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THE EQUILIBRIUM APPROACH TO FISCAL POLICY

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A. Introduction

Macroeconomists recently have reconsidered the effects which the public sector's spending and tax decisions may have on the macroeconomic variables of employment, output, investment and the interest rate. Models have been constructed on the basis of optimizing agents making consumption and production decisions on the basis of all available information in a competitive equilibrium setting. This article lays out a simple model to discuss the positive and normative aspects of fiscal policy.

B. An Expositional Model

The analysis of the effects of fiscal policy actions will be undertaken by considering variations of the following simple model. The economy is composed of a "representative" agent who attempts to maximize the utility functional

$$V = \sum_{t=1}^{\infty} \beta^{t-1} u(\underset{+}{c_t}, \underset{-}{l_t}, \underset{+}{g_t}) \tag{1}$$

where β is a subjective discount factor, $0 < \beta < 1$, c denotes physical consumption, l is work effort, and g equals government expenditures on goods and services. It is assumed that consumption and work effort provide utility and disutility, respectively. Government spending adds to private utility, possibly as a substitute for private consumption goods (e.g., school lunches, library books) or as a complement to leisure activity (e.g., public parks, scenic highways).

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The agent has access to the constant returns to scale production technology

$$y_t = f(\underset{+}{l_t}, \underset{+}{k_{t-1}}, \underset{?}{g_t}) = w_t l_t + \rho_t k_{t-1} + \mu_t g_t \tag{2}$$

where k_{t-1} is physical capital accumulated up to the beginning of period t; w_t is the marginal product of labor; ρ_t is the marginal product of capital; and μ_t is the marginal product of goods and services provided by the public sector. The sign of μ in general will be ambiguous since some public inputs to the private production process (e.g., police services, highways) likely will enhance production while other inputs (e.g., pollution control, occupational safety regulations) likely will detract from production.

Given this production process, the agent's period t budget equation is given by

$$(b_t - b_{t-1}) + (k_t - k_{t-1}) + c_t + t_t =$$
$$(1 - \tau_t)[w_t l_t + (\rho_t - \delta)k_{t-1} + r_t b_{t-1}] + \mu_t g_t \tag{3}$$

where b_{t-1} are bonds (private or public) accumulated by the agent up to the beginning of period t; t are lump sum taxes; and τ is a proportional tax rate on income from labor, capital (net of depreciation charges), and securities. It is convenient, though not restrictive, to exclude the income attributable to the inputs provided by the public sector from the tax base. As written, the budget constraint dictates that available resources in period t—net of tax income from production and the agent's portfolio of bonds—be disposed of by saving—adding to the stock of bonds or physical capital—or by consuming.

Although this model involves many abstractions, we note three in particular. First, the formulation combines consumption and production decisions in the household sector, thereby ignoring possible complications arising from differences in the tax treatment of personal and corporate income. Indeed, tax effects are limited to the common, proportional rate τ on taxable income. Brock and Turnovsky (1981) consider some of the issues below in a more general model with a richer tax structure and with the problems of utility maximization by consumers and value maximization by firms separated. Second, the representative agent has been modelled as having an infinite planning horizon. This has been rationalized along two lines. On the one hand, although individuals are not infinitely lived, their planning horizons may be of sufficient length, given reasonable discount rates, to render the abstraction of an infinite planning horizon a good approximation. On the other hand, finitely lived individuals may have, in effect, infinite planning horizons given the existence of an operative chain of bequests from generation to generation; more will be said on this in the next subsection. Third, private and public bonds are taken to be perfect substitutes in the agent's portfolio of securities. The empirical results to be found in Plosser's (1982) study of the effects of public financing decisions on excess bond returns suggest that this assumption is not overly restrictive.

The optimality conditions for the agent's problem may be obtained from the Lagrangian functional

$$L = \sum_{t=1}^{\infty} \beta^{t-1}[u(c_t, l_t, g_t) + \lambda_t[(1-\tau_t)(w_t l_t + (\rho_t - \delta)k_{t-1} + r_t b_{t-1}) + \mu_t g_t - b_t + b_{t-1} - k_t + k_{t-1} - c_t - t_t]] \tag{3}$$

which, upon differentiation, yields

$$\frac{U_l(\cdot t)}{U_c(\cdot t)} = -(1-\tau_t)w_t \qquad t = 1, 2, \ldots \tag{4}$$

$$\frac{U_c(\cdot t)}{U_c(\cdot t+1)} = \beta[1 + (1-\tau_{t+1})r_{t+1}] \qquad t = 0, 1, \ldots \tag{5}$$

$$r_{t+1} = \rho_{t+1} - \delta \qquad t = 1, 2, \ldots \tag{6}$$

Equation (4) ensures that the marginal rate of substitution between leisure and consumption equals the net of tax marginal product of labor. Equation (5) states that the individual adjusts his consumption profile so that the marginal rate of substitution between current and future consumption is equal to the subjectivity discounted net of tax return to bonds. Equation (6) indicates the individual varies the capital stock to equate the returns to capital, net of depreciation, to the return to debt securities. Note that it is being assumed that the individual may take a short or long position in the debt market and that a resale market for physical capital exists.

