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Abstract

This paper is an empirical investigation into the effects of public expenditure--in particular, public investment spending--on private capital accumulation. The empirical evidence is consistent with the major implications of the neoclassical approach to fiscal policy. In particular, holding fixed the rate of return to private capital, public investment spending is significantly more depressive to private investment than is public consumption expenditure.

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I. Introduction

This paper is an empirical investigation of the effects of various fiscal policy actions on private investment. Conventional macroeconomic models suggest that the major impact of fiscal policy on private investment arises from changes in the overall level of taxation or the overall level of public sector expenditure. For instance, it typically is argued that a decrease in taxes, holding fixed the level of government spending, will be associated with higher real interest rates (as the government issues debt securities to cover the deficit) and lower private investment.

Recently, theoretical models have been constructed, and empirical models have been estimated, which cast a dark shadow on the appropriateness of this traditional line of reasoning. Barro [1974] argues that given adequate concern about future generations, a fiscal policy as traced out above will have a negative impact on private investment as rational agents save the current tax cut in anticipation of the future taxes which will be necessary, under most circumstances, to service or amortize the public debt.

There is a substantial amount of recent empirical evidence which is supportive of this theoretical equivalence between public debt and taxes in financing a given public expenditure stream. Kormendi [1983] studies consumption behavior and obtains the result that changes in the level of taxation have insignificant effects on private consumption while Seater and Mariano [1985], also studying consumption behavior, find complete tax discounting as well after deriving an improved permanent income series. Aschauer [1985] derives an Euler equation for "effective" consumption--a weighted sum of private and public consumption--and finds that public sector deficits are important in explaining private consumption only to the extent that the deficits aid in predicting future government spending. Plosser [1982] and Evans [1985] find insignificant effects of changes in the tax/debt mix on asset returns, while Evans [1986] provides evidence that public sector deficits are not responsible for movements in the exchange rate.

A few studies also have argued that it is important to consider the differential impact of various forms of public expenditure on private sector variables. Barro [1981] splits public expenditure on goods and services into "transitory" and "permanent" components and gives evidence that output responds to a greater extent to temporary public purchases. Kormendi [1983] briefly considers the impact of public investment on private consumption and finds, empirically, little relationship. Although this result is consistent with the neoclassical approach, it is also consistent with a substantial crowding out of leisure and, consequently, an expansion of output. This paper also considers the impact of public investment spending, but on private investment, which allows for a tighter test of the appropriateness of the neoclassical approach to fiscal policy.

In Section II the theoretical implications of various fiscal policies for private investment are traced out in a simple neoclassical set-up. Section III contains some empirical results on the influence of fiscal policies on the accumulation of private capital. Section IV concludes the paper by drawing together these results and by suggesting topics for future research.

II. Theoretical Concerns

The essential theoretical points may be illustrated in the context of a simple two period representative agent model. The agent has preferences given by

$$U = u(c^*) + \frac{u(\bar{c}^*)}{\rho} \tag{1}$$

where $c^*=c + \theta c^g$ is a measure of current "effective" consumption, a linear combination of private consumption, c, and government consumption, c^g, and where $\bar{c}^* = \bar{c} + \theta\bar{c}^g$ is future effective consumption. The utility rate of time preference, ρ, is assumed to lie between zero and unity.[1] Here θ represents a constant marginal/average rate of substitution between private and public consumption goods. The agent may transform current resources into future consumption by making use of the private transformation technology:

$$\bar{y} = f(k + i, k^g + i^g) \tag{2}$$

where $\bar{y}$ is future private production, k and k^g are the current stocks of private and public capital, respectively, and i and i^g are private and public investment levels. It is assumed at this point that $f_1 > 0$, $f_2 \geq 0$, and $f_{11} < 0$ while discussion of possible complementarities between private and public capital in the production process is postponed momentarily.

