth quarter of the fiscal stimulus, real income is far below the corresponding historical value, indicating that the $10 billion of additional government spending has crowded out more than $10 billion of private spending. After ten quarters, business capital formation is also below its historical path. Nominal income, of course, remains well above the historical path because of the induced higher price level.[17] The stock market has approximately stabilized, in comparison with the historical path, after the first year.

The broken lines in the figure show the contrasting analysis of fiscal policy indicated by the simulation of the combined MPS and corporate bond market model. Here the peak in the expansionary effect of government spending on real income again comes in the fifth quarter. In contrast to the simulation of the MPS model alone, however, here the real crowding out is about complete — but not much more than that — by the end of the simulation period. Again in contrast to the simulation of the MPS model alone, business capital formation remains above the historical path throughout the ten quarters. Among the

FIGURE 1

COMPARISON OF SIMULATED FISCAL POLICY EFFECTS (NONACCOMODATIVE MONETARY POLICY)



——— historical

········ MPS model alone

– – – – combined model

Notes: The simulation period plotted is 1967:I – 1969:II.
See Table 1 for definitions of variable symbols.

variables specific to the bond market model, the business deficit first declines and then recovers while the household cash flow first rises and then falls back, in comparison with the historical. As a result, net bond volume varies irregularly, and the corporate bond yield first rises slightly above, then falls slightly below, and finally rises sharply above the corresponding historical path.

Since the peak effect of expansionary fiscal policy on real income comes in the fifth quarter of the simulation period, the three right-hand columns of Table 1 show the precise comparative values for that one quarter. These results bear little explicit comment. In the simulation of the combined MPS and corporate bond market model, the business deficit is sufficiently small (and the household cash flow sufficiently large) that both net bond volume and the bond yield are lower than the corresponding historical values, and equity prices are accordingly higher. As a result, the peak effect on business capital formation is not trivial (over $4 billion, or 4%), and the peak effect on real income is $22 billion (or a peak multiplier of 2.15). By contrast, in the simulation of the MPS model alone the peak effect on investment is only $0 billion, and the peak effect on real income is $16 billion (or a peak multiplier of 1.65).

B. Fiscal Policy with Accommodative Monetary Policy

Although the most appropriate analytical conception of a "pure" fiscal policy action is one that leaves the money stock (or a reserve aggregate) unchanged, in reality the Federal Reserve System need not and often does not maintain monetary rigidity in the face of fiscal activism. More often, in the past the Federal Reserve has accommodated at least some of the change in the demand for money that results from fiscal actions, thereby damping the required change in interest rates. The resulting effects on economic activity are then a combination of fiscal and monetary effects.

Table 2 presents summary statistics for a pair of fiscal policy simulations — one using the unaltered MPS model and one using the combined MPS and corporate bond market model — that are structured identically to those reported in Table 1 except that, instead of exogenously maintaining the money stock on its historical path, each simulation exogenously maintains the Treasury bill rate on its historical path throughout the ten quarters of the simulation period.[18] The money stock is therefore an endogenous variable in these simulations.

The results reported in Table 2 largely speak for themselves, and the two simulations exhibit only quantitative differences. In both simulations a substantial increase (about 3%) in the money stock over the corresponding historical mean value is required to keep short-term interest rates from rising. The corporate bond yield rises on average only slightly in the simulation of the unaltered MPS model and not at all in the simulation of the combined model,[19] and the market value of equities is consistently higher (on average 15% and 21%). The average effect on real income is strongly positive (ten-quarter average multipliers of 3.15 and 3.61), and the positive effect on business fixed investment is especially strong (on average over 5% in both simulations).

Since there is no mechanism in the MPS model generating an intermediate-run crowding out result when monetary policy accommodates fiscal policy actions, the expansionary effect of this joint policy action continues to grow through the final quarter of the simulation period without reaching any internal peak. The three right-hand columns of Table 2 present the specific simulation results for the final (tenth) quarter.

TABLE 2

COMPARISON OF SIMULATED FISCAL POLICY EFFECTS (ACCOMMODATIVE MONETARY POLICY)