In addition, the transversality conditions

$$\lim_{t\to\infty} \beta^t U_c(\cdot t) b_t = 0 \tag{7}$$

$$\lim_{t \to \infty} \beta^t U_c(\cdot t) k_t = 0 \tag{8}$$

are imposed on the agent's problem to rule out the possibility of the agent increasing current consumption without the penalty of a reduction in consumption at some point in the future. Given the initial conditions $c_0 = c^0$, $l_0 = l^0$, $k_0 = k^0$, $b_0 = b^0$, equations (2) and (4)-(8) are sufficient to insure an optimum for the individual's problem as given in (3) and so to determine the individual's choices of consumption, work effort, additions to the capital stock, and bond acquisitions in all periods t = 1, 2, ...

It will prove convenient to work with the agent's intertemporal budget constraint which may be obtained using (3) and (6) as

$$\sum_{t=1}^{\infty} \hat{R}_t [c_t + (1 - \tau_t) w_t (1 - l_t)] =$$

$$k_0 + b_0 + \sum_{t=1}^{\infty} \hat{R}_t [(1 - \tau_t) w_t + \mu_t g_t - t_t] \tag{9}$$

where $\hat{R}_t^{-1} = \prod_{j=1}^{t} [1 + (1 - \tau_j) r_j]$. As written, this equation states that expenditures on goods and leisure in present value terms must equal initial wealth plus the value of the time endowment and government goods and services provided as an input to the private production process minus taxes, also in present value terms.

The public sector purchases goods and services which are used in private activities. The financing of these purchases as well as the acquisition of bonds, b^g, is achieved by use of the proceeds from lump sum and income taxation and from the return to public sector bond holdings. The flow budget constraint of the government, therefore, is given by

$$b_t^g - b_{t-1}^g + g_t = t_t + \tau_t [w_t l_t + (\rho_t - \delta) k_{t-1} + r_t b_{t-1}] + r_t b_{t-1}^g. \tag{10}$$

We also may obtain the government's intertemporal budget constraint from (10) as

$$\sum_{t=1}^{\infty} \hat{R}_t g_t = b_o^g + \sum_{t=1}^{\infty} \hat{R}_t \big[t_t + \tau_t [r_t (b_{t-1} + b_{t-1}^g)$$

$$+ (\rho_t - \delta) k_{t-1} + w_t l_t]\big] \tag{11}$$

which ensures that the present value of government purchases of goods and services equals initial holdings of debt plus the present value of lump sum and income tax revenues.

The model is closed by asserting that equilibrium is maintained continuously in the goods and bond markets by appropriate adjustments to the rate of return on bonds. The market clearing conditions are

$$c_t + i_t + g_t = y_t \tag{12}$$

$$b_t + b_t^g = 0 \tag{13}$$

where the economy has been assumed to be barred from trading in international goods or bond markets. Note that by Walras' Law the set of equations (3), (9), (12), (13) are linearly dependent so that the interest rate may be viewed as being determined in either the goods or the bond market. The analysis below will focus on the effects of fiscal policy in the goods market.

C. Equivalence between Public Debt and Taxes

A fundamental feature of the model outlined above is that the temporal pattern of lump sum taxation required to finance a particular public expenditure stream is irrelevant to the determination of real variables of the economy. This equivalence between tax and debt finance, the possibility of which may be traced back at least to the writings of Ricardo, is of crucial importance to the neoclassical analysis of fiscal policy as it allows the focus of attention to be shifted from financial to real resource considerations.

Abstracting from distortional taxation, the private sector budget constraint (9) becomes

$$\sum_{t=1}^{\infty} R_t[c_t + w_t(1 - l_t)] = k_0 + b_0 + \sum_{t=1}^{\infty} R_t[w_t + \mu_t g_t - t_t] \tag{14}$$

while the government budget contraint (11) is now

$$\sum_{t=1}^{\infty} R_t g_t = b_0^g + \sum_{t=1}^{\infty} R_t t_t \tag{15}$$

where $R_t^{-1} = \underset{j=1}{\overset{t}{\pi}} (1 + r_j)$. Substitution of equation (15) into equation (14) yields the economy wide budget condition

$$\sum_{t=1}^{\infty} R_t[c_t + w_t(1 - l_t)] = k_0 + (b_0 + b_0^g) + \sum_{t=1}^{\infty} R_t[w_t - (1 - \mu_t)g_t]. \quad (16)$$

This expression is independent of any direct influence of lump sum taxes and thereby illustrates that the economy's opportunities are unchanged by a change in the temporal pattern of taxes. There arises an equivalence between debt and tax finance of the public expenditure stream, with any change in lump sum taxes bringing forth a completely offsetting change in private savings behavior. Real economic outcomes need not, and will not, be affected by the choice of public financial policy.

This result has been illustrated in the context of a highly stylized economy, the assumptions of which may be regarded as overly restrictive. In particular, various authors, especially Tobin (1971, 1978), have argued against the Ricardian equivalence proposition on practical grounds. The subsequent discussion centers on three necessary conditions for an exact derivation of debt neutrality: infinite planning horizons, certainty about future tax distributions, and perfect capital markets.

(i) infinite planning horizons

In the case of finite planning horizons, the neutrality of government financing decisions is overturned simply because potentially it then becomes possible for current generation individuals to avoid a portion of the future taxes which would be involved in the service or repayment of contemporaneous public debt issuance.

