Fiscal Policy in General Equilibrium

By MARIANNE BAXTER AND ROBERT G. KING*

This paper studies four classic fiscal-policy experiments within a quantitatively restricted neoclassical model. Our main findings are as follows: (i) permanent changes in government purchases can lead to short-run and long-run output multipliers that exceed 1; (ii) permanent changes in government purchases induce larger effects than temporary changes; (iii) the financing decision is quantitatively more important than the resource cost of changes in government purchases; and (iv) public investment has dramatic effects on private output and investment. These findings stem from important dynamic interactions of capital and labor absent in earlier equilibrium analyses of fiscal policy. (*JEL* E13, E62)

This paper studies the equilibrium effects of fiscal-policy disturbances within a quantitative version of the basic neoclassical model of macroeconomic activity. We focus on four central questions:

(i) What are the macroeconomic effects of permanent changes in the level of government purchases? Specifically, does an increase in government purchases lead to a greater than one-for-one increase in output?
(ii) How do the effects of temporary changes in government purchases differ from the effects of permanent changes?
(iii) How important is the financing decision in determining the effect of changes in government purchases?
(iv) If government purchases augment the public capital stock and thus alter private marginal products, how does this alter the analysis?

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The macroeconomic literature on "the equilibrium approach to fiscal policy," summarized by David Aschauer (1988) and Robert Barro (1989), was also motivated by these questions. We share with this literature an emphasis on the supply-side responses of labor and capital to shifts in government demand and tax rates. In the analyses of Aschauer and Barro, however, dynamic interactions of capital and labor input were severely restricted. In Aschauer (1988), labor input may be varied, but there is no capital; in Barro (1989), the labor input is fixed, but capital can be varied. Our model is a standard one-sector model with variable labor and endogenous capital accumulation. In equilibrium, *both* labor and capital react strongly to most policy shocks. Further, the presence of strong dynamic interaction effects alters standard neoclassical predictions about the macroeconomic implications of fiscal disturbances.

The organization of the paper is as follows. Section I briefly summarizes the major features of U.S. fiscal policy that we take as background to our analysis. Section II provides a brief discussion of our model and our methods of policy analysis. Sections III–VI address the four policy experiments; throughout, we use the research of the equilibrium approach to fiscal policy as a reference point. For each policy issue we review prior empirical findings, discuss their consistency with our results, and indicate directions for additional empirical research. Section III investigates the macroeconomic consequences of permanent shifts in basic government purchases (defined as those which have no effect on private marginal product or marginal utility schedules) and details the conditions under which large multipliers result from permanent changes in basic government purchases. Section IV compares the macroeconomic effects of temporary and permanent changes in government purchases, and Section V investigates the implications of alternative methods of public finance for basic government purchases. Section VI studies the effects of government capital that has direct effects on private marginal products. Conclusions are presented in Section VII.

I. Fiscal Policy in the United States, 1930–1985

The past 50 years have witnessed a permanent increase in the fraction of gross national product absorbed by government, as shown in Figure 1A. This fraction increased from 10 percent of GNP in 1930 to 20 percent in 1985. There also have been large temporary movements in government purchases, as stressed by Barro (1981a). At one point during World War II, for example, government purchases exceeded 45 percent of GNP, with most of this expenditure devoted to military purchases. In addition to an increasing volume of government purchases of goods and services, Figures 1A and 1B show that there have also been important changes in the composition of government purchases. Since World War II, military purchases have declined as a fraction of total government purchases, with some increases during the Korean and Vietnam wars, as well as during the Reagan rearmament. Public net investment rose sharply during the 1960's and fell sharply during the 1970's: it reached a high of about 9 percent of total spending in 1966 and a low of about 1 percent in 1982.

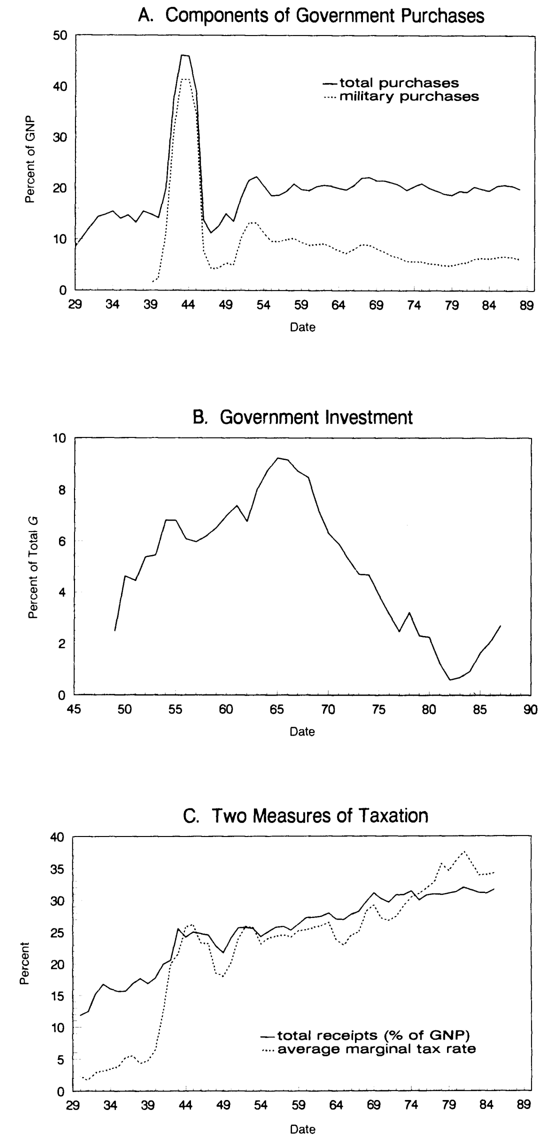

FIGURE 1. U.S. GOVERNMENT PURCHASES AND TAX RATES

The expanding influence of government over this period has generated increases in taxation, as shown in Figure 1C, which plots two comprehensive measures of taxation: (i) total government receipts as a fraction of gross national product, and (ii) the series of average marginal personal income tax rates, as generated by Barro and Chaipat Sahasakul (1986). These measures of taxation rose substantially between 1930 and 1985, reaching a level in excess of 30 percent. Of the total increase in taxes during this period, roughly half reflect an increase in tax-financed government purchases. The remainder correspond to tax-financed transfer payments, which have also grown substantially since World War II.

II. Modeling Fiscal Policy in General Equilibrium

To study the macroeconomic consequences of changes in fiscal policy, we construct a version of the basic neoclassical model that permits a variety of fiscal interventions. The model's structural elements are preferences, technologies, and resource constraints for both private and public agents, together with rules governing public finance.

Preferences.—The representative agent has preferences over sequences of consumption and leisure and maximizes expected lifetime utility, as summarized by the lifetime utility function:

$$(1)\quad U = E_1 \sum_{t=1}^{\infty} \beta^{(t-1)} u_t$$

$$u_t = \frac{1}{1-\sigma}[C_t \nu(L_t) - 1]^{1-\sigma} + \Gamma(G_t^{\mathrm{B}}, K_t^{\mathrm{G}})$$

with $\sigma = 0$. Utility depends positively on privately provided consumption services C_t and leisure L_t; $\nu(L)$ is a positive and increasing function, which governs the labor supply elasticity in the model.[1] Future consumption and leisure are discounted using the subjective discount factor $\beta < 1$. The function Γ has two arguments: G_t^{B}, which denotes "basic" government purchases, defined as those that absorb resources without altering the marginal utility of private consumption or the marginal product of private factors of production; and K_t^{G}, the stock of publicly provided capital. We assume that Γ is nondecreasing in each of its arguments. The preference specification (1) can rationalize government expenditures such as military purchases, which we think of as one component of G_t^{B}: while these expenditures increase utility, they do not directly affect private production or consumption decisions. For most of our analysis, we further specialize momentary utility to

$$(2)\quad u_t = \{\log(C_t) + \theta_L \log(L_t) + \Gamma(G_t^{\mathrm{B}}, K_t^{\mathrm{G}})\}$$

which is a form commonly employed in equilibrium macroeconomics, although for simplicity the term $\Gamma(G_t^{\mathrm{B}}, K_t^{\mathrm{G}})$ typically is omitted (see e.g., Edward Prescott, 1986).[2]