Variable	1967:I - 1969:II Mean Values			Values in 1969:II		
	Historical	MPS Model Alone	Combined Model	Historical	MPS Model Alone	Combined Model
G	95.0	105.0	105.0	97.1	107.1	107.1
r_{TB}	5.09	5.09	5.09	6.20	6.20	6.20
r_{CP}	5.82	5.82	5.82	7.54	7.54	7.54
r_{Aaa}	6.03	6.18	6.03	6.89	7.28	6.89
M	193.2	200.2	199.8	206.7	224.1	224.6
S	729.6	839.4	879.5	774.5	1081.0	1248.5
X	1039.3	1070.8	1075.4	1079.6	1132.6	1152.4
IP	41.9	43.8	44.0	43.6	47.4	48.4
IE	65.5	68.9	69.2	70.2	75.9	77.6
P	81.73	83.83	84.04	86.05	92.03	93.30
GNP	850.1	899.4	905.9	929.0	1042.3	1075.2
DN	31.8	—	30.0	37.0	—	29.2
WH	66.6	—	76.0	56.4	—	79.1
B	14.0	—	12.8	10.1	—	6.2
r_{Aa}	6.56	—	6.56	7.58	—	7.63

Note: See Table 1 for definitions of variable symbols.

IV. Analysis of Monetary Policy Effects

A. Monetary Growth Rate Policy

Table 3 presents the results of a pair of simulations analogous to those discussed in Section III but instead focusing on the effects of monetary policy, under the assumption that the Federal Reserve System operates by setting the rate of growth of the money stock. Once again, one simulation is based on the unaltered MPS model and the other on the combined MPS and corporate bond market model. In both simulations the policy experiment consists of setting exogenously a rate of growth of the money stock equal to 8.8% per annum over the ten quarters of the simulation period, 2% per annum greater than the historical monetary growth.[20] Fiscal policy, represented by the level of government spending, remains unchanged from the historical.[21]

The results shown in Table 3 indicate that the effect of this monetary policy action is strongly expansionary in both simulations, but more so in that for the MPS model alone. On average for the ten quarters of the simulation period, the additional 2% per annum of monetary growth raises the growth rate of nominal income in the unaltered MPS model by 3.4% per annum, of which nearly one-half represents additional price inflation and just over one-half represents additional real growth. (In considering the average simulation-period consequences of a monetary policy action like this one, it is most convenient to work with average growth rates rather than levels for the key aggregate variables.) In the combined MPS and corporate bond market model, the result of the same monetary policy action is to raise the growth rate of nominal income by only 1.7% per annum, but here nearly two-thirds of that extra nominal growth represents additional real growth while only one-third represents additional price inflation. The expansionary monetary policy stimulates business capital

TABLE 3

COMPARISON OF SIMULATED MONETARY POLICY EFFECTS (MONETARY GROWTH RATE)

Variable	1967:I - 1969:II Mean Values: Historical	MPS Model Alone	Combined Model	Values in 1969:II: Historical	MPS Model Alone	Combined Model
M	6.83*	8.83*	8.83*	206.7	217.3	217.3
G	95.0	95.0	95.0	97.1	97.1	97.1
r_{TB}	5.09	3.90	3.43	6.20	5.49	3.76
r_{CP}	5.82	4.48	3.97	7.54	6.64	4.76
r_{Aaa}	6.03	5.71	5.86	6.89	6.38	6.44
S	729.6	821.1	773.7	774.5	1047.5	920.9
X	3.41*	5.24*	4.44*	1079.6	1128.1	1106.7
IP	41.9	43.0	42.4	43.6	46.7	45.2
IE	65.5	67.3	66.3	70.2	75.1	72.8
P	4.15*	5.53*	4.77*	86.05	88.94	87.34
GNP	7.70*	11.07*	9.42*	929.0	1003.3	966.5
DN	31.8	—	31.1	37.0	—	33.6
WH	66.6	—	69.6	56.4	—	65.5
B	14.0	—	13.0	10.1	—	5.7
r_{Aa}	6.56	—	6.34	7.58	—	6.97

Notes: See Table 1 for definitions of variable symbols.
* indicates value reported is growth rate per annum.

formation in both simulations, and more so in that based on the unaltered MPS model; the difference between the two simulations in this regard is small on average for the entire simulation period, but by the final quarter it becomes sizeable.

The financial side of these simulations mirrors that discussed in Section III for the case of fiscal policy with nonaccommodative monetary policy. Here the larger supply of money drives short-term interest rates lower, especially in the early quarters before nonfinancial economic activity responds. Even by the end of the simulation period, short-term interest rates in both simulations are well below the corresponding historical values — especially in the simulation based on the combined model, in which the more modest increase in nominal income generates a smaller increase in the demand for money. The corporate bond yield is also lower than the historical in both simulations, and of the two it is lower on average in the MPS model alone. This difference is largely a matter of timing, however, since the level is about the same in both simulations by the end of the simulation period. By contrast, the market value of equities is higher than the historical in both simulations (on average by 13% and 6%), and here the two simulated paths continue to diverge through the end of the simulation period (to 35% and 19% in the final quarter). In the bond market a combination of forces leads to smaller bond volume on lower yields.