The agent may borrow or lend in an economy-wide credit market at the interest rate r and is constrained in his choice of current and future consumption by the intertemporal budget equation

$$c + i + \frac{\bar{c}}{r} = y + \frac{\bar{y}}{r} - (t + \frac{\bar{t}}{r}) \tag{3}$$

where t and $\bar{t}$ are current and future levels of lump sum taxes.[2]

The government utilizes the revenues from lump sum taxation in order to engage in expenditure on public consumption goods or on public investments.[3] Allowing the government to have access to the credit market on the same terms as the representative agent, we have the public sector budget constraint[4]

$$c^g + i^g + \frac{\bar{c}^g}{r} = t + \frac{\bar{t}}{r}. \tag{4}$$

The "Ricardian" view of fiscal policy involves the representative agent taking into account the public sector budget constraint (4) in making intertemporal decisions. Accordingly, we consolidate the private and public budget equations to yield, in terms of effective consumption, the economy-wide budget constraint

$$c^* + i + i^g + \frac{\bar{c}^*}{r} = y + \frac{f(k+i,\ k^g+i^g)}{r} + (\theta-1)(c^g + \frac{\bar{c}^g}{r}). \tag{5}$$

The agent chooses current and future effective consumption levels and the level of private investment so as to maximize utility, expressed as in equation (1), subject to the economy-wide intertemporal constraint, equation (5). First order necessary conditions for this problem are, in addition to equation (5),

$$\frac{u'(c^*)}{u'(\bar{c}^*)} = \frac{r}{\rho} \tag{6}$$

$$r = f_1(k + i,\ k^g + i^g). \tag{7}$$

Equation (6) indicates that the agent chooses effective consumption optimally when the utility gain from consuming an extra unit of goods in the present, $u'(c^*)$, equals the present value of the utility gain from saving and obtaining r extra units of consumption in all future periods, $ru'(\bar{c}^*)/\rho$. Equation (7) illustrates that the agent chooses future capital so as to equate the returns to physical capital and bonds.

Equations (5), (6), and (7) may be employed to obtain solutions for c^*, $\bar{c}^*$, and i as implicit functions of the interest rate, initial capital stocks, and fiscal expenditure variables. However, as this paper focuses on the general equilibrium effects of fiscal actions, we assert goods market equilibrium in both periods,

$$c^* + i + i^g + (1-\theta)c^g = y \tag{8}$$

$$\bar{c}^* + (1-\theta)\bar{c}^g = f(k + i,\ k^g + i^g) \tag{9}$$

which, upon substitution in (6) along with (7), yields

$$\frac{u'(y-(1-\theta)c^g-i-i^g)}{u'(f(k+i,k^g+i^g)-(1-\theta)\bar{c}^g)} = \frac{f_1(k+i,k^g+i^g)}{\rho}. \tag{10}$$

Equation (10) now will be used to consider the effect of alternative fiscal policies on private capital accumulation. The specific policies looked at are: a change in the temporal pattern of taxation; a rise in public consumption (current account) expenditure; and an increase in public investment (capital account) expenditure.

A. A Change in the Temporal Pattern of Taxation

Consider, to begin, the substitution of future for present taxation, while holding the time profile of public expenditure on goods and services fixed. The simple neoclassical model as sketched out here implies an equivalence between taxation and public debt issuance to finance the current level of public expenditure on consumption or capital goods. Specifically, for a particular path of public expenditure, the decision by the government to lower current taxes, sell public debt, and raise future taxes to service the debt has no effect on the agent's intertemporal opportunities as indicated by equation (5). In this model, as long as the public sector bonds pay the same rate of return as private sector bonds, an attempt by the government to manipulate aggregate demand in such a fashion will be frustrated. In particular, as current and future consumption levels are undisturbed, it follows that there is no "crowding out" of private investment through this channel.

B. An Increase in Public Consumption

Next consider an increase in the level of public expenditures on nondurable goods and services such as paper for the bureaucracy, police services, military uniforms, and the like. The effect of such a change in public policy on private investment will depend on three factors, namely: the extent to which the public sector consumption goods substitute for their private sector counterparts; the persistence of the expenditure change; and the time profile of the agent's marginal propensity to consume out of wealth. Let a change in current public consumption expenditure be followd by a change in future public consumption purchases equal to α times the current change. Hence if the current shock is transitory, $\alpha=0$ while if permanent, $\alpha=1$. Differentiation of equation (10) results in[5]

$$\frac{di}{dc^g} = \frac{\rho}{r} \frac{(1-\theta)}{\Delta} \left(\frac{\partial \bar{c}^*}{\partial w} - \alpha \frac{\partial c^*}{\partial w}\right)$$

where

$$\Delta = f_{11} - \frac{\rho}{r} (r\partial c^*/\partial w + \partial \bar{c}^*/\partial w) \cdot$$

Clearly, if $\theta=1$ there is no effect of a change in the level of public consumption expenditure on the agent's effective intertemporal consumption opportunities and private investment is left unaltered. The higher public expenditure crowds out an equivalent amount of private consumption expenditure, leaving effective consumption levels unchanged.