Technology.—Output at date t is the result of private capital, public capital, and labor applied to a Cobb-Douglas production function:

$$(3)\quad Y_t = F(K_t, K_t^{\mathrm{G}}, N_t) = A K_t^{\theta_K} N_t^{\theta_N} (K_t^{\mathrm{G}})^{\theta_G}$$

where K_t is the private capital stock, K_t^{G} is the stock of publicly provided capital, and N_t is the quantity of labor input.[3] In (3), both capital stocks are predetermined at date t. We also assume that there are constant returns to scale over privately provided inputs: $\theta_N + \theta_K = 1$. Private capital evolves according to

$$(4)\quad K_{t+1} = [(1-\delta_{\mathrm{K}})K_t + I_t]$$

where I_t is gross investment, δ_{K} is the rate of depreciation of capital and K_1 is the initial capital stock. Given K_1^{G}, public capi-

[1]The restriction on the form of the utility function in equation (1) is motivated by the observation that the postwar U.S. economy has displayed only small changes in average hours worked in the face of major secular growth in real wages and real incomes. Equation (1) insures that trend growth in wages and income will leave hours invariant. We also require that momentary utility is concave, which restricts the range of values for σ once $\nu(L)$ has been specified.

[2]This utility function arises as a limiting case of (1) as σ approaches unity and $\nu(L)$ is a power function with parameter θ_L.

[3]We abstract from those factors that explain trend growth in the economy, such as technical progress. However, in our quantitative analysis, we assume the production function incorporates labor-augmenting technical progress at the constant gross rate γ_X, which is chosen to match the average growth of U.S. output.

tal similarly evolves according to:

$$(5) \qquad K^{G}_{t+1} = \left[(1-\delta_K)K^{G}_{t} + I^{G}_{t}\right]$$

where I^{G}_{t} denotes government investment.

Resource Constraints.—In each period, the representative agent faces two resource constraints: (i) the sum of time devoted to work and leisure cannot exceed his endowment of time, and (ii) total uses of goods (for consumption and investment) cannot exceed disposable income:

$$(6) \qquad L_t + N_t \leq 1$$

$$(7) \qquad C_t + I_t \leq (1-\tau_t)Y_t + \text{TR}_t$$

where, τ_t denotes the tax rate on output (or, equivalently, the uniform tax rate on labor and capital income) and TR_t denotes transfer payments. Aggregate government purchases satisfy $G_t \equiv G^{B}_{t} + I^{G}_{t}$. Finally, the economy-wide resource constraint is given by

$$(8) \qquad C_t + I_t + G_t \leq Y_t.$$

Below, when we refer to the resource cost of government purchases, we mean that consumption or investment must fall when government purchases increase.

Public Finance Rules.—The flow government budget constraint is

$$(9) \qquad \tau_t Y_t = G_t + \text{TR}_t.$$

In the analysis below, we explore the importance of the financing decision by considering the use of either changes in the tax rate, τ_t, or changes in transfer payments, TR_t to finance a given increase in total purchases. We do not explicitly consider financing by debt issue, since Barro's (1974) arguments imply that changes in transfer payments are equivalent to debt financing when the sequence of tax rates, $\{\tau_t\}$, is held fixed.

A. *Macroeconomic Equilibrium*

Given the initial position of our economy, summarized by (K_1, K^{G}_{1}), competitive equilibrium is defined as a sequence of quantities and prices consistent with (1)–(9) and the private efficiency conditions discussed below.

Private Efficiency Conditions.—The representative consumer selects consumption, leisure, and investment in a dynamically efficient manner, equating the marginal utility of date-t consumption to its opportunity cost, the marginal utility of leisure to the value of forgone earnings, and the opportunity cost of investment to its future returns, subject to the transversality condition. We assume that each agent acts competitively, treating the tax rate and transfer payments as exogenous to the choice of consumption and investment, even though (9) must hold in the aggregate by appropriate adjustment of taxes or transfers. Formally, the efficiency conditions are:

$$(10) \qquad \partial U(C_t, L_t, G^{B}_{t}, K^{G}_{t})/\partial C_t = \lambda_t$$

$$(11) \qquad \partial U(C_t, L_t, G^{B}_{t}, K^{G}_{t})/\partial L_t = \lambda_t(1-\tau_t)\left[\partial F(K_t, N_t, K^{G}_{t})/\partial N_t\right]$$

$$(12) \qquad \beta E_t\{\lambda_{t+1}(q_{t+1} + 1 - \delta_K)\} = \lambda_t$$

$$(13) \qquad E_1\left\{\lim_{t\to\infty} \beta^t \lambda_t K_{t+1}\right\} = 0$$

where $q_t = (1-\tau_t)\partial F(K_t, N_t, K^{G}_{t})/\partial K_t$, $E_t(x)$ denotes the mathematical expectation of x conditional on information available at date t, and λ_t represents the shadow value of private consumption at date t [i.e., the Lagrange multiplier on (7) in a discrete-time dynamic optimization problem].[4] Taken together, these equations can be used to answer questions about the dynamic effects of fiscal policy.

[4]See King et al. (1988a section 2.4) for a discussion of the construction of the Lagrangian and derivation of first-order conditions. We simply note here that there is local stability of the system for all experiments studied here; this can be verified by examining the numerical values of the roots of the system. In each case, there is one stable and one unstable root, implying saddlepoint stability.

The Steady State.—In the long run, our economy progresses to a steady-state position in which the values of all variables are constant through time. In every steady state of the neoclassical model, the "supply side" of the model dictates that relative prices and "great ratios" are independent of the level of labor input. The standard demonstration of this result in the absence of government purchases or taxes is as follows. Since the production function is constant returns to scale, the real rental rate, q, and the real wage rate, w, are solely functions of the capital:labor ratio, κ. The long-run value of κ is implicitly determined by $q(\kappa)+1-\delta_K=1+r$, where r is the steady-state real rate of return, determined by the rate of time preference. Hence the supply side determines the relative prices $w(\kappa)$ and $q(\kappa)$. The supply side also determines the great ratios: the average product of labor $\alpha\equiv Y/N=F(\kappa,1)$; the shares of capital and labor in national income, $s_K=qK/Y=(\kappa/\alpha)q(\kappa)$, and $s_N=1-s_K$. Finally, the supply side determines the allocation of national product between consumption and investment:

$$s_I=(I/K)(K/N)/(Y/N)$$

$$=(\kappa/\alpha)(I/K)=\delta_K(\kappa/\alpha)$$

and $s_C=1-s_I-s_G$ where $s_G\equiv G/Y$. Given these relative prices and great ratios, the scale of labor input is then determined by preferences [i.e., by the efficiency conditions (10) and (11)]. Below, we discuss how changes in government policy affect this long-run situation.

B. *Methods of Policy Analysis*

Our investigation involves two types of policy analysis: (i) analysis of long-run effects, through comparative steady-state analysis; and (ii) analysis of short-run effects, through analysis of approximate dynamics near an initial steady state.

Steady-State Analysis.—The long-run effects of public policies are studied using the equations that describe the economy's steady state; it is useful to separate the two ways in which public policies affect this steady state. First, government purchases generally influence the net resources available to the society along the resource constraint. For example, basic government purchases financed by lump-sum taxation exert *only* a resource cost; as we shall see, in equilibrium this type of purchase simply removes resources from the economy without altering equilibrium prices. Government investment, on the other hand, involves a resource benefit as well as a direct resource cost, since a larger stock of publicly provided capital makes private factors more productive.

Second, in addition to affecting private opportunities via the resource constraint, some policies studied below affect steady-state relative prices and "great ratios," leading to substitution effects. To get an idea of the likely magnitudes of these effects, our approach is to provide numerical solutions for the equilibrium shifts in the steady state arising from small perturbations in fiscal policies.