In an important paper, Barro (1974) expands the conditions under which agents rightfully might be regarded, from an economic standpoint, as being possessed of an infinite planning horizon. Barro's model, built upon the overlapping generations framework of Samuelson (1958) and Diamond (1965), involves a constant population of agents each of whom lives for two periods but whose utility depends not only upon consumption in the two periods but also on the attainable utility of the agent's direct descendant. This presents the possibility that an operative bequest mechanism might exist such that in the face of public debt issuance the agent would maintain the size of a *net* bequest to his descendant by raising his current demand for assets one to one with the increase in public securities. Further, Barro argues that the important consideration for this result is not the existence of a pecuniary bequest but rather some form of intergenerational transfer (such as expenditure on the education of the descendent) to ensure that prior to the public debt issuance the agent already had the ability to shift resources from his descendent to himself. In such a fashion, finite lived individuals may be taken as making decisions as if their planning horizon were infinite.

A recent paper by Blanchard (1985), however, makes a strong case for the nonneutrality of public debt. Following Yaari (1965), Blanchard argues that individuals face a constant probability of death, p. Thus, an individual alive at the end of period 0 may expect to be alive in period t with probability $(1-p)^t \equiv s^t, t \geq 0$. This alters the framework of the original neoclassical model in two ways. First, agents now maximize expected utility given by

$$E\sum_{t=1}^{\infty} \beta^{t-1} u(c_t, g_t, l_t) = \sum_{t=1}^{\infty} (\beta s)^{t-1} u(c_t, g_t, l_t)$$

so that future utilities are discounted at a higher rate than previously. Second, private individuals must pay a premium to insure against loan default which transforms the discount factor applicable between 0 and t to $s^t R_t$. If the probability of survival is unity then the insurance premium is zero, but as long as the probability of death is positive the effective discount rate will exceed that in the standard model. The government, however, is able to borrow without payment of an insurance premium since the population, and hence the taxing capacity of the public sector, is assumed to remain constant. After aggregating across individuals the economy wide budget constraint becomes

$$\sum_{t=1}^{\infty} s^t R_t[c_t + w_t(1-l_t)] = k_0 + b_0 + b_0^g$$
$$+ \sum_{t=1}^{\infty} R_t[s^t(w_t + \mu_t g_t) + (1-s^t)t_t - g_t]. \tag{17}$$

Consider the impact of a current tax cut financed by bond issuance which, in turn, induces a rise in taxes at time $t^* \geq 1$. The effect on the economy's opportunity set is to raise (perceived) wealth by the amount $-(1-s^{t-1})sR_1 dt_1$. Thus, associated with a current tax reduction will be an increase in wealth and an increase in the demand for current consumption goods. Furthermore, the further into the future the required tax increase is postponed, the larger will be the initial effect on wealth as this implies a smaller probability the agent will be subject to the tax increase.

(ii) distributional effects and uncertainty

Tobin (1971, 1978) has argued that because of distributional effects and uncertainty government debt differs from the implicit tax liabilities lying behind it. Chan (1983) addresses this aspect of the controversy surrounding debt neutrality. He first demonstrates that different individual tax shares will not overturn the equivalence of debt and taxes. Suppose these are n individuals, indexed by i, each with the share $\lambda^i = t_t^i/t_t$, constant across time. The individual's budget constraint becomes, in this case,

$$\sum_{t=1}^{\infty} R_t[c_t^i + w_t(1 - l_t^i)] = k_0^i + b_0^i + \sum_{t=1}^{\infty} R_t[w_t + \mu_t g_t - \lambda^i t_t]. \tag{18}$$

A change in current taxes, to be followed by a future, offsetting change in taxes at time t* will alter the agent's wealth in the amount $-\lambda^i[R_1 dt_1 + R_t R dt_t^*]$. However, the government budget constraint implies that the term in brackets equals zero so that, as before, there is no change in the agent's opportunity set. Accordingly, as long as the distribution of tax obligations remain constant over time, individuals may have different tax shares and the equivalence of debt and taxes remains intact.

This result says nothing, however, about the risk inherent in the shifting of tax burdens across time. In the context of a two period model Chan also considers the case where individual tax liabilities are given by

$$t_t^i = \theta_t^i + \gamma\varepsilon_t^i$$

where θ_t^i denotes a time and state invariant share of aggregate taxes levied on individual i and ε_t^i is a mean zero stochastic term with the property $\sum_i \varepsilon_t^i = 0$. Thus, particular realizations of the stochastic term represent a pure income redistribution across households, and an increase in γ represents an increase in the risk of such redistribution. Chan finds that, in general, the effect of increased taxes on current consumption is ambiguous but that under the assumptions of time separable preferences, normality of consumption, and nonincreasing absolute risk aversion current consumption *falls* in the presence of a tax cut. In this case, individuals hedge against the uncertainty associated with future random taxation by increasing saving by more than the amount of the tax cut. The equivalence between debt and taxes no longer holds, but the relationship between tax cuts and consumption behavior is the opposite of the usual one.

Barsky, Mankiw, and Zeldes (1985) also consider the effect of uncertainty on the equivalence proposition. In their model the agent has future income given by

$$y_t^i = \alpha^i + \eta_t^i$$

where α^i is constant over time and η_t^i is a mean zero random term such that $\sum_i \eta_t^i = 0$ and $E(\eta_t^i \eta_t^j) = 0$ for $i \neq j$. Taxes are levied on uncertain future income at the rate τ_t such that the total amount raised is equal to the amount of debt created in the first period. In this case, sufficient conditions to ensure that consumption *rises* with a current period tax cut are as stated above in the discussion of Chan's result; the reason for the opposite result for consumption lies in the fact that in this case the tax cut replaces an uncertain claim to future income with a certain claim. As long as the marginal utility or consumption is convex in consumption, this will induce an increase in current consumption expenditure.