However, available empirical evidence suggests that public consumption goods substitute poorly for their private sector counterparts. Kormendi [1983] and Aschauer [1985] obtain estimates of θ in the range (.20, .35). Accordingly, a rise in the level of government consumption would be expected to reduce the agent's effective consumption possibilities and result in a possible effect on private investment as the agent reallocates the "burden" of the public sector expansion intertemporally.

Assuming $0 < \theta < 1$, consider the case where the rise in public consumption is permanent, $\alpha=1$. Equation (11) indicates that private investment will be unaltered given a flat time profile of the marginal propensity to consume since the agent then would bear the burden equally over time. On the other hand, if the agent's marginal propensity to consume profile has an upward (downward) tilt, private investment will fall (rise) as the agent chooses to bear the majority of the negative wealth effect in the future (present).

Finally, assuming that $0 < \theta < 1$ and that the time profile of the marginal propensity to consume is flat, but the change in public consumption spending is to some extent transitory, we have

$$\frac{di}{dc^g} = \frac{\rho}{r} \frac{(1-\theta)(1-\alpha)}{\Delta} \frac{\partial c^*}{\partial w}$$

which may be rewritten as

$$\frac{di}{dc^g} = \frac{-(1-\theta)(1-\alpha)}{1+r(1-f_{11}/\rho(\partial c/\partial w))}$$

so that we have $-1<di/dc^g<0$.

Thus, on net, a rise in public consumption expenditure is likely to have a negative impact on private investment expenditure, the effect being stronger (a) the more transitory is the rise in public purchases and/or (b) the less the publically provided goods substitute for private goods on the margin.

C. A Rise in Public Investment

We now turn our consideration to the impact of various forms of public investment--Veterans' Administration hospitals, dams, highways, etc.--on private capital formation. Public capital is assumed to enhance private production, holding fixed the private capital stock, according to equation (2), rewritten here

$$\bar{y} = f(k + i, k^g + i^g).$$

Utilizing equation (10) we find that the impact of a rise in public investment on private capital accumulation is given by the expression

$$\frac{di}{di^g} = -1 + \frac{f_{11}}{\Delta} - \frac{f_{12}}{\Delta} + \frac{\rho}{r}\,\frac{(f_2 - f_1)\partial c^*/\partial w}{\Delta}. \qquad (12)$$

As a reference case, suppose that private and public capital are perfect substitutes in the private production process, so that future output is dependent only on the national capital stock, $\bar{k}$, + $\bar{k}^g$, where $\bar{k} = k + i$ and $\bar{k}^g = k^g + i^g$; specifically, we write

$$\bar{y} = f(\bar{k} + \bar{k}^g)$$

with $f' > 0$, $f'' < 0$. In this case, only the first term on the right hand side of equation (12) remains, indicating a complete crowding out of private by public capital accumulation. For the most part, public investment policy would be irrelevant to private sector outcomes, with the only exception being that private capital would become a smaller fraction of the national capital stock.

In general, however, public capital is likely to bear some complementary relationship to private capital, so $f_{12} > 0$. In this instance, a rise in public investment and direct substitution for private investment will have additional effects. First, the reduction in the private capital stock will boost the marginal product of private capital and, given the interest rate, will provide a mitigating effect on private investment expenditure; this is captured by the second term in equation (12). Second, the rise in public capital, given $f_{12} > 0$, raises the marginal product of capital directly and provides an additional offset to the direct effect on private investment as is evidenced by the third term. Finally, the public capital stock may be too low, in which case $f_2 > f_1$, or too high, so $f_2 < f_1$. If the public sector has overaccumulated capital, then an addition to the public capital stock and an equal crowding out of private capital will lower future output, creating a negative future income effect. The attempt by the agent to bear some of this future burden in the present results in a final possible partial offset to the direct effect of higher public capital accumulation on private investment expenditure as in the last term in equation (12).

Thus, holding fixed the rate of return to the private capital stock (thereby putting aside the second and third terms in equation (12)), higher public investment would be expected to crowd out a nearly equal amount of private investment, somewhat less if the public sector has accumulated too much capital, but somewhat more in the alternative case.