Dynamic Analysis.—We similarly employ numerical methods for studying the dynamic response of macroeconomic quantities and prices to shifts in government policies. The manner in which we solve this suboptimal equilibrium system is described in King et al. (1988b section 4). Essentially, this procedure is a log-linear version of the "Euler-equation approach" to computing suboptimal dynamic equilibria (see Baxter [1991] for a general discussion of this approach). Our model is calibrated to match salient features of postwar U.S. macroeconomic activity; baseline parameter values are given in Table 1.

III. Macroeconomic Effects of Permanent Government Purchases

In the past 50 years the U.S. economy has experienced an apparently permanent increase in the fraction of output purchased by the government. Thus our first experiment studies the effects of a permanent increase in government purchases. We assume that the initial increase is unanticipated but is known to be permanent as soon

TABLE 1—NOTATION AND PARAMETERIZATION

I. Benchmark Model with Basic Government Purchases

A. *Preferences:*
θ_L chosen to imply steady state $L = 0.8$ and $N = 1 - L = 0.2$;
β chosen to imply steady state real rate of 6.5 percent per year

B. *Production Function:*
θ_N, θ_K chosen to match U.S. factor share data: $\theta_N = 0.58$, $\theta_K = 0.42$;
annual depreciation rate, $\delta_K = 0.10$.

C. *Government:*
$s_G = G/Y = 0.20$, chosen to match historical experience in postwar period;
$\tau = 0.20$, tax rate implies zero transfers in steady state.

II. Model with Productivity-Augmenting Government Purchases

share of public investment: $s_I^G = I^G/Y = 0.05$;
production function: θ_G varied, $\theta_G = s_I^G = 0.05$ used as benchmark;
depreciation of public capital: $\delta_K = 0.10$.

Note: This parameterization closely follows that of King et al. (1988a); see that paper for more discussion.

as it occurs. In order to understand the neoclassical mechanisms leading to potential multiplier effects in a dynamic model with investment and capital accumulation, it is useful to begin by analyzing this fiscal intervention in a static setting.

A. *Static Analysis*

We begin by discussing the effects of permanent government purchases in a static setting similar to that of Martin Bailey (1962). Consider an (unexpected) increase in government purchases in the amount ΔG, financed by lump-sum taxes, starting from a position of zero government purchases or taxes. For simplicity, we fix the marginal product of labor (the real wage), w, independently of the level of labor input.[5] Since the consumer experiences a reduction equal to ΔG in his income, he reduces both consumption and leisure as long as neither is an inferior good. There is thus an increase in output, but the multiplier is less than 1.

More formally, the consumer's budget constraint requires that purchases of goods and leisure not exceed a measure of "full income," which includes both the value of the (unit) time endowment and nonwage income, Π:

$$Y^{\mathrm{f}} \equiv w + \Pi \geq wL + C. \tag{14}$$

In this static economy without capital, $\Pi = -G$ since this experiment assumes that government expenditures are financed with lump-sum taxes. Denoting the full-income elasticity of leisure demand in the static setting as η_L and the leisure expenditure share in full income as $s_L^{\mathrm{f}} = wL/Y^{\mathrm{f}}$, the influence of a small change in full income on leisure is $w\Delta L/\Delta Y^{\mathrm{f}} = s_L^{\mathrm{f}}\eta_L$. Higher government purchases simply decrease full income by the same amount, so that

$$\frac{\Delta Y}{\Delta G} = w\frac{\Delta N}{\Delta G} = -w\frac{\Delta L}{\Delta G} = s_L^{\mathrm{f}}\eta_L. \tag{15}$$

To determine the quantitative output effect of a government purchase, we require values for η_L and s_L^{f}. Equation (2) implies

[5]The assumption that the real wage does not depend on labor input is the natural one for two reasons. First, the results reported in the text are upper bounds to the $\Delta Y/\Delta G$ values if there are consumption–leisure substitutions associated with a diminishing marginal product of labor. Second, the steady state of the neoclassical model has a real wage that does not depend on the level of labor input.

$\eta_C = \eta_L = 1$. From Table 1, $N = 0.2$. If the starting point is $G = 0$, leisure expenditure is quite a large fraction of full income: $s_L^f = wL/Y^f = 0.8$; thus $\Delta Y/\Delta G = 0.8$. Alternative assumptions about leisure demand can alter this specific numerical result, but the output multiplier, $\Delta Y/\Delta G$, is less than 1 so long as consumption and leisure are both normal goods. (The requirement that consumption is a normal good, $\Delta C/\Delta Y^f > 0$, implies that $s_L^f \eta_L < 1$, since share-weighted income elasticities must sum to unity). The preference specification (2) requires that leisure is invariant to common growth in full income and the real wage; it follows that the wage elasticity of leisure demand ε_L, is equal to $-\eta_L$. Thus a lower wage elasticity of leisure demand would lead to a smaller output effect of government purchases in the static model.

B. *The Dynamic Response to Permanent Government Purchases*

We now turn to the neoclassical model with investment and capital accumulation, and consider the same unanticipated, permanent increase in government purchases equal to 1 percent of initial output, which we call a commodity unit. Figure 2 shows the dynamic response of price and quantity variables. In all figures, the changes in consumption, investment, and output are expressed in commodity units. The changes in other variables are expressed as percentage deviations from initial steady-state values.

The permanent increase in government purchases has a negative wealth effect on private individuals, permanently decreasing their full income as described above. As in the static setting, individuals respond by decreasing consumption and leisure, so that steady-state labor supply increases. Because the increase in labor input shifts up the marginal product schedule for capital, there are important short- and long-run effects on investment and capital accumulation. In the short run, an accelerator mechanism operates to generate a strong increase in investment. In the long run, to which the economy rapidly converges, there will be higher capital and labor input, but the capital:labor ratio is unchanged. In the long run, output rises by 1.16 units, consumption falls by about 0.2 units, and investment rises by about 0.3 units. Labor input rises by slightly over 1 percent in the long run. To build up the long-run capital stock, however, there must be the aforementioned investment

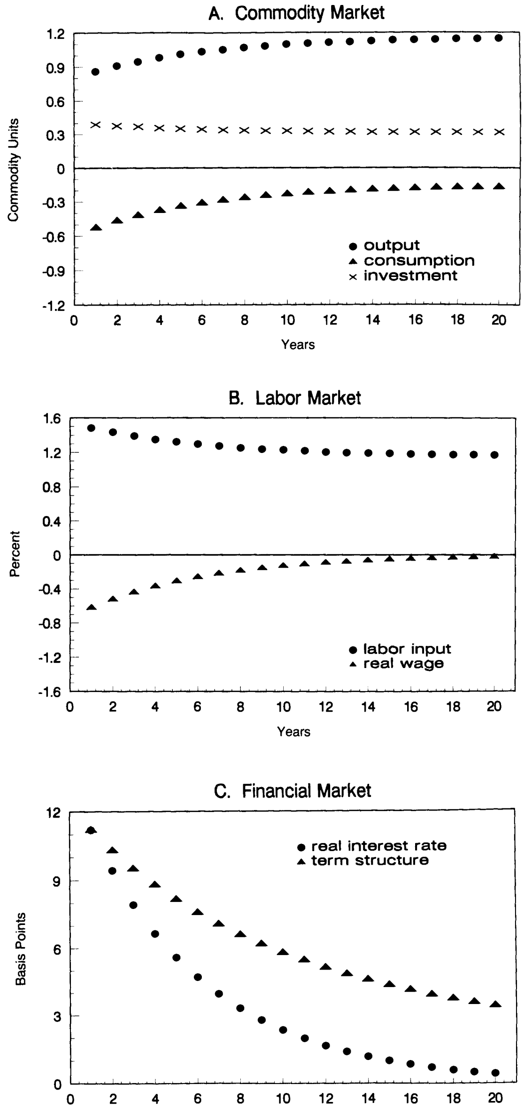

FIGURE 2. MACROECONOMIC EFFECTS OF A PERMANENT INCREASE IN BASIC GOVERNMENT PURCHASES

boom: on impact (date $t = 1$) investment rises by 0.4 units, with output rising by 0.8 units and consumption falling by 0.6 units. These quantitative results highlight a more general principle: there is an important dynamic interaction of labor and capital input as the economy responds to permanent shifts in government purchases.