(iii) imperfect capital markets

Another frequent criticism of the debt neutrality theorem is that it relies on the assumption of equal access by various groups of economic agents to the capital market. As seen above, in the context of Blanchard's (1985) model, the ability of the public sector to borrow on terms superior to those of private economic actors results in a refutation of the equivalence of debt and taxes.

It is also revealing to consider the case where private agents have differential access to the credit market due to various reasons, perhaps differences in qualifying collateral (Barro (1974)). Then fiscal policy of the sort being discussed here may be thought of as the provision of loans, on net, from individuals with good collateral to those with poor collateral. For example, suppose there are two classes of individuals in the economy, denoted i = 1, 2. Individuals in group 1 may borrow and lend at the risk free rate while individuals in group 2 must pay a premium reflecting transactions or monitoring costs so that their interest factor is given by $\lambda^{-t}R_t$, $\lambda \geq 1$. The public sector may borrow at the risk free rate but, in the process, incurs transactions costs equal to $(\theta$-1)x100 per cent so that its effective discount factor is given by $\theta^{-t}R_t$, $\theta \geq 1$. Finally, the individuals in the good collateral group comprise α_1 of the total taxpayers while members of the poor collateral group make up α_2 of the taxpayers, $\alpha_1 + \alpha_2 = 1$. We then obtain

$$\sum_{t=1}^{\infty} R_t[(c_t^1 + w_t(1 - l_t^1)) + \lambda^{-t}(c_t^2 + w_t(1 - l_t^2))] =$$

$$k_t + b_t^1 + b_t^2 + \sum_{t=1}^{\infty} R_t((1 + \lambda^{-t})(w_t + \mu_t g_t)) \tag{19}$$

$$- \sum_{t=1}^{\infty} R_t t_t(\alpha_1(1 - \theta^{-t}) + \alpha_2(\lambda^{-t} - \theta^{-t})).$$

Attention is directed to the last term in the expression which, apart from the term in braces, is the present value of taxes. The term in braces has an easy interpretation. The first component, $\alpha_1(1 - \theta^{-t})$, is the loss in wealth to members of the good collateral group arising from the government's decision to intermediate in the loan market. The second component, $\alpha_2(\lambda^{-t} - \theta^{-t})$, reflects the (possible) net gain to members of the poor collateral group given that the transactions costs faced by the public sector are lower than those faced by the private sector intermediaries. The effect of public debt policy on aggregate wealth, then, depends crucially on the sign of

$$[\alpha_1(1 - \theta^{-t}) + \alpha_2(\lambda^{-t} - \theta^{-t})]$$

which, if negative, will raise wealth. If $\lambda = \theta > 1$, so that private and public "loans" are equally costly on the margin, a tax cut would lower wealth since it amounts to a forced loan to the private sector with positive transactions costs. Clearly, a necessary (though not sufficient) condition for government debt policy to raise wealth is that $\theta < \lambda$ so that financial intermediation by the public sector is more efficient than that by the private sector, perhaps arising from governmental power to tax to ensure "loan repayment." However, if this is the rationale for activist fiscal policy, a more reasonable policy would have the government making explicit, direct loans to the poor collateral group on the grounds that such a policy would then avoid the deadweight loss to members of the good collateral group who are forced to participate in the debt issuance policy.

Empirical evidence on debt neutrality

The bulk of empirical work attempting to determine the extent to which public financial policy is neutral has centered on looking for effects on consumption behavior. Examples are Kochin (1974), Tanner (1979), Feldstein (1982), and Kormendi (1983). These studies typically are based on an equation of the general form

$$c_t = \beta_0 + \beta_1 y_t + \beta_2 z_t + \beta_3 g_t + \beta_4 t_t + \beta_5 tr_t + \beta_6 b_t^g + \varepsilon_t \qquad (20)$$

where all variables are as defined previously (in per capita terms) and additionally where $z_t \equiv$ wealth (inclusive of public debt) and $tr_t \equiv$ transfers. Kochin (1974) and Tanner (1979) center on the tax discounting question and obtain results compatible with debt neutrality. Feldstein (1982) criticizes this work on two counts: first, by relating consumption to the government deficit, these studies artificially impose the constraint $\beta_3 = -\beta_4 = \beta_5$; and, second, as ordinary least squares regressions are employed, no adjustment is made for the endogeneity of the tax variable. After making these adjustments, Feldstein argues that the data provide no support for the hypothesis of tax discounting, $\beta_4 = 0$, nor neutrality $\beta_2 + \beta_6 = 0$. Kormendi (1983), however, finds strong support for his "consolidated" approach to consumer behavior where agents completely internalize corporate and public balance sheets in private consumption decisions.

Aschauer (1985) argues that the conventional methodology employed in the previously mentioned studies is likely to result in a spurious rejection of the null hypothesis of tax discounting. As is clear from the agent's intertemporal budget constraint (see, for instance, equation (16)), future government spending levels are important to the determination of current consumption. The omission of future government spending from the empirical consumption relation (20) and the inclusion of a current tax variable implies that it is likely that the estimated coefficient on the tax variable will be biased downward from the true theoretical value of zero, leading to a rejection of the null hypothesis of debt neutrality.

Aschauer proposes jointly estimating consumption and government expenditure equations wherein the imposition of rational expectations implies a set of cross equation restrictions on the data. The data are incapable of rejecting the joint hypothesis of rational expectations and Ricardian equivalence at conventional marginal significance levels. The data appear consistent with the idea that deficits play a role in influencing consumption only insofar as they aid in the forecasting of future levels of government spending.