To summarize the analysis of this section, an empirical study of the effects of fiscal policy on private investment should, according to the neoclassical model, produce results consistent with the following hypotheses. First, an increase in public investment expenditure, given the return to the private capital stock, should have in significant negative impact on the level of private capital formation. Given that public and private capital are perfect substitutes in private production, the crowding out of private capital should be complete, while in more general cases the crowding out will be more or less depending on the extent to which the public sector has accumulated the appropriate level of capital. Second, given that public consumption expenditure is sufficiently transitory, an increase in such spending should depress private investment as agents attempt to reallocate the burden of the expenditure over their economic lifetimes. However, this avenue of crowding out is likely to be less important than that of public investment, particularly in a period of limited variability in public consumption goods purchases.

III. Empirical Analysis

The empirical analysis focuses on the effect of public expenditure on private investment. The private investment series is net fixed investment in nonresidential equipment and structures and is obtained from various issues of the Survey of Current Business.[6] This annual series is computed along "perpetual inventory" lines by subtracting cumulative depreciation from the gross capital stock (cumulative gross investment minus discards) in order to obtain the net capital stock. This net capital stock is valued in current, as opposed to historical, prices and thus is a close measure of the replacement value of the private nonresidential capital stock. The accuracy of this procedure, however, depends crucially upon (a) the chosen depreciation methodology--straight-line, double-declining balance, etc.--and (b) the useful service lives employed for depreciation purposes. The particular series used in this paper is computed using straight-line depreciation over 85% of the service lives published in Bulletin F of the Treasury Department. Future research is intended to make use of somewhat broader notions of the capital stock (e.g., inclusive of residential capital) and alternative methods of depreciation.[7] The specific series utilized in the current study--equipment and structures--was chosen because it seemed a priori to be most comparable to available public investment series. The straight-line, 85% service life methodology is that lying behind most of the net investment series published in the "National Income and Product Accounts" and elsewhere in the Survey of Current Business.

A rate of return to private capital variable is taken from a study by Feldstein and Jun [1986] on the effects of distortional tax changes on private investment expenditure. This rate of return is computed as the ratio of net (of depreciation) corporate profits plus net interest expenses plus state and local property taxes to the total value of the net capital stock (net stock of equipment and structures plus inventories plus land) times one minus the total effective tax rate on capital (corporate profits taxes, state and local property taxes, taxes on dividends, interest, and capital gains). Under conditions of perfect competition and constant returns of scale, this variable would be a measure of the after tax marginal product of private capital. As computed, this variable measures the rate of return on nonfinancial corporate capital since the net of depreciation corporate profits series published in the Survey of Current Business presently is restricted to that legal category.

The public investment series consists of federal, state, and local net expenditures on equipment and structures, inclusive of military expenditures on these items. A priori, one might expect that while these latter expenditures substitute somewhat poorly for private capital in the production process-thereby leading to less than complete crowding out-they nonetheless will have a significant positive effect on the private rate of return to fixed capital by reducing the probability of future expropriation or the limitation of overseas markets. Depreciation of this form of capital to derive a net capital stock series is based on comparisons with similar private capital, data form governmental agencies on actual service lives, and on the assumptions made by Goldsmith in a background study on corporate stock ownership by institutional investors.[8]

Two other variables will enter the empirical analysis as well. Current account expenditures by the public sector are measured by subtracting the net public investment series from total purchases of goods and services by the government. It thus is inclusive of replacement investment expenditures as well as of government purchases of consumption goods and services. An output deviation variable is computed as the deviation of the actual growth rate of gross national product from the constant, average growth rate of gross national product over the sample period, 1953-84, of 3.1 percent per year.

Sample statistics for these variables, all of which (with the exception of the rate of return to capital) are measured relative to gross national product, are presented in Table I. Thus $i \equiv$ private net investment as a ratio to gross national product, $r \equiv$ net rate of return to private nonfinancial corporate capital, $i^g \equiv$ public net investment as a ratio to gross national product, $c^g \equiv$ public current account expenditures relative to gross national product, and $t \equiv$ total tax revenues as a percentage of gross national product. Note, in particular, that public investment was, on average, more than 50 percent as large as private investment during the sample period (1.8 percent compared to 3.3 percent of gross national product) while being characterized by nearly the same amount of volatility, with a standard deviation of 0.8 percent as opposed to 0.9 percent of gross national product. Further, the maximum value of public net investment, 3.4 percent of output (attained in 1953), is roughly two thirds as large as the maximum value for private net investment, 5.4 percent of gross production (achieved in 1966). Finally, on average public net investment amounted to roughly 7.4 percent of total government expenditures on goods and services.