In response to the short-run increase in labor supply, the real wage declines dramatically on impact. The rental rate on capital correspondingly increases dramatically on impact (this is not shown in the figure), since a predetermined capital stock is cooperating with more units of labor. Despite the fact that the increase in government purchases is permanent, these factor-price movements are temporary since the accumulation of capital ultimately restores the original capital:labor and wage:rental ratios at the new higher level of labor input.

Panel C of Figure 2 traces out the effects of ΔG on the path of one-period interest rates and the impact effect on the term structure. One-period real interest rates, r_t, are computed as the return on one-period discount bonds representing a claim to one unit of the consumption good. With preference specification (2), the period-t price of this bond is $b_t = \beta E_t(\lambda_{t+1}/\lambda_t)$, and the return from this bond is $r_t = b_t^{-1} - 1$. The term structure is computed in standard fashion, given the sequence of expected future one-period real rates. Along the transition path, the one-period real interest rate is high but declining: at early dates, its high value encourages labor supply and postponement of consumption, enabling the investment boom to take place. The term structure shifts at date $t = 1$ to reflect this expected future path of short rates: since the short rate is declining over time, the near end of the term structure increases the most sharply.

C. *The Amplification Effect of Capital*

Why does the dynamic model imply $\Delta Y/\Delta G > 1$ in the long run, while the static model does not? In both models, labor supply increases, and consumption falls in response to the permanent increase in government purchases. However, in the dynamic model, the increase in labor supply raises the marginal product of capital schedule, which stimulates capital accumulation until the initial steady-state capital:labor ratio is restored. This "amplification effect" of endogenous capital supply means that it is possible for the long-run multiplier to exceed 1. Yet the expansion of capital input also has implications for full income that act to counter this amplification mechanism: as individuals become wealthier, they wish to work less and consume more.

We develop the long-run multiplier formally as follows. First, in the steady state of the dynamic model, a natural definition of nonwage income is capital income less the sum of investment and government purchases: $\Pi = qK - IG$. Second, steady-state capital income net of gross investment is proportional to labor input, so $Y^{\mathrm{f}} = w + qK - I - G = w + \alpha(s_K - s_I)N - G$. Using this fact along with the other steady-state conditions, we find:

$$\text{(16)}\quad \frac{\Delta Y}{\Delta G} = \frac{\left(s_L^{\mathrm{f}}\eta_L/s_N\right)}{1+(s_K - s_I)\left(s_L^{\mathrm{f}}\eta_L/s_N\right)}$$

where η_L denotes the long-run, full-income elasticity of leisure demand. The numerator of (16) combines the direct labor-supply effect [as in (15)] with the amplification effect of capital accumulation (since $1/s_N = \alpha/w$). The denominator reflects the mitigating influence of accumulation on labor supply due to net income from capital ($qK - I$).

Table 2 explores the sensitivity of the long-run multiplier to parameter values.[6]

[6]To include steady-state taxation in formula (16), we need to make the following revisions. First, steady-state full income is adjusted as follows:

$$Y^{\mathrm{f}} = (1-\tau_w)w + (1-\tau_q)qK + \mathrm{TR} - I$$

$$= (1-\tau_w)w + qK + \tau_w wN - I - G$$

using the steady-state government budget constraint, Generally, we find long-run multipliers which exceed 1, with an upper bound provided by indivisible labor economy which effectively has infinite intertemporal substitutability of leisure (see Richard Rogerson, 1988). With a low labor-supply elasticity, as in the studies of male labor supply surveyed by John Pencavel (1986), the multiplier is much less than 1.

D. *The Short-Run Multiplier*

The interaction of capital and labor is also crucial for generating a short-run multiplier greater than 1. To see why, consider the response to a permanent increase in government purchases with investment exogenously held fixed at the level necessary to maintain the preexisting capital stock. Then, as in Barro and King's (1984) analysis of a point-in-time production economy, permanently higher government purchases imply lower consumption and higher labor input, at levels that are constant through time. Hence the real interest rate is constant at the rate of time preference. Yet, with the constant-returns-to-scale production function of the neoclassical model, higher labor input implies that the marginal product of capital is also higher. In fact, the capital stock would need to respond proportionately to the rise in labor input in the impact period, if the rate of return on capital is to be equated to the rate of time preference. It is this large investment demand shift at unchanged interest rates which yields the potential for a multiplier greater than 1 at date $t=1$.

TABLE 2—SENSITIVITY OF THE MULTIPLIER TO ALTERATIONS IN MODEL PARAMETERS

Alteration	$\Delta Y/\Delta G$	s_L^f	η_L
No tax ($\tau=0$)	1.20	0.78	1.00
Benchmark (Table 1 values)	1.16	0.78	1.00
Indivisible labor	1.37	0.78	1.29
Panel-data labor supply	0.49	0.78	0.33
Lower depreciation rate ($\delta_K=0.06$)	1.12	0.77	1.00
Lower real interest rate ($r=3$ percent)	1.29	0.80	1.00
Positive transfers ($\tau=0.30$, $TR/Y=0.10$)	1.10	0.74	1.00
Higher steady-state hours ($N=0.33$)	1.01	0.64	1.00
Higher labor's share ($s_N=0.67$)	1.07	0.78	1.00

Notes: The first line of the table reports results from equation (16) of the text, which is applicable without taxes. Subsequent lines report results for equation (16′) of footnote 6, which is a modification for an economy with steady-state taxation. The benchmark multiplier corresponds to Figure 2.

As shown in Table 2, the degree of intertemporal substitution in labor supply is important for generating this result, since it determines the extent to which the shift in investment demand yields additional output. If the labor-supply elasticity is maximized, as in the indivisible labor economy studied by Rao Aiyagari et al. (1990), then there is a short-run multiplier, $\Delta Y/\Delta G|_{t=1}=1.09$. On the other hand, the Pencavel (1986) estimates of male labor-supply elasticity imply that $\Delta Y/\Delta G|_{t=1}=0.31$.

In summary, there is a potential for large multiplier effects of permanent government purchases on output in both the short and long run. Both arise from the dynamic interaction of labor and capital supply, but the mechanisms differ in their details. The long-run multiplier results from the effects of higher long-run labor input on the steady-state capital stock. The short-run multiplier results from a version of the investment accelerator, in which increases in the de-

$TR+G=\tau_w wN+\tau_q qK$. Notice that τ_q does not alter this measure except as it affects quantities, while τ_w has a direct effect, since it influences the valuation of the leisure endowment. Second, the share of leisure expenditure in full income becomes $(1-\tau_w)wL/Y^f$, which may be shown to be

$$\frac{(1-\tau_w)(L/N)s_N}{(1-\tau_w)(s_N/N)+\tau_w s_N+s_K-s_I-s_G}.$$

Hence, the multiplier becomes:

$$(16') \quad \frac{\Delta Y}{\Delta G}=\frac{[\eta_L s_L^f]/[s_N(1-\tau_w)]}{1+[\eta_L s_L^f][s_K-s_I+\tau_w s_N]/[s_N(1-\tau_w)]}.$$

This formula produces the results in Table 2.

sired capital stock exert a dramatic short-run influence on labor input.

E. *Implications for Empirical Research*

Estimates of the output and real-interest-rate effects of permanent components of government purchases have been one focus of empirical research in the equilibrium approach to fiscal policy, as in Barro (1981a, b). Barro estimates that a measure of permanent government purchases has an output effect of about 0.5 with little detectable effect on the real interest rate. In particular, he finds that an increase in permanent government purchases relative to trend national product raises output relative to trend but has a negligible effect on the level of the real interest rate. This set of empirical findings accords with theoretical predictions obtained by Aschauer (1988) for a variable-labor economy without capital and by Barro (1989) for a fixed-labor economy with capital accumulation. Both models imply that unanticipated changes in permanent government purchases do not affect the real rate in the short run or in the long run.