Other studies have centered on the relationship between deficits and interest rates. Plosser (1985) estimates the equation system

$$\underline{H}_{t+1} - R_{1t} = \underline{\phi} + A[\underline{X}_{t+1} - B(L)\underline{X}_t] + \underline{V}_{t+1}$$

$$\underline{X}_{t+1} = B(L)\underline{X}_t + \underline{U}_{t+1}$$

where $\underline{X}_{t+1} \equiv$ vector of policy variables, $\underline{H}_{t+1} \equiv$ vector of holding period returns to various assets, $R_{1t} \equiv$ yield to a U.S. Treasury bill with one quarter to maturity, $\underline{\phi} \equiv$ liquidity premia. The policy variables Plosser employs are the log of monetized public debt, the log of privately held public debt, and the log of government spending. Of particular relevance to the current discussion, Plosser is unable to uncover any significant relationship between innovations in privately held public debt—a "surprise" substitution of debt for taxes—and excess asset returns.

Evans (1985) considers variants of the equation

$$r_t = \gamma_0 + \gamma_1 g_t + \gamma_2 d_t + \gamma_3 m_t + \eta_t$$

where r $\equiv$ (nominal) interest rate, g $\equiv$ ratio of real federal spending to trend national income, d $\equiv$ ratio of real deficit to trend national income, and $m_t \equiv$ ratio of real stock of money to trend national income. Surveying U.S. experience from the Civil War period to the present, Evans typically finds either nonexistent or negative effects of the deficit ratio on interest rates.

D. Government Spending, Output, and Interest Rates

We now consider the effects of changes in government spending assuming, momentarily, that the conditions of the Ricardian equivalence theorem obtain. We first abstract from the effects of distortional taxation and defer discussion of the impact of public spending on physical capital accumulation to the subsequent section. The economy-wide intertemporal resource constraint, in competitive equilibrium, is expressed as

$$\sum_{t=1}^{\infty} R_t[c_t + w_t(1 - l_t)] = \sum_{t=1}^{\infty} R_t[w_t - (1 - \mu_t)g_t]. \tag{21}$$

Define "effective consumption" as a linear combination of private consumption and public consumption goods, i.e., $c_t^* = c_t + \gamma g_t$. In general, γ , the marginal rate of substitution between private and public consumption goods, may be taken as a function of government spending, but for simplicity it is taken here to be constant. Similarly, assume a constant marginal product of public inputs to production. Then, substitution in equation (21) yields

$$\sum_{t=1}^{\infty} R_t[c_t^* + w_t(1 - l_t)] = \sum_{t=1}^{\infty} R_t[w_t - (1 - \mu - \gamma)g_t]. \tag{22}$$

The right hand side of this expression may be considered to be a measure of economy wide "effective" wealth: the present value of the time endowment minus the present value of government spending weighted by the term $(1 - \mu - \gamma)$. This last term dictates the degree to which a change in government spending may affect wealth. If $\mu + \gamma = 1$ —so that resources extracted from the private sector provide productive and consumption benefits of equal magnitude—the time path of government spending disappears from (22) and fiscal policy (neglecting the impact of distortional taxes—see below) would become completely irrelevant to the overall level of effective wealth. On the other hand, if $1 > \mu + \gamma$ then increases in government expenditure are associated with decreases in effective wealth, with consequent impacts on economy-wide output and interest rate levels. Evidence on the values of μ and γ is scanty; however, Ahmed (1985) reports a value for μ of .4 while Aschauer (1985) and Kormendi (1983) present estimates of γ in the range .25 of .4. The discussion below assumes that the inequality $1 > \mu + \gamma$ is applicable and, in doing so, follows Barro (1981).

We define a *temporary* change in government spending as one which induces no change in the present value of public expenditure, $\sum_{t=1}^{\infty} R_t dg_t = 0$.

Such changes in public expenditure will leave effective wealth unaltered. However, a *permanent* rise in public expenditure levels, $dg_t = d\bar{g} > 0$, will carry with it a non-negligible decline in wealth equal to

$$(1 - \mu - \gamma)\sum_{t=1}^{\infty} R_t d\bar{g}.$$

We now illustrate the effect of temporary and permanent changes in public spending on output and interest rates. The immediate effect on excess commodity demand, $e_t \equiv y_t^d - y_t^s$, of a temporary rise in spending is

$$\begin{aligned} de_t &= dy_t^d - dy_t^s \\ &= dc_t + dg_t - dy_t^s \\ &= dc_t^* + (1 - \gamma)dg_t - dy_t^s \\ &= dc_t^* + (1 - \gamma)dg_t - \mu dg^t \\ &= (1 - \mu - \gamma)dg_t \end{aligned}$$

as there is no reason, at the original level of interest rates, for the agent to alter the time profiles of *effective* consumption or work effort. However, in the attempt to smooth out effective consumption and work effort in the face of the temporary rise in spending, an excess demand for current commodities occurs. The excess demand for goods requires a rise in the interest rate to clear the commodity market, bringing about an equilibrium output response of

$$\frac{dy_t}{dg_t} = \mu + w_t \frac{\partial l}{\partial r} \frac{dr}{dg}$$

the second term reflecting the intertemporal substitution of work effort $(\partial l/\partial r)$ in response to a rise in perceived intertemporal returns.