Public consumption expenditures accounted, on average, for a significantly larger share of output, 21.2 percent, and varied from a low of 18.3 percent in 1979 to a high of 26 percent in 1953. The share of gross product devoted to these uses during the period 1981-1984 averaged 19 percent. The output (growth rate) deviation variable ranged between -5.7 percent and 3.2 percent. The potential importance of the public expenditure variables for private investment in an intertemporal setting seems clear from these statistics.

We now focus on the relationship between private investment and public expenditure. We begin by investigating the impact of public investment on private capital accumulation, given the rate of return to private capital.

Although the theoretical exposition involved no costs of adjusting the private capital stock, most investment studies have found various lags in response of investment to be important. Accordingly, we regress private investment on the contemporaneous and two lagged values of both the rate of return to capital and public investment. The result is to be found in column (a) of Table II. We find that private investment responds strongly to the rate of return variable, lagged one year, in the positive manner suggested by theory. Further, private investment is significantly adversely affected by contemporaneous movements in the public investment variable. The point estimate of -1.34 suggests that the crowding out through this channel is greater than one-to-one, although the null benchmark hypothesis of 100 percent crowding out cannot be rejected at usual significance levels.

Note that the low value of the Durbin-Watson statistic indicates the possibility of serial correlation in the residuals of the estimated equation. Reestimating this equation allowing for a first order autocorrelation correction yields the estimates contained in column (b) of Table II. As before, private investment reacts positively to a one year lag of the rate of return to capital but also, at the 10 percent level of significance, to the two year lagged return variable. Again, only the contemporaneous value of the public investment variable is of significant importance in explaining private investment expenditure.

Columns (c) and (d) of Table II indicate that the exclusion of the time trend from the regression does not have a substantial impact on the results, though it reduces the absolute value of the coefficient on the current public investment variable (and lowers its standard error). Columns (e) through (h) investigate the effect of eliminating first the two year and then the one year lagged value of the public investment variable from the equation. The net effect is to alter to only a minor degree the coefficient estimates of the rate of return variable while lowering, in absolute value, the estimated parameter value of the public investment variable.

Columns (i) and (j), obtained by eliminating the contemporaneous value of the rate of return, appear to offer the best parsimonious description of the relationship between private investment, the marginal/average product of capital, and public investment. All included variables are significant at the 5 percent level, including a minor negative trend in private investment as a ratio to gross national product. The computed value for the F-statistic relevant for testing the appropriateness of restricting to equal zero the coefficients on the contemporaneous rate of return variable and the lagged public investment variable is 1.02, substantially below the five percent critical value for the $F(3,23)$ distribution of 3.03. Private investment reacts positively to movements in the marginal/average productivity of capital, with the cumulative effect of a one percentage point rise in capital's marginal product lifting investment by roughly nine tenths of a percentage point. A two standard deviation rise in the contemporaneous level of public investment of 0.016 depresses private investment by 0.021, or roughly 2.3 times its own standard deviation. Given the rate of return variable, the point estimate in columns (i) and (j) suggest more than complete crowding out, although the 95 percent confidence interval is wide, stretching from -.46 to -2.10.

As a further check on the robustness of the relationship between private and public investment, the basic specification was reestimated in first differenced form. These results are in columns (a) and (b) of Table III. Here the intercept indicates an insignificant downward trend in private investment during the sample period. The estimates, when compared to the relevant columns in Table II, are basically unaffected, although the parameter value associated with the public investment variable is further reduced. It is comforting that the data thus support the theory not only on average but also from year to year as well.

It might be argued that estimation by ordinary least squares (with or without correction for serial correlation) is inappropriate since the public investment variable is measured relative to the contemporaneous value of gross national product and is likely to be determined simultaneously with the private investment variable. Using the lagged value of the public investment variable and public investment relative to trend gross national product as instruments, the equation was estimated by two stage least squares to yield

$$\underset{}{i_t} = \underset{(1.98\alpha(2))}{4.81\alpha(2)} - \underset{(2.43\alpha(4))}{4.32\alpha(4)}\ \text{time} + \underset{(.16)}{.53r_{t-1}} + \underset{(.13)}{.33r_{t-2}} - \underset{(.37)}{1.05ig_t} + e_t$$

$$DW = 1.06$$
$$R^2 = .65$$
$$SER = 5.91\alpha(3)$$

which exhibits a substantial reduction, in absolute value, of the coefficient on public investment from that obtained in most previous cases. After taking account of the possible serial correlation by quasi-differencing the data, we obtain

$$i_t = 2.46\alpha(2) - 2.26\alpha(4)\ \text{time} + .57r_{t-1} + .33r_{t-2} - 1.08ig_t + e_t$$
$$\quad (1.57\alpha(2))\ (1.91\alpha(4)) \qquad (.14) \qquad (.13) \qquad (.42)$$

$$DW = 1.62$$
$$R^2 = .59$$
$$SER = 5.27\alpha(3)$$

The point estimate on the public investment variable now is much closer to indicating 100 percent crowding out and an appropriate level of public capital accumulation, although this statement must be made with caution due to the size of the associated standard error.