B. Interest Rate Policy

Finally, Table 4 and Figure 2 present the results of analogous simulations of the effects of a contractionary monetary policy action consisting of an exogenously maintained increase in the Treasury bill rate by 1% (that is, 100 basis points) over the corresponding historical values for this interest rate. The money stock again (as in the simulations reported in Table 2) becomes an

TABLE 4

COMPARISON OF SIMULATED MONETARY POLICY EFFECTS (SHORT-TERM INTEREST RATE)

Variable	1967:I - 1969:II Mean Values			Values for 1969:II		
	Historical	MPS Model Alone	Combined Model	Historical	MPS Model Alone	Combined Model
r_{TB}	5.09	6.09	6.09	6.20	7.20	7.20
G	95.0	95.0	95.0	97.1	97.1	97.1
r_{CP}	5.82	6.95	6.95	7.54	8.68	8.68
r_{Aaa}	6.03	6.30	6.24	6.89	7.37	7.61
M	6.74*	4.93*	5.16*	206.7	197.0	199.2
S	729.6	636.4	645.7	774.5	557.2	598.8
X	3.41*	1.75*	1.98*	1079.6	1033.09	1042.7
IP	41.9	40.8	41.0	43.6	40.2	41.0
IE	65.5	63.4	63.9	70.2	64.3	66.0
P	4.15*	3.23*	3.39*	86.05	83.83	84.48
GNP	7.70*	5.04*	5.43*	929.0	866.0	880.8
DN	31.8	—	33.2	37.0	—	41.3
WH	66.6	—	63.8	56.4	—	48.2
B	14.0	—	16.1	10.1	—	15.4
r_{Aa}	6.56	—	6.88	7.58	—	8.74

Notes: See Table 1 for definitions of variable symbols.
* indicates value reported is growth rate per annum.

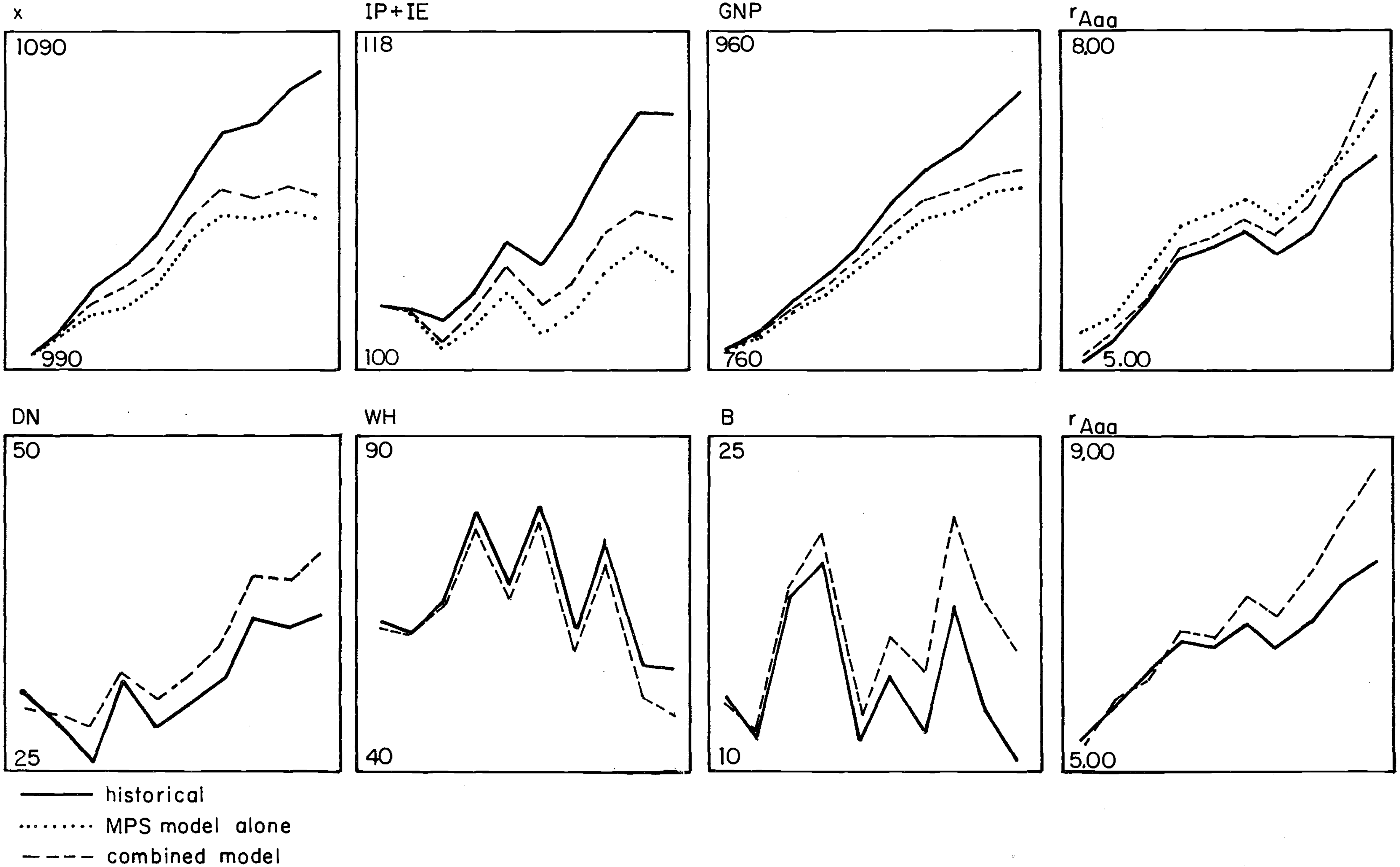
endogenous variable, varying below the corresponding historical path by as much as is necessary to clear the money market at the higher short-term interest rate level. Once again, government spending remains unchanged from the historical.