By contrast, our model predicts a sizable short-run increase in the real interest rate with an unanticipated, permanent increase in G. Thus, we are naturally led to inquire about the consistency of this implication with Barro's (1981a, b) empirical findings. Since Barro's empirical specification regresses the level of the real interest rate on the level of permanent government purchases, our interpretation is that his results are principally long-run findings. Given the trend in the share of government in Figure 1, the least-squares estimator will seek to match the trend in the dependent variable (real interest rate) with the trend in the explanatory variable (share of government purchases). The implication of our model is that, in fact, there should be no long-run relation between trends in the share of government purchases and the long-run real interest rate, since the latter is pinned down by time preference. Thus, our model's implications seem to be consistent with Barro's evidence.

In order to detect the short-run interest-rate effect predicted by our model, one would need to extract unanticipated changes in the permanent component of government purchases. The empirical prediction of our model is that unexpected changes in permanent government purchases should be accompanied by high real rates and increases in investment.

IV. Temporary versus Permanent Movements in Government Purchases

In U.S. history, wars have been associated with temporarily high levels of government purchases and temporary increases in aggregate output.[7] To investigate the effects of temporary changes in government purchases financed by lump-sum taxation, we consider an unanticipated, one-commodity-unit increase in basic purchases which, as soon as it occurs, is known to last for T years. We first study a four-year disturbance, which we think of as a four-year war. Next, we study how the impact effect, $\Delta Y/\Delta G|_{t=1}$, changes with the duration of the disturbance.

A. *A Four-Year War*

Figure 3 shows that the dynamic response to the four-year war is broken into two phases. First, during the war years, there are reduced opportunities for private consumption, leisure, and investment due to the increased government absorption of resources. Second, after the war has ended and government purchases have returned to their steady-state level, investment is above its long-run level as the economy works to rebuild the capital stock. Private consumption and leisure are correspondingly low along this transition path. Labor input in-

[7] Mark Wynne (1989 Ch. 1) considers the basic neoclassical model's response to temporary government absorption of goods in a simulated version of the World War II experience. He argues that it is empirically important to distinguish between government absorption of goods and labor, a distinction which we do not pursue here.

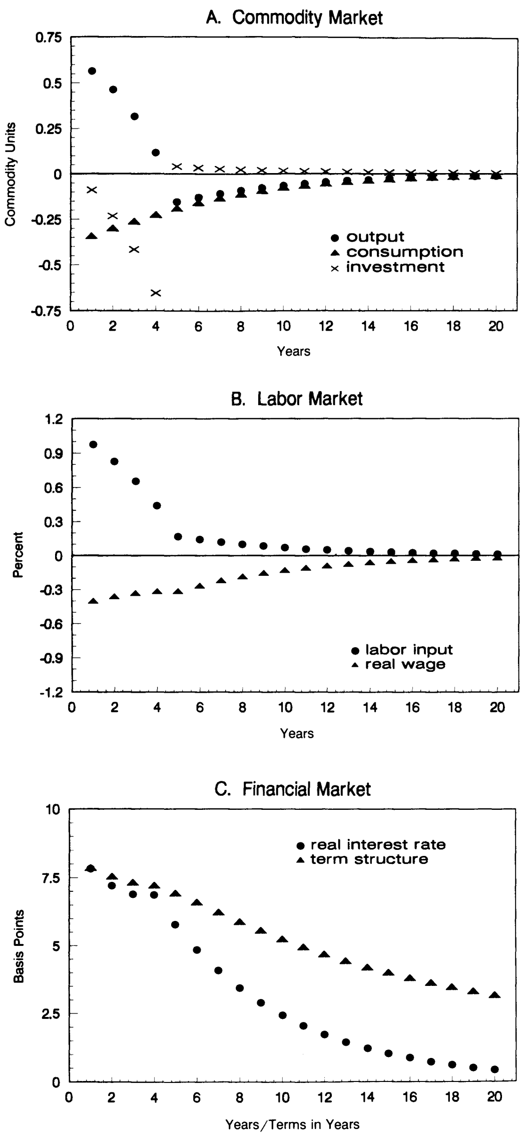

FIGURE 3. MACROECONOMIC EFFECTS OF A FOUR-YEAR WAR

creases more in the initial phase—when government spending is high—than it does along the transition path. Higher labor input is the dominant factor in the output increase during the war years. In contrast to the case of a permanent change in purchases, the temporary war generates a decline in investment on impact and further declines over the next three years.

TABLE 3—DURATION OF GOVERNMENT PURCHASES AND THE IMPACT MULTIPLIER ON OUTPUT

Duration (years)	Benchmark	$\Delta Y/\Delta G|_{t=1}$ (panel data)	Indivisible labor
1	0.20	0.06	0.28
2	0.36	0.11	0.49
3	0.47	0.14	0.64
4	0.56	0.17	0.76
5	0.63	0.20	0.84
6	0.69	0.22	0.91
7	0.73	0.24	0.95
8	0.76	0.25	0.99
9	0.78	0.26	1.01
10	0.80	0.27	1.03
20	0.86	0.30	1.09
∞	0.86	0.31	1.09

Notes: Each row of the table gives the impact multiplier value $\Delta Y/\Delta G|_{t=1}$ if the change in basic spending is presumed to last the number of years specified in the first column. The three columns correspond to alternative assumptions about labor-supply behavior previously studied in Table 2. Throughout, the share of leisure in full income equals 0.78. The full-income elasticity of leisure demand, η_L, is 1.00 for the benchmark column, 0.33 for the panel-data column, and 1.29 for the indivisible-labor column.

In terms of relative price implications, the wage rate and the rental rate move in opposite directions during the initial period of high government spending and also in the subsequent transition phase. This accords with the quantity movements, since labor input is high and capital input is low during both phases. Looking across the term structure in the impact period (the first period of the war), we find that short- and long-term interest rates rise, but with the short end of the term structure moving more. This pattern of interest-rate responses is similar to that observed for permanent changes in basic purchases (see Fig. 2). Comparing the output effects of permanent versus temporary changes in purchases (Figs. 2 and 3) we see that the impact effect on output is smaller for the temporary change: 0.56 percent for the temporary change versus 0.86 percent for the permanent change.

Table 3 explores the influence of the duration of spending on the impact effect on output, $\Delta Y/\Delta G|_{t=1}$. The impact effect of temporary purchases is smaller, the shorter is the duration of the spending disturbance. As the duration of the disturbance increases, the impact effect for the benchmark labor-supply elasticity asymptotically approaches the value shown in Figure 2. Note that the disturbance must be very persistent (lasting nine years or more) to generate a short-run multiplier greater than 1, even if there is high intertemporal substitution in leisure.

The relative magnitudes of the output effects of permanent and temporary shifts in basic purchases displayed here are contrary to predictions made by Barro (1981a) and Robert Hall (1980). Barro and Hall noted that permanent and temporary changes differ in two ways. First, there is a larger wealth effect associated with more permanent purchases. Second, increased persistence of government spending limits opportunities for intertemporal substitution. Barro and Hall assumed—incorrectly in the context of our model—that the substitution effect is quantitatively more important than the wealth effect. They consequently argued that temporary changes in government purchases should exert larger output effects than permanent changes.

Our quantitative analysis shows that increased persistence of government purchases leads to larger impact effects on output and consumption. The analysis of Barro and King (1984) suggests that the result that permanent changes have larger effects will hold in any neoclassical model in which preferences are time-separable.[8] The argument hinges on two characteristics of the basic neoclassical model. First, consumption obeys the permanent-income hypothesis and will fall by more, the more persistent are shocks to basic purchases. (Basic purchases can be thought of as a negative technology shock of an additive form.) Second, consumption and labor obey an intratemporal efficiency condition requiring that the utility-denominated value of the marginal product of labor equals its utility cost in terms of forgone leisure. Because consumption falls by more with more persistent shocks, this means that effort must also rise by more. Since capital is predetermined when the shock occurs, the multiplier on output is necessarily larger, the more persistent is the shock to purchases.

B. *Implications for Empirical Research*

Empirical research to date has estimated the output effects of changes in temporary components of government purchases, which are dominated statistically by wartime movements in military spending. Informal estimates by Barro (1984 p. 313) of the impact effects of wartime government purchases (i.e., temporary purchases) imply $\Delta Y/\Delta G = 0.6$, and his own formal statistical estimates yield an impact effect on output of 0.85 with a confidence interval of 0.5–1.2.