A more conventional explanation of the crowding out of private investment might also be given. Specifically, the rise in public investment creates an excess demand in the capital goods producing sector and raises the relative price of capital which, in turn, lowers private investment. Thus, the public investment variable acts as a proxy for the cost of capital. After defining the relative price of capital, pk_t, as the ratio of the implicit deflator for gross private nonresidential investment to the deflator for gross national product, we get

$$i_t = -6.90\alpha(3) - 4.70\alpha(4)\ \text{time} + .62r_{t-1} + .31r_{t-2} - 1.16ig_t + .06pk_t + e_t$$
$$\quad (.07) \qquad (3.19\alpha(4)) \qquad (.14) \qquad (.13) \qquad (.41) \qquad (.06)$$

$$P = .38(.19)$$
$$R^2 = .74$$
$$SER = 4.80\alpha(3)$$

Here the estimation made use of a first order autocorrelation correction, with estimated coefficient given by P. The relative price of new capital goods enters with a sign opposite to that which would be expected on theoretical grounds, although it is statistically insignificant from zero at usual levels. Further, the addition of this variable is incapable of substantially lowering (in absolute value) the estimated coefficient on public investment, thereby casting doubt on the appropriateness of the more conventional explanation for the crowding out of private investment discussed above.

It might also be thought that the public investment variable is proxying for cyclical effects. As a check on this possibility, the basic specification was augmented by a variable measuring the deviation of the growth rate of output from trend, with the result below:

$$\underset{}{i_t} = \underset{(.02)}{.07} - \underset{(3.02\alpha(4))}{6.71\alpha(4)}\,\text{time} + \underset{(.13)}{.55r_{t-1}} + \underset{(.12)}{.36r_{t-2}} - \underset{(.39)}{1.37ig_t} + \underset{(.04)}{.07ydev_t} + e_t$$

$$\begin{aligned} P &= .48(.18) \\ R^2 &= .77 \\ SER &= 4.50\alpha(3) \end{aligned}$$

Addition of the output growth deviation variable does not in any way reduce the importance of public investment in the regression; the point estimate of the public investment coefficient remains substantially greater than unity in absolute value. The output variable enters with the logical sign but is only of marginal importance in helping to explain private investment.

Next, consider the introduction of current account expenditures by the public sector--defined above as all purchases of goods and services minus net public investment--into the regression equation. The result of ordinary least squares estimation is given in column(a) of Table IV. Two results are of particular interest. First, the estimated coefficient on the public consumption variable is negative and highly statistically significant. Second, the estimated coefficient on the public investment variable is lowered, in absolute value, to a level consistent with nearly complete crowding out of private capital accumulation. Inspection of column (b) of Table IV indicates that these results are not sensitive to correction for first order autocorrelation.

It is of interest to determine if public consumption or public investment is more depressive to private investment spending. The statistic relevant for testing the null hypothesis of equal effects versus a larger effect of public investment is distributed as a t variable; computation yields values of -1.36 and -1.52 for the ordinary least squares and first order autocorrelation correction estimations, respectively. Accordingly, it is not possible to claim at this stage that public investment is significantly more potent in it's impact on private capital spending.

The equation was reestimated treating the expenditure variables as endogenous, using the expenditure variables relative to trend output and lagged expenditure variables as instruments. In raw form, the data yield the estimates in column (c) of Table IV. Importantly, the public consumption variable becomes much less important in explaining movements in private investment, with a point estimate of -.27, and which is statistically insignificant at the 5 percent level. The coefficient on public investment still indicates nearly complete crowding out, while the rate of return variables remain at nearly the same values and levels of significance. Quasi-differencing the data and reestimating yields the same interpretation. Now, the relevant t-statistics take on the values of -2.18 and -2.07, which allow rejection of the hypothesis of equal effects on private investment in favor of that of public investment having more importance.