In terms of effects on nonfinancial economic activity, there is little to distinguish the two simulations. Nominal income growth slows in comparison to the historical by 2.7% per annum in the unaltered model and by 2.3% per annum in the combined model, and in both cases about two-thirds of the slower nominal growth represents slower real growth and the remainder reduced price inflation. Business fixed investment is weaker than the historical in both simulations, somewhat more so in the unaltered MPS model.

In the financial markets, however, the time path of the corporate bond yield differs sharply in the two simulations. On average over the simulation period, the bond yield is higher than the historical in both simulations — and, of the two, slightly higher in the unaltered MPS model. By the end of the sample period, the bond yield is distinctly higher in the combined MPS and corporate bond market model, as a result (in part) of a larger business external deficit (higher by 12%) together with a shrunken household cash flow (lower by 15%). These cumulating developments emerge distinctly in the full sets of quarterly values plotted in Figure 2.

FIGURE 2

COMPARISON OF SIMULATED MONETARY POLICY EFFECTS (SHORT-TERM INTEREST RATE)



Notes: The simulation period plotted is 1967:I - 1969:II.
See Table 1 for definitions of variable symbols.

V. Conclusions and Further Prospects

What should one make of these four sets of simulation results?

First — and most significantly — these comparative simulations confirm the importance of long-term asset yields (and prices) in financial-nonfinancial interrelationships, and they illustrate the corollary sensitivity of even the most central features of a macroeconomic model to the model's representation of long-term interest rate determination. The substitution of a demand-supply model for the conventional single term-structure equation does not merely provide auxiliary detail about the size of (perhaps disaggregated) securities issues and purchases. It also changes a key link in the mechanism connecting financial market phenomena to nonfinancial economic activity. As a result, the overall model gives different answers to familiar policy questions.

At a more specific level, the simulation results presented in Sections III and IV suggest that, in the short to intermediate run, fiscal policy may have somewhat larger real-sector effects and monetary policy somewhat smaller real-sector effects than conventional macroeconometric models like the MPS have indicated. Moreover, the results also suggest that these differences (for both fiscal and monetary policy) are more pronounced when the Federal Reserve System implements monetary policy by setting the monetary growth rate than when it does so by setting interest rate levels. Nevertheless, the preliminary, and in some ways very rudimentary, nature of the combined MPS and corporate bond market model used in these simulations warrants regarding such specific conclusions at best with great caution.

Finally, among the many ways of further improving and refining this combined model's representation of long-term interest rate determination, the one that stands out most clearly as of potential benefit in the analysis of macroeconomic policy effects is the addition of an explicit demand-supply treatment of the government bond market to parallel that of the corporate bond market. As Ando [3] has explained, the MPS model does not explicitly incorporate the relative asset stock effects necessary to represent the "portfolio crowding out" mechanism emphasized by Christ [10] and Silber [39]. In the model as it stands, even with the addition of the corporate bond market model, the displacement of private spending by government spending as discussed in Section III primarily reflects the "transactions crowding out" that results from the positive effect of income on the demand for money. Nowhere does the model's determination of interest rates explicitly allow for the need to have private sector investors purchase the increased net flow of government securities associated with a stimulative fiscal policy action. The demand-supply model of the U.S. government securities market developed by Roley [34] is an empirical counterpart to the model of the corporate bond market developed in Friedman [17, 19], and Roley and I are currently working on incorporating that model into the combined MPS and corporate bond market model with the specific object of explicitly incorporating such "portfolio crowding out" effects. The implications of that extended model for the effects monetary and fiscal policies (as well as debt management policy) remain as the subject of future research.