On the other hand, if the rise in government purchases is regarded to be a permanent phenomenon, there are additional wealth effects to consider. The effect on excess commodity demand is, in this case,

$$de_t = (1 - \mu - \gamma)[1 - \left(\frac{\partial c_t}{\partial \Omega_t} + w_t \frac{\partial l_t}{\partial \Omega_t}\right)\sum_{t=1}^{\infty} R_t] d\bar{g}$$

where the latter term in the square bracket arises from the effect of the change in government spending on effective wealth (Ω_t) and hence consumption demand and work effort. Differentiation of the budget constraint (21) with respect to Ω_t yields.

$$\sum_{t=1}^{\infty}\left(\frac{\partial c_t}{\partial \Omega_t} + w_t\frac{\partial l_t}{\partial \Omega_l}\right)R_t = 1.$$

Thus, if we assume that the marginal propensities to consume (goods and leisure) as well as the marginal product of labor are constant over time we have by substitution that the rise in government spending has no effect on excess demand.[1]

The absence of an excess demand for current goods implies that the commodity market will continue to clear at the prevailing interest rate. Also, output rises by an amount less than the rise in public spending. For example, in the permanent spending case,

$$\frac{dy_t}{d\bar{g}} = 1 - \gamma - \frac{\partial c_t}{\partial \Omega_t}\ (1 - \mu - \gamma)\sum_{t=1}^{\infty} R_t < 1.$$

This result arises because the intial stimulus to demand is offset by reductions in demand as (a) the publicly provided goods substitute for private goods and (b) the reduction in wealth reduces consumption demand. The neoclassical framework suggests that spending multipliers are bounded above by unity.

It also is characteristic of this particular model that the output effects of government spending on goods and services are identical in both the temporary and permanent spending cases. This result arises because of (a) time separability in preferences and (b) the absence of physical capital, which together imply that there is no mechanism by which events in future periods (e.g., anticipated future government spending) may impact on the present other than by altering relative prices. The addition of physical capital to this model would provide such a mechanism, with the result that the output effect of a permanent rise in public expenditure then would outweigh that of a temporary spending increase. A discussion of this and other implications of time separability in preferences may be found in Barro and King (1984).

Distortional taxation

So far the analysis has been devoid of the effects of distortional taxation. Allowing for a tax on labor and interest income at the mutual rate τ leads to the intertemporal constraint, evaluated at competitive equilibrium, given by

$$\sum_{t=1}^{\infty}\hat{R}_t[c_t^* + w_t(1 - l_t)] = \sum_{t=1}^{\infty}\hat{R}_t[w_t - (1 - \mu - \gamma)g_t] \qquad (23)$$

which is identical to (22) above except that the relevant discount factor now involves the after-tax rate of interest, $r(1 - \tau)$. If we recognize that a temporary change in public spending (defined as above) need not require a change in tax rates, then the analysis of a temporary change in government spending continues to hold, with the redefinition of the relevant relative price of goods as the net of tax interest rate. However, associated with a higher permanent level of government expenditure will be a higher rate of taxation on income. Coincident with the rise in public expenditure levels will then be a decreased incentive to engage in market activity. Thus, the effect on output will be less than in the case of a temporary rise in public spending; indeed, if the substitution effect involved in a higher rate of taxation is sufficient to offset the productive input effect of public spending plus the wealth effect on work effort, output may decline in the face of a permanent rise in spending by the government. Given constant time profiles of marginal propensities to consume, however, the (net of tax) real interest rate would be left unaltered.

Thus, the main distinctions to be drawn between the effects of temporary and permanent changes in public expenditure are that the former is likely to raise output and the net real interest rate relative to the latter. Barro (1981, 1985) attempts an empirical analysis of these two respective predictions of the equilibrium model. In his 1981 paper, Barro constructs a normal defense expenditure variable by regressing real defense purchases on past, present, and future values of a casualty rate variable. Transitory government purchases then are taken to be the difference between actual and normal government purchases. Using annual data for the periods 1942-78 and 1946-78 he then regresses (the log of) output on these variables and finds that temporary increases in public spending encourage output responses of roughly double the magnitude of equal sized permanent changes. Furthermore, in all cases the evidence suggests a government spending multiplier of less than unity, consistent with the predictions of the neoclassical approach.

In a more recent paper Barro (1985) employs annual U.K. data for the period 1730-1918 in an attempt to verify the strong positive association between (long term) interest rates and temporary government spending as predicted by the theory. For the sample including World War I observations, Barro finds that a one percent increase in the ratio of temporary government spending to trend output is associated with an increase of 2.1 basis points in the long term interest rate; excluding the World War I observations (where wartime controls may have crowded out private expenditures directly) the same increase in temporary public spending raises the long term rate by over 5 basis points. For quarterly U.S. data Plosser (1982) also documents a statistically significant positive relationship between innovations in government spending and interest rates. In the latter study, however, no attempt was made to distinguish between temporary and permanent shifts in public sector expenditure.

Ahmed (1984) considers an open economy extension of the analysis, wherein movements in the current account take the place of interest rate movements in relieving excess demand pressure as a consequence of temporary government spending. Using U.K. data, he uncovers statistical support for the prediction that balance of trade deficits are to be associated with transitory increases in government spending.