IV. Conclusion

This paper investigates the relationship between private net investment in nonresidential structures and equipment and public spending. The empirical results suggest that, consistent with neoclassical theory, higher public expenditure is associated with lower private investment, given the rate of return to private capital. The extent of the ex ante crowding out of private investment appears greater for public net investment than for public consumption and replacement investment expenditure. Specifically, the point estimates suggest that an increase in the ratio of public capital accumulation to output of one percentage point reduces private capital spending by one to one and one half percentage points, while an equal sized rise in public consumption would depress private investment by roughly 0.20 of a percentage point. This last result is consistent with increases in public consumption expenditure which are largely permanent, a result which is reflective of the sample period chosen for this study.

Interesting topics for future research appear to be: consideration of different series on private and public net capital accumulation, utilizing differing depreciation methodologies; analysis of the impact of changes in various types of public investment; and the detailed investigation of possible complementarities in production operating through impacts on the marginal product of private capital.

The neoclassical approach to the effects of public sector deficits on private investment expenditure emphasizes real, as opposed to purely financial, considerations. This paper has provided some evidence consistent with that approach and shows that while pure deficits may not matter, public spending--especially public investment--is of crucial importance in determining the overall rate of capital accumulation in the economy.

Table I

Summary Statistics of Variables (1953-84)

	Mean	Standard deviation	Maximum	Minimum
i	0.030	0.009	0.051	0.013
r	0.038	0.013	0.068	0.012
i^g	0.018	0.008	0.034	0.006
c^g	0.212	0.019	0.260	0.183
ydev	0.000	0.025	0.032	-0.568

Table II

Dependent Variable = i_t

	(a)		(b)		(c)		(d)	
constant	.03	(.03)	.04	(.03)	.02*	(3.94α(3)	.01*	(5.00α(3))
time	-1.59α(4)	(3.44α(4))	-3.04α(4)	(4.00α(4))				
r_t	-.22	(.16)	-.04	(.16)	-.25	(.15)	-.14	(.14)
r_{t-1}	.65*	(.19)	.58*	(.16)	.63*	(.18)	.54*	(.15)
r_{t-2}	.21	(.16)	.26**	(.14)	.18	(.14)	.22	(.14)
ig_t	-1.34*	(.52)	-1.43*	(.48)	-1.23*	(.45)	-1.26*	(.42)
ig_{t-1}	.82	(.78)	.66	(.66)	.86	(.76)	.79	(.64)
ig_{t-2}	-.01	(.51)	.02	(.48)	.08	(.46)	.14	(.44)
ρ		-	.34	(.21)			.32	(.20)
	DW = 1.27 R^2 = .70 SER = 5.20α(3)		R^2 = .75 SER = 4.70α(3)		DW = 1.31 R^2 = .70 SER = 5.20α(3)		R^2 = .74 SER = 4.80α(3)	

Note: Standard errors in parentheses. An * denotes statistical significance of the 5 percent level; ** at the 10 percent level. $\alpha(x) \equiv 10^{-x}$.

Table II (cont'd)

	(e)		(f)		(g)		(h)	
constant	.03	(.02)	.04	(.03)	.05*	(.02)	.06*	(.02)
time	-1.56α(4)	(3.10α(4))	-3.04α(4)	(3.70α(4))	-4.16α(4)	(2.16α(4))	-5.912(4)**	(3.08α(4))
r_t	-.22	(.16)	-.04	(.15)	-.13	(.15)	-1.40α(3)	(.13)
r_{t-1}	.65*	(.18)	.58*	(.15)	.64*	(.19)	.59*	(.15)
r_{t-2}	.21	(.15)	.26**	(.14)	.30*	(.14)	.33*	(.13)
i_{gt}	-1.34*	(.46)	-1.43*	(.46)	-1.01*	(.41)	-1.25*	(.44)
ig_{t-1}	.81	(.55)	.67	(.54)	-	-		-
ig_{t-2}	-	-	-	-			-	-
P	-	-	.34**	(.20)	-	-	.36**	(.19)
	DW = 1.27		R^2 = .75		DW = 1.21		R^2 = .73	
	R^2 = .70		SER = 4.70α(3)		R^2 = .67		SER = 4.90α(3)	
	SER = 5.20α(3)				SER = 5.40α(3)			

Table II (Cont'd)