More generally, the empirical literature has sought to compare the macroeconomic effects of permanent and temporary movements in government purchases; however, the literature does not provide a convincing empirical case for the Barro-Hall hypothesis that temporary government purchases should have larger output effects than permanent ones. Our model indicates that this is not surprising: comparison of the implications of permanent and temporary government purchases in our Figures 2 and 3 reveals that neither output nor interest-rate effects differ markedly in the impact period, although the output effect is smaller for the temporary case and does depend on the duration of the episode (Table 3).

Our results indicate that the major differences between the effects of permanent and temporary changes in government purchases appear at the endpoints. For example, Figure 3 shows that in the last year of the temporary increase in purchases (year 4) there is substantial crowding out of investment by government purchases and minimal

[8] Working independently but using the sort of argument sketched here, Aiyagari et al. (1990) formally prove that permanent increases in government purchases have larger output effects than temporary ones, under the standard assumption that both consumption and leisure are normal goods. Barro (1989 section 5.2.3) also provides an intuitive discussion of why this must be the case.

output response. This analysis suggests that it may be fruitful to conduct empirical studies of the *ends* of wars to evaluate the macroeconomic effects of temporary shifts in government purchases.

V. Taxation and the Macroeconomic Effects of Government Purchases

This section examines the macroeconomic effects of government purchases under a stylized version of the Gramm-Rudman-Hollings (GRH) amendment of 1985 which would require the government to finance current expenditures from current (distortionary) tax revenues. In the context of our model, therefore, we require that revenues from the output tax equal expenditures on a period-by-period basis, holding constant the path of transfer payments: $\tau_t = [G_t + \mathrm{TR}_t]/Y_t$. First, we study unanticipated, permanent changes in government purchases, focusing solely on steady-state effects. Second, we study temporary increases in purchases, again within the context of a four-year war. We find that the GRH amendment would radically alter the output effects of both temporary and permanent government purchases, leading output to decline on impact, rather than increase. As before, we consider an initial increase, ΔG, equal to one commodity unit.

A. *Permanent Increases in Government Purchases*

With an increase in government purchases, there must be a corresponding increase in the tax rate to satisfy the government budget constraint. Because the increase in the tax rate reduces individuals' incentives to work and to invest, thus reducing the tax base, tax rates must increase by more than $\Delta G/Y$. There is a "supply-side multiplier" at work, by which increases in purchases and tax rates induce declines in output that in turn require additional increases in tax rates.

To calculate the size of this supply-side multiplier, it is easiest to begin by holding labor input fixed. Combining the production function (3), the steady-state equilibrium condition for capital accumulation, and the fiscal constraint (9) yields

$$\text{(17)} \qquad \Delta Y = -\left(\frac{\theta_K}{\theta_N - \tau}\right)\Delta G < 0$$

so long as $\theta_N - \tau > 0$, as is the case for the United States.

We study the magnitude of $\Delta Y/\Delta G$ starting from an initial position in which $\tau = G/Y = 0.20$; this corresponds to the "benchmark" case in Table 2. Output falls by more than the increase in government purchases: $\Delta Y/\Delta G = -1.10$. This contrasts with the earlier multiplier of 1.16 reported in Table 2 for a change in purchases financed by lump-sum taxation; evidently, the public-finance decision is central to the effects of government purchases. To balance the budget under GRH, the necessary tax change is

$$\text{(18)} \quad \Delta\tau = (1-\tau)\left(\frac{\theta_N}{\theta_N - \tau}\right)(\Delta G/Y).$$

With $\tau = (G/Y) = 0.2$, the implied increase is $\Delta\tau = 1.22(\Delta G/Y)$.

To this point, we have ignored variation in labor input. In fact, since the preference specification (1) implies an exact offset of the income and substitution effects of technical shifts, there will be no equilibrium variation in labor if initial transfers are zero (TR = 0). In this case, an increase in taxes works like a permanent, total-factor-augmenting technical shift from the standpoint of the private sector: since permanent technical shifts do not affect steady-state labor, neither do permanent tax-financed shifts in government purchases. Thus, this result is independent of labor-supply elasticities, other than the restrictions imposed by steady-state growth.

On the other hand, if initial transfers are nonzero, there generally will be equilibrium changes in labor input. This makes the output adjustment more complicated than that given in expression (17), since there are additional terms reflecting the interaction of output, labor input, and capital accumulation. For example, if we set the initial level of (TR/ Y) at 10 percent, we find that $\Delta Y/\Delta G = -2.54$. This more dramatic output adjustment reflects the fact that the increase in the tax rate reduces labor input, thereby shrinking the tax base. Tax rates must therefore rise more, the more elastic is the labor-supply response to changes in taxes. The tax rate change with variable labor supply is $\Delta\tau = 1.76(\Delta G/Y)$.

B. *Temporary Increases in Government Purchases*

This subsection explores how the economy responds to an unexpected change in government purchases that is known to be temporary, when the change in purchases is financed by current revenues from distortionary taxation. Specifically, we consider the four-year war studied in Section IV, above. This requirement means that the period of temporarily high government purchases also becomes an interval of temporarily high distortionary taxes. Since high taxes imply temporarily low after-tax factor rewards, there is a strong incentive to substitute work effort intertemporally away from the wartime period and also to curtail investment during this period.

Figure 4 displays the dynamic response of the economy to the tax-financed war. The solid circles indicate the result obtained under GRH, while the open circles indicate the result obtained in Section IV under lump-sum taxation. In contrast to our earlier findings, under GRH the economy exhibits a decline in output and work effort during the four war years, reflecting the dominance of substitution effects induced by higher taxes.[9] The GRH amendment would impose tax distortions precisely when society must reduce consumption, leisure, and investment due to temporarily high government purchases. This particularly poor timing of tax distortions would be avoided by the smoothing of taxation over time (as discussed by Barro [1979] and Sahasakul [1986]) and the related use of public debt for financing temporarily high purchases.

C. *Implications for Empirical Research*

The requirement that the government finance current expenditures from current revenues from distortionary taxes implies major differences in the response of the macroeconomy to both permanent and temporary changes in government purchases, relative to the case of lump-sum taxation. In our model, the public-finance decision is quantitatively far more important than the issue of the duration of government purchases discussed earlier. Yet most of the literature on the equilibrium approach to fiscal policy has concentrated on the duration of purchases, rather than the method of financing them. Future empirical work should control for the public-finance decision, perhaps by including comprehensive measures of the tax rate as an explanatory variable in regressions. This practice is likely to be especially important for studying permanent movements in government purchases, since there have also been associated, permanent changes in U.S. tax rates (Sahasakul, 1986).

The strong negative influence of tax-financed government purchases on output, discussed in Subsection V-A above, principally involves the depressing effect of income taxation on capital formation. If we start from a position of no transfer payments, however, such income taxation does not affect labor supply. The difference in long-run capital and labor-supply elasticities suggests that future theoretical and empirical analyses would profit by distinguishing between capital and labor income taxation.[10]

[9]Lee Ohanian (1992) suggests that the Korean War interval involved this type of negative influence of fiscal policy on real activity due to contemporaneous financing via distortionary taxation.

[10]Promising initial research along these lines has been conducted by Anton Braun (1989) and Ellen McGrattan (1991).