The theoretical analysis also predicts that the impact of a transitory government spending on consumption should be less than that of an equal sized permanent increase, as agents attempt to smooth effective consumption intertemporally. Seater and Mariano (1985) estimate a consumption function by regressing aggregate consumption on constructed temporary and permanent income and government expenditure variables, an average marginal tax rate variable constructed by Seater (1985), and other variables. In general, they find that temporary changes in government spending have a small negative impact on consumption, in accordance with the neoclassical framework, while permanent increases in spending raise or lower consumption, depending on the particular consumption variable employed in the regression. They also find a strong negative influence of the average marginal tax rate on consumption which implies that the total effect of a permanent rise in government spending, carrying with it a rise in the tax rate, is negative as well.

E. Optimal Taxation

The description of the effects of government spending above took as a maintained hypothesis that tax rates would not be raised or lowered in response to temporary movements in public expenditure. The appropriateness of this hypothesis now will be considered in the context of the literature on optimal taxation pioneered by Ramsey (1927) and Sandmo (1976) and adapted to macroeconomic issues by Barro (1979), Kydland and Prescott (1980), and Lucas and Stokey (1983).

The problem is outlined in the following way. The public sector chooses a sequence of tax rates $\{\tau_t\}_{t=1}^{\infty}$ to maximize the objective function

$$W = \sum_{t=1}^{\infty} \beta^{t-1} u(c_t, l_t)$$

where c_t and l_t are competitive equilibrium levels of consumption and work effect and, as such, generally are dependent upon contemporaneous levels of government spending, tax rates, and productivity. (Here we assume

$\gamma = \mu = 0$ for simplicity). The maximization is constrained by the public sector's budget constraint

$$b_0^g + \sum_{t=1}^{\infty} \beta^{t-1} \frac{U_c(c_t,l_t)}{U_c(c_0,l_0)} \left[(w_t + \frac{U_l(c_t,l_t)}{U_c(c_t,l_t)}) l_t - g_t \right] = 0$$

where use has been made of the first order conditions of the agent's problem as given in (4) and (5) in order to eliminate R_t and $\tau_t w_t$. The first order necessary conditions of the government's problem after some manipulation, yield the following elasticity formula:

$$(\frac{\tau_t}{\tau_{t+j}}) = \frac{\eta_{Uc}(\cdot t) + (1 - \tau_t)\eta_{Ul}(\cdot t)}{\eta_{Uc}(\cdot t + j) + (1 - \tau_{t+j})\eta_{Ul}(\cdot t + j)} \quad j = 1, 2, \ldots \qquad (24)$$

where the η's are defined by

$$\eta_{U_c}(\cdot k) = (U_c(\cdot k))^{-1}(c_k U_{cc}(\cdot k) - l_k U_{lc}(\cdot k))$$

$$\eta_{U_c}(\cdot k) = (U_1(\cdot k))^{-1}(l_k U_{ll}(\cdot k) - c_k U_{cl}(\cdot k)).$$

Thus, relative tax rates depend on the relative value of the weighted sum of the elasticities of the marginal utility of consumption and the marginal disutility of work effort.

We now investigate cases in which tax rates should be equalized across time. To begin, suppose that periods t and t+j are identical in terms of productivity ($w_t = w_{t+j}$) and public expenditure ($g_t = g_{t+j}$). Equation (24) then would indicate that tax rates should be made equal to one another.

Next, by assuming that utility is additively separable in consumption and work effort as well as a constant marginal utility of consumption, equation (24) collapses to

$$\frac{\tau_t/(1 - \tau_t)}{\tau_{t+j}/(1 - \tau_{t+j})} = \frac{\eta_{n^*, \hat{w}}(\cdot t + j)}{\eta_{n^*, \hat{w}}(\cdot t)}$$

where $\hat{w} = (1 - \tau)w$ and $\mu_{n^*, \hat{w}}(\cdot k)$ is the elasticity of equilibrium employment with respect to the after tax marginal product of labor in period k. This is a variant of the "inverse elasticity" formula whereby tax rates should be relatively higher on goods with relatively low elasticities of demand (here, leisure). However, it must be emphasized that these elasticities are evaluated appropriately at competitive equilibrium values of work effort which, in turn, depend upon the contemporaneous levels of government spending, productivity, and tax rates.

Finally, there is a benchmark specification of momentary utility which ensures tax rate constancy across time in the face of temporary fluctuations in government spending and revenue levels. Assuming preferences are characterized by

$$U = c^{\alpha} - n^{\beta}$$

where $0 < \alpha < 1$ and $\beta > 1$ are time invariant parameters yields constant elasticities of the marginal utility of consumption and of the marginal disutility of work effort. Equation (24) then implies that tax rates should be constant across periods. Other results on dynamic tax smoothing may be found in Aschauer and Greenwood (1984), and Razin and Svensson (1983).

To the extent that tax rate smoothing is efficient policy, then government budget deficits will be positively correlated with transitory public expenditure increases and negatively correlated with temporary surges in output and tax revenue. Barro (1979) examines this prediction of efficient tax policy and finds that the annual U.S. data for the period 1922-76 are roughly consistent with the theory, although there is some evidence of excess response of deficits to temporary fluctuations in output, suggesting the possibility of purposive countercyclical policy. Canarella and Garston (1983) reexamine these hypotheses using full information likelihood methods which allows tests of the theory based on cross equation restrictions imposed on the data. They find that the data support the hypotheses that the deficit responds negatively to cyclical movements in output and that the deficit rises one-to-one with anticipated inflation. Barro (1981) tests the parallel proposition that marginal tax rates should follow a random walk process; using average tax rates as a proxy for marginal rates, he is unable to reject the random walk specification. Kingston (1984) presents a model in which the marginal income tax rate is a first order autoregressive process with less than unit coefficient but where the marginal collection cost of an income tax behaves as a random walk. Using Seater's (1983) series on marginal tax rates, he is unable to reject the hypothesis of smoothing of marginal collection costs.