	(i)		(j)	
constant	.05*	(.02)	.06*	(.03)
time	-5.08α(4)*	(2.41α(4))	-6.22α(4)*	(3.07α(4))
r_t				–
r_{t-1}	.56*	(.16)	.59*	(.14)
r_{t-2}	.34*	(.13)	.33*	(.13)
ig_t	-1.19*	(.36)	-1.28*	(.41)
ig_{t-1}				
ig_{t-2}				–
P			.44*	(.18)

DW = 1.02	R^2 = .74
R^2 = .66	SER = 4.80α(3)
SER = 5.50α(3)	

Table III
Dependent Variable = Δi_t

constant	-8.06α(4)	(1.24α(3))	-1.06α(3)	1.13α(3)
Δr_t	.09	(.15)	-	-
Δr_{t-1}	.60*	(.14)	.62*	(.13)
Δr_{t-2}	.29*	(.14)	.32*	(.13)
Δig_t	-1.54*	(.50)	-1.40*	(.48)
Δig_{t-1}	.44	(.55)	-	-
Δig_{t-2}	.08	(.48)	-	-
	DW = 1.93 R^2 = .61 SER = 5.20α(3)		DW = 2.00 R^2 = .57 SER = 5.50α(3)	

Table IV

	(a) OLS		(b) FOAC		(c) 2SLS		(d) 2SLS (FOAC)	
constant	.22*	(.04)	.22*	(.04)	.13*	(.06)	.05	(.04)
time	-1.26α(3)*	(2.31α(4))	-1.27α(3)*	(2.58α(4))	-8.04α(4)*	(3.26α(4)	-3.68α(4)	(2.61α(4))
r_{t-1}	.40*	(.12)	.47*	(.11)	.47*	(.14)	.55*	(.13)
r_{t-2}	.62*	(.11)	.54*	(.11)	.47*	(.14)	.37*	(.13)
ig_t	-.95*	(.26)	-1.03*	(.29)	-.99*	(.30)	-1.05*	(.38)
cg_t	-.59*	(.12)	-.55*	(.13)	-.27	(.19)	-.16	(.21)
P	-	-	.23	(.20)	-	-	-	-
	DW = 1.49 R^2 = .83 SER = 3.90α(3)		R^2 = .84 SER = 3.50α(3)		DW = 1.19 R^2 = .74 SER = 4.84α(3)		DW = 1.68 R^2 = .65 SER = 4.78α(3)	

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Footnotes

[1]To focus on the "present" and the "future" we take all future periods (of equal length) to be identical so lifetime utility is given by

$$U = u(c^*) + \frac{1}{1+\rho} u(\bar{c}^*) + \frac{1}{(1+\rho)^2} u(\bar{c}^*) + \ldots$$

$$= u(c^*) + \frac{u(\bar{c}^*)}{\rho}.$$

[2]As in footnote 1, all future periods are assumed identical so that the present value of consumption, etc., is given by

$$PV(c) = c + \frac{\bar{c}}{1+r} + \frac{\bar{c}}{(1+r)^2} + \ldots$$

$$= c + \frac{\bar{c}}{r}.$$

Also, in obtaining an intertemporal constraint as in (3), a solvency condition has been imposed such that as time nears infinity the present value of the agent's stock of debt approaches zero; this rules out the possibility of perpetual debt finance.

[3]The theoretical section deals only with changes in lump sum taxes. Changes in distortional tax rates, investment tax credits, and depreciation schedules generally will affect private investment (see, for example, Feldstein [1983]). Empirically, the rate of return variable employed below takes into account these effects so that given the net (of tax) rate of return to capital we may isolate the first order effects of changes in taxes.

[4]Similar arguments to those in footnote (2) apply here.

[5]Here, we define

$$\partial c^*/\partial w = - ru'(c^*)u''(\bar{c}^*)/[u'(\bar{c}^*)]^2$$

$$\partial \bar{c}^*/\partial w = - ru'(\bar{c}^*)u''(c^*)/[u'(\bar{c}^*)]^2$$

as the present and future marginal propensities to consume out of wealth, respectively.

Footnote (cont'd)

[6]A complete listing of the data used in this study is available from the author on request.

[7]Boskin, Robinson, and Roberts [1985] derive estimates of public fixed investment by making use of an alternative depreciation methodology based on used asset price data. However, this series is inclusive only of federal expenditures on capital goods.

[8]For details, see Fixed Reproducible Tangible Wealth of the United States, 1925-79.

[9]Feldstein [1983] also employs the lagged rate of return in his study of private investment and notes that this "lag in response has been found in all previous investment studies . . ." and that it reflects possible delays in the making of capital acquisition plans and delays in the production of capital goods.