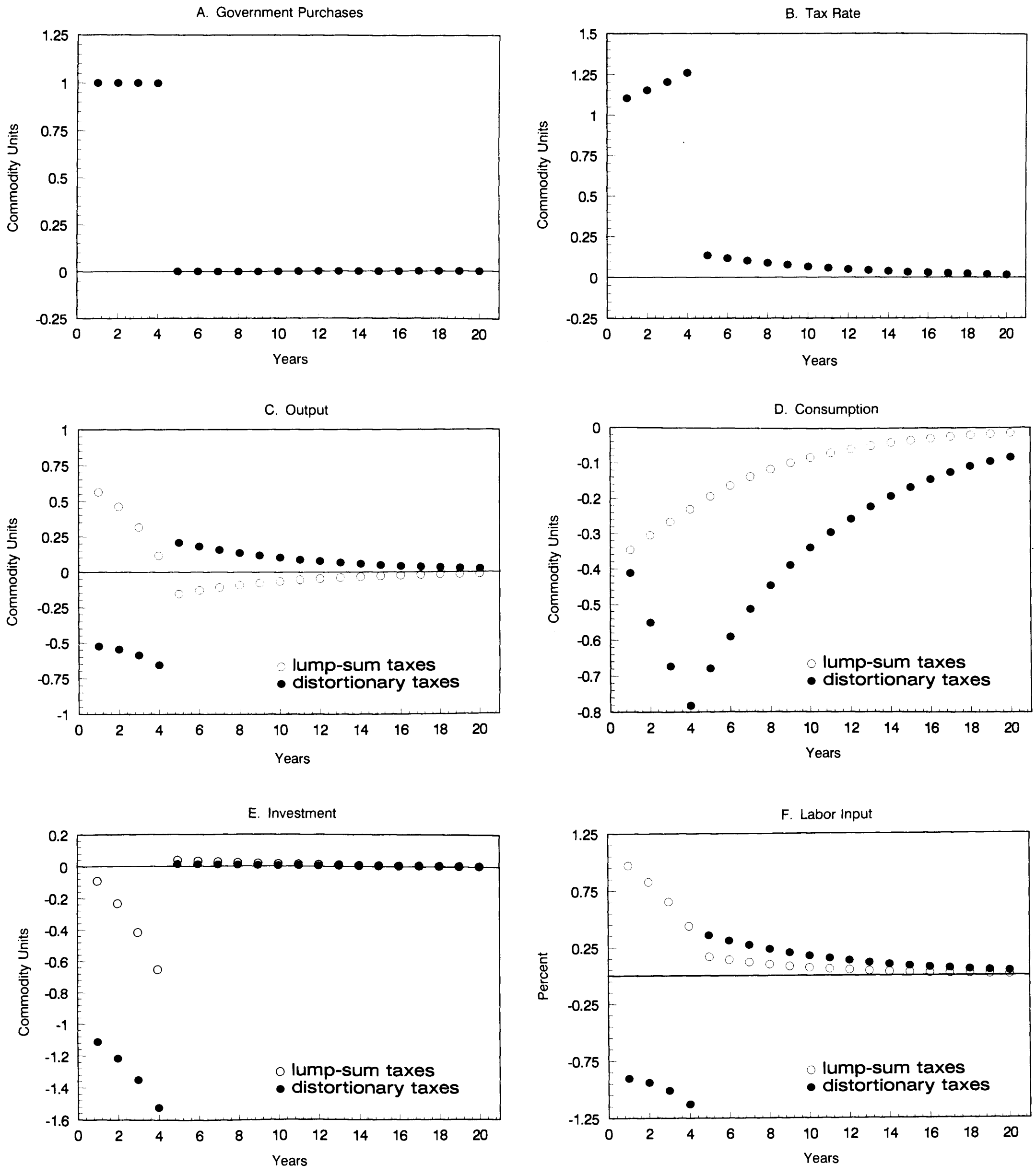

FIGURE 4. MACROECONOMIC EFFECTS OF ALTERNATIVE TAX POLICIES

VI. Productive Government Purchases

This section studies the effects of government purchases which directly affect private decisions by shifting marginal product schedules. In light of the historical evidence of Section II, we focus on permanent changes in public investment. First, we look at the long-run effects of an increase in public investment under alternative assumptions about the productivity of public capital. Second, we trace out the dynamic implications of this shift using a specific value of the productivity parameter for government

TABLE 4—LONG-RUN EFFECTS OF PUBLIC INVESTMENT

θ_G (i)	Direct effect, $\Delta Y/\Delta I^G$ (ii)	K adjusts, $\Delta Y/\Delta I^G$ (iii)	Both K and N adjust $\Delta Y/\Delta I^G$ (iv)	$\Delta C/\Delta I^G$ (v)	$\Delta I/\Delta I^G$ (vi)
0.00	0.00	0.00	1.16	−0.15	0.31
0.01	0.20	0.34	1.45	0.01	0.44
0.03	0.50	0.86	1.90	0.25	0.64
0.05	1.00	1.72	2.64	0.66	0.98
0.10	2.00	3.45	4.12	1.48	1.65
0.20	4.00	6.90	7.09	3.11	2.98
0.40	8.00	13.79	13.02	6.37	5.65

Notes: The column marked "direct effect" gives output effects holding private factors of production fixed. The column marked "*K* adjusts" gives output effects with labor fixed and private capital adjusting. The final three columns are output, consumption, and private-investment effects with both private factors adjusting.

capital. In each case, shifts in purchases are financed via lump-sum taxation.

To begin, recall that government capital works like a productivity shift from the standpoint of the private determination of capital and labor input: $F(K_t, K_t^G, N_t) = (K_t^G)^{\theta_G}[K_t^{\theta_K} N_t^{\theta_N}]$. Holding government capital fixed, government investment works like basic government purchases (or a production-function shift which does not affect private marginal product schedules). If we treat private capital and labor as unresponsive to government capital, then steady-state net output, $Y - I^G$, is maximized when $s_I^G \equiv I^G/Y = \theta_G$. With this rate of public investment, a marginal increase in I^G leaves net output unchanged, so we describe this as the case of "zero net resource use."

A. *Long-Run Effects of Public Investment*

The response of output to an unexpected increase in public investment (which is known to be permanent, once it occurs) depends on (i) the direct effect of higher public capital, holding private capital and labor inputs fixed; and (ii) a supply-side effect due to the response of private capital and labor. Table 4 reports the magnitudes of these effects for a range of values of the productivity parameter θ_G, under the assumption that the share of public investment, s_I^G, is equal to 0.05. When public capital is unproductive, $\theta_G = 0$, the first row of the table replicates the results for basic government purchases obtained in Section III above.[11] Subsequent rows report results for higher values of θ_G. As we increase the productivity parameter, there are larger direct effects, as reported in the second column of the table. The direct effect is unity in the case of zero net resource use ($\theta_G = s_I^G = 0.05$).

The results of Table 4 show that the supply-side responses of capital and labor are key determinants of the output response to public investment. With fixed labor and endogenous capital accumulation (column iii), the output effect is uniformly 1.72 times the direct effect since, in equilibrium, private capital expands to the point where its marginal product is equal to an unchanged return. Thus, output expands by

[11] The results correspond to those obtained in Section III as follows: the first two columns of results for $\Delta Y/\Delta I^G$ show that (i) there is no direct output effect; and (ii) there is no output effect with variable capital and fixed labor, since basic purchases do not shift the marginal productivity schedule for capital. With endogenous labor input, we have results that accord with Figure 2 and Table 2: output increases by more than the increase in government purchases, consumption falls, and private investment rises.

$1/(1-\theta_K)=1.72$ with $\theta_K=0.42$; the endogenous response of private capital is therefore quantitatively less important than the direct effects of public capital on output. With variable labor input, however, output effects attributable to the *combined* supply-side responses of labor and capital can substantially exceed the direct productivity effects, so long as the substitution effect on labor input outweighs the wealth effect. For example, when $\theta_G = s_I^G$, the output effect with variable capital and labor is 2.6 times the direct effect. Table 4 also indicates that permanent increases in public investment induce long-run increases in private consumption and investment, so long as public capital is even slightly productive. Again using $\theta_G = s_I^G$ as a specific example, we find that the unit increase in public investment raises private consumption by about two-thirds of a unit ($\Delta C/\Delta I^G = 0.66$).

Our largest value of θ_G ($\theta_G = 0.40$) corresponds to the highest estimate obtained by Aschauer (1989),[12] yielding results that are dramatic in two respects. First, the direct output effect is eight times the change in public investment. Second, in contrast to results with smaller values of θ_G, there is little difference between the output effects with fixed labor and those with variable labor. Presumably, this reflects a wealth effect of highly productive public capital on the demand for leisure.

B. *Short-Run Effects of Public Investment*

An unexpected permanent increase in the flow of public investment introduces three forces which operate on the economy along its transition to the new steady state. First, there is a permanent increase in governmental absorption of resources, as with the basic government purchase studied above. Second, as the stock of public capital accumulates over time, it directly yields an increased flow of output. Third, the marginal product schedules for private labor and capital shift over time as a result of the rising stock of public capital, stimulating alterations in labor and private capital.