F. Capital Accumulation and Steady State Effects of Fiscal Policy

The steady state of the model is described by the equations

$$-\frac{U_l}{U_c} = (1 - \tau)f_l \tag{25}$$

$$\theta = (1 - \tau)f_k \tag{26}$$

$$y = c + \delta k + (1 - \mu)g \tag{27}$$

where θ is the subjective rate of time preference. Equation (25) dictates that at all points in time the marginal rate of substitution between consumption and leisure equals the net of tax marginal product of labor. Equation (26) ensures that consumption is unchanging our time, while equation (27) implies that there is zero net investment.

In order to consider the additional effects which the introduction of capital brings into the model, take the simple case where government spending is a pure drain on the economy ($\gamma = \mu = 0$). Then the equations may be written compactly in the form

$$\frac{-U_l(f(k,l), \delta k - g - l)}{U_c(f(k,l) - \delta k - g, l)} = (1 - \tau)f_l(k,l) \tag{28}$$

$$\theta = (1 - \tau)f_k(k,l). \tag{29}$$

This is a system of two equations in the endogenous variables k, l as well as the policy variables τ and g. Note that other policy variables—investment tax credits, depreciation allowances, etc—could be added and that all policy exercises must take account of the government budget constraint. Here, equation (29) determines the marginal product of capital and, given the linear homogeneity of the production function, the capital-labor ratio as well. This, in turn, determines the marginal product of labor which may be used in equation (28) to determine the level of employment. The production function then determines the level of output and the goods market clearing condition the level of consumption.

A rise in the rate of taxation reduces the net of tax return to capital at the original levels of capital and labor. To maintain the steady state, the capital stock, and the capital-labor ratio, unambiguously decline to raise the net of tax interest rate back to the subjective rate of time preference. The effect on employment is ambiguous—on the one hand, the rise in the tax rate and the decline in the capital stock both reduce the net of tax return to work effort (the former directly and the latter through its effect on the marginal product of labor) and induce a substitution toward leisure, while on the other hand the decline in wealth reflected in the reduction in the capital stock induces an increase in work effort. Nevertheless, the levels of output and consumption both decline in the new steady state.[2]

Dynamics

Several papers, most notably Hall (1971), Abel and Blanchard (1983) and Judd (1985), contain an analysis of the dynamic effects of changes in fiscal policy, although for a simplified version of the model where the level of employment is fixed exogenously. Hall and Abel and Blanchard consider the effects of changes in fiscal policy which are unanticipated and anticipated in turn. For example, an unanticipated increase in government spending financed by lump sum taxes will induce an immediate, downward shift in consumption with no effect on the capital stock, while an anticipated rise in government spending will induce an anticipatory rise in the capital stock as agents attempt to buffer the future restriction of resource availability.

Judd argues that the analysis in the tradition of Hall and Abel and Blanchard is quantitatively inconclusive and, in particular cases, may be qualitatively ambiguous as well. As an example, suppose that government spending is to rise in the future, with the financing to begin immediately via a rise in the tax rate on income. If the period until the rise in spending is short, the capital stock will rise to provide a buffer against the future demand for resources; however, if the period until the rise in public spending is relatively long, the investment process will respond immediately to the lower after tax return to capital and the capital stock will fall before rising in the future. Judd carries out quantitative analysis by linearizing the equations specifying the motion of the system and using the properties of Laplace transforms to obtain an expression for changes in net investment as a result of various fiscal policies:

$$\frac{\partial i}{\partial \varepsilon} = \frac{U_c}{U_{cc}} \cdot f_k \tau(\lambda) + \lambda g(\lambda) - g$$

where i $\equiv$ net investment, $\tau(\lambda) \equiv$ present value of tax rate change, $g(\lambda) \equiv$ present value of change in government spending, where both of the latter use as a discount rate λ, the positive root of the linearized system describing the motion of the system, and ε measures the extent to which policy changes occur. Using this equation and specifying a range of values for parameters of preferences and production, Judd is able to obtain quantitative estimates of the effects of government spending and tax changes on current investment.

G. Conclusion

This paper provides a survey of recent developments in the theoretical and empirical analysis of the impact of fiscal policies on aggregate economic variables such as consumption, employment, investment, interest rates, and output. The unifying theme of the papers surveyed may be found in the common methodological approach of neoclassical, optimizing agents choosing quantities of goods and factor services according to relative prices in an environment of efficient markets. Although extreme and patently false—nothing, including the market, is perfect—the equilibrium approach to issues of fiscal impact as discussed here is useful in providing an alternative viewpoint to that of the conventional (Keynesian) wisdom. Much empirical work remains before we may decide which is the more relevant of the two approaches; until then it is probably best to take a Comptian attitude toward the effects of public spending and taxation policy on the macroeconomy.

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[1] It is interesting to note that the absence of an effect of government spending on excess demand depends on flat profiles for the marginal propensities to consume and not on flat profiles of consumption per se. A further discussion can be found in Aschauer and Greenwood (1985) and in Greenwood and Kimbrough (1984).

[2] The government budget has been balanced by a change in lump sum transfers to offset changes in revenues arising from the manipulation of the tax rate.

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