Footnotes

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1. To date the most comprehensive attempt to represent such effects within the single-equation term-structure approach has been that of Modigliani and Sutch [33].

2. See Friedman [17,18,19,20] and Friedman and Roley [21,23].

3. The basic thrust of this approach is the same as in the work of Silber [37, 38] and Hendershott [25,26], and it is similar in spirit to that of Bosworth and Duesenberry [7]. See the references cited in footnote 2 for contrasts to these authors' work.

4. Other researchers have also successfully applied this approach to the U.S. government securities market (Roley [34,35,36]), the municipal bond market (Dick [14]) and the equity market (Jones [27]). The discussion in Section V below indicates potential opportunities for incorporating these other models in work analogous to that reported in this paper.

5. This section, intended as a summary, draws heavily on the papers cited in footnote 2. See those references for further detailed descriptions and results.

6. In some contexts, such as the government bond market, asset supply is determined by a process that does not directly reflect private market participants' behavior.

7. Friedman and Roley [22] showed that linear homogeneous asset demand equations, as in (4), follow from the assumptions of constant relative risk aversion and joint normally distributed assessments of asset returns.

8. In some versions of the bond market model, variables like fixed investment and retained earnings affect bond supply even apart from their effect via the external deficit; see Friedman [18,19]. The version used in conjunction with the MPS model excludes these features. In addition, an important business use of funds that the MPS model does not determine is the net accumulation of liquid assets; it is therefore necessary to add a liquid asset equation to the model.

9. For the household sector it is necessary to add an equation for non-mortgage borrowing (mostly consumer credit) in order to determine the net financial asset accumulation.

10. Portfolio diversification behavior is a key element in the "relative asset stock effects" that, as Ando [3] has pointed out, are missing from the familiar MPS model. The discussion in Section V below suggests ways to incorporate additional aspects of relative stock effects in a further expanded model.

11. The variability of price inflation also affects investors' demands in the bond market model. The MPS model's original term-structure equation also includes some attempt to capture variability effects via a single term with the standard deviation of the commercial paper yield.

12. For descriptions of the MPS model (and its antecedents), see deLeeuw and Gramlich [12,13], Jaffee and Gramlich [24], Cooper [11], Modigliani [30], Ando [3] and Modigliani and Ando [31]. The version of the model used for this paper is the 1978 version as supplied by the staff of the Federal Reserve Board.

13. The most important aspects of financial quantity variables' effects on non-financial behavior in the MPS model concern credit availability effects in the mortgage market; see deLeeuw and Gramlich [13] and the papers by Gramlich and Hulett, Modigliani, and Jaffee in Gramlich and Jaffee [24].

14. In reality, the Treasury always finances its deficit by issuing interest-paying debt instruments, and the point is whether or not the Federal Reserve System "monetizes" that debt by purchasing some itself and thereby providing the banking system with enough reserves to absorb the remainder. The discussion in Section V below discusses ways of making this process more explicit by further extensions of the MPS model.

15. Simply eliminating the Aaa seasoned yield from the model and using the Aa new-issue utility yield in its place would have required re-estimating each such equation.

16. The table does not report corresponding mean values for the simulation of the MPS model alone, because the unaltered MPS model does not determine these variables.

17. Ando and Modigliani [31] emphasized this feature of the model and contrasted it with the puzzling implication of some reduced-form models (for example, Andersen and Jordan [2] and Andersen and Carlson [1]) that fiscal policy results in complete <u>nominal</u> crowding out. More recent work (for example, Friedman [16] and Federal Reserve Board [15]) has shown that reduced-form models estimated using current data no longer exhibit this property, although Carlson [9] has shown that it is still possible to construct and estimate such a model (if, for some reason, one wants to do so).

18. In the MPS model fixing the Treasury bill rate also fixes the commercial paper rate, as Table 2 shows.

19. The results reported in the table, showing no change at all in the bond yield in the latter simulation either on average or for the final quarter, do not imply that the bond yield is exogenous in this simulation. In fact the bond yield does change, varying sometimes above and sometimes below the historical path.

20. As the right-hand columns of the table indicate, this increase in monetary growth amounted to an extra $10.6 billion over the ten quarters. In the simulations this additional money was added in equal proportional amounts in each quarter.

21. In addition, the model imposes unchanged tax rates. Hence the monetary stimulus increases tax revenues, thereby reducing the government deficit.

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