The importance of public capital for private factor supply is highlighted in Figure 5, which plots the response of quantity variables to the increase in public investment for the case of zero long-run net resource use ($\theta_G = s_I^G$). Figure 5A plots the direct resource cost of public investment, and Figure 5B shows the direct productivity effect of public capital (i.e., the output response holding private factors fixed). The difference between the two measures the decline in resources available for private consumption and investment. This loss equals the full shift in public investment on impact; is one-half at six years; and is negligible after 20 years.

The remaining panels of Figure 5 plot the response of quantity variables to this permanent increase in the level of public investment. To evaluate the importance of the third effect described above (the effect of public capital on private marginal products and factor supply), two cases are presented. The triangles show the response of the economy to this shock under the assumption that the increase in public investment does not affect private marginal products. The circles show the response of the economy when labor and capital respond to their steadily rising productivity caused by the rising stock of public capital. (This is similar to the approach taken in Table 4 to isolate components of the steady-state responses.)

In the first year of the circle economy, private investment increases, since its marginal product has shifted up due to increases in labor input and the stock of public capital. In the reference (triangle) case, however, with no direct effect of the increase in government investment on private marginal products, private investment declines slightly. These responses reflect the fact that the economy is subject to a highly persistent but ultimately temporary drain on the resources for private consumption and investment (while there is zero net resource use in the long run, government capital ac-

[12] In his table 1 (panel A, equations 1.1 and 1.2), Aschauer (1989) reports estimates that correspond to $\theta_G = 0.39$.

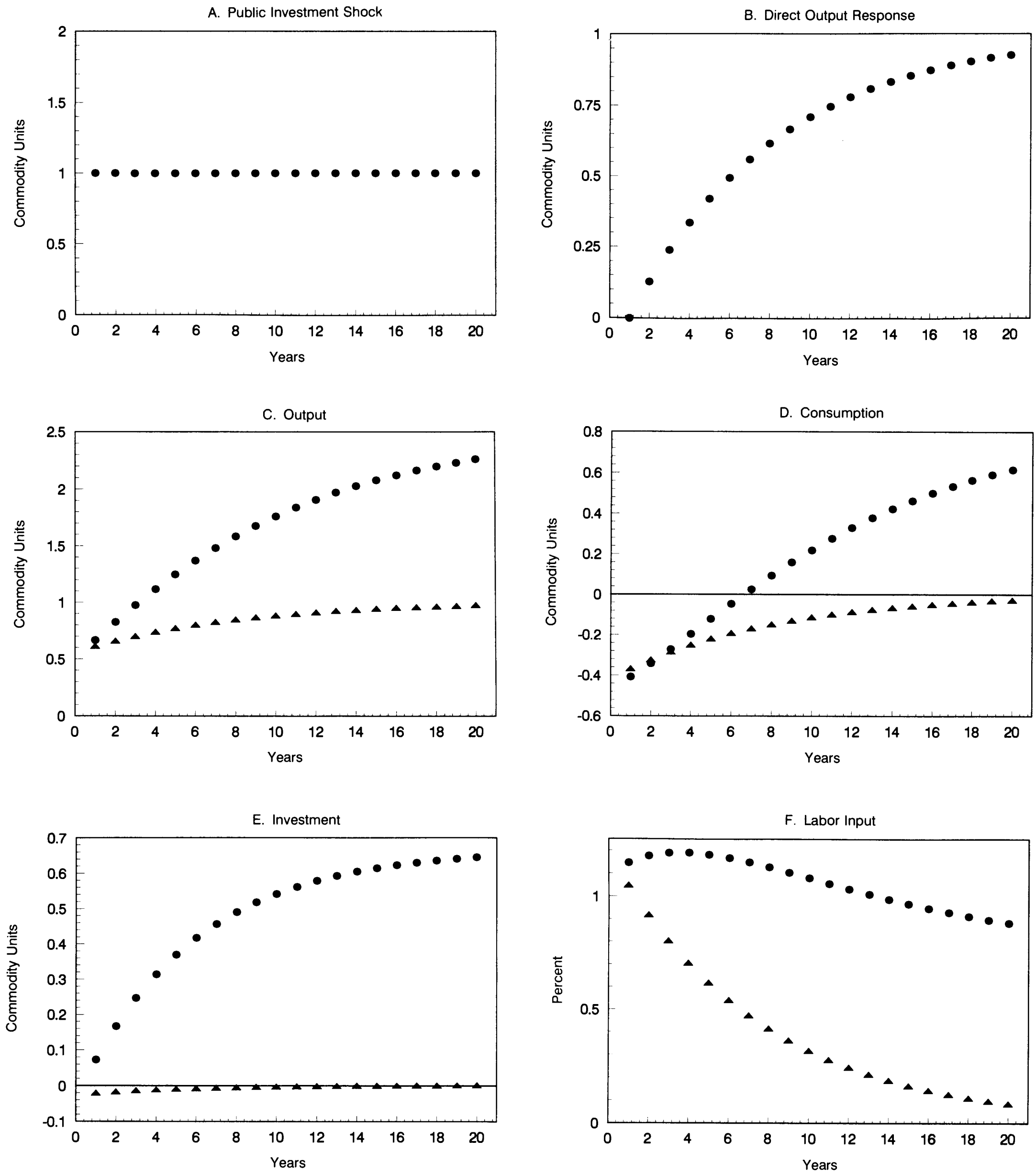

FIGURE 5. MACROECONOMIC EFFECTS OF A PERMANENT INCREASE IN PRODUCTIVE PUBLIC INVESTMENT

cumulates slowly). In both cases, consumption declines on impact while labor input rises. In later years, as the public capital stock increases, its implications for private marginal products stimulate additional supply of both labor and capital in the circle economy. The gap between the two economies rapidly widens as the circle economy transits to a new steady state with higher private investment, consumption, and labor input, while the triangle economy moves to the original steady state with unchanged private investment, consumption, and labor input.

C. *Implications for Empirical Research*

Our analysis of the effects of public investment supports Aschauer's (1989) view that variations in publicly provided capital may have important macroeconomic effects. In particular, the recent decline in public investment, as seen in Figure 1B, could provide a partial explanation for the roughly contemporaneous decline in private factor productivity. Using a productivity parameter for government capital only one-fourth as large as that estimated by Aschauer for nonmilitary public capital, we find a long-run multiplier of about 4. If we use Aschauer's estimate, we obtain a long-run multiplier of about 13. The sensitivity of our results to this parameter suggests that further effort should be devoted to obtaining more precise estimates. Further empirical work would also be useful in clarifying (i) the extent to which public capital augments labor versus capital productivity, (ii) which sectors of the economy are most sensitive to variation in public capital, and (iii) which types of public capital are most important for private productivity (Aschauer [1989] provides some information on this subject).

VII. Conclusions

In this paper, we have explored four central fiscal-policy topics within the context of a quantitative equilibrium model. Our main findings are as follows. First, we find that permanent changes in government purchases have important effects on macroeconomic activity when these are financed by lump-sum taxation. There is likely to be a multiplier greater than 1 in the long run; if labor supply is highly elastic, a short-run multiplier greater than 1 is also possible. Second, we find that permanent changes in government purchases are associated with larger output effects than are temporary changes in purchases, contrary to the suggestions of Barro (1981a) and Hall (1980). Third, we find that the financing decision is quantitatively much more important than the direct resource cost of government purchases. For example, we find that output *falls* in response to higher government purchases when these are financed by general income taxes. Fourth, we find that the macroeconomic effects of government purchases depend importantly on whether these directly affect private marginal product schedules. If government capital augments the productivity of private capital and labor, public investment policies can have dramatic effects on output and private investment.

In each case, our analysis uncovered empirical predictions of the basic neoclassical model that have not previously been investigated in the literature on the equilibrium approach to fiscal policy. In particular, we found surprising the important role played by the public finance decision in determining the evolution of economic activity. In our future work, we plan a detailed exploration of the links between taxation and macroeconomic activity.

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