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STAFF MEMORANDA

PUBLIC SPENDING AND THE RETURN TO CAPITAL

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Over the last decade, various authors have noted the apparent "productivity slowdown" in the United States. Specific reference has been made to a "falling rate of profit" or a "profits squeeze" as an indicator of a reduction in the productivity of capital. This paper looks at the recent behavior of the rate of return to private capital and then considers the extent to which its movements can be explained by public sector capital accumulation as well as the overall level of government expenditures on goods and services.

Often, discussion of fiscal policy issues centers on the public sector deficit, its relation to financial market rates of return and thereby its impact on private investment and economic growth. Little or no importance is placed on the precise way in which the deficit is created, whether by tax or expenditure changes, nor on the possible distinctive impacts which the two types of deficits may have on economic variables of interest.

The newclassical approach to fiscal policy, by claiming the approximate infiniteness of economic planning horizons, asserts that (lump sum) financial policy of the government sector is irrelevant to the determination of macroeconomic variables such as production and capital accumulation. Specifically, a current bond-financed tax reduction and rise in disposable income is optimally absorbed by private sector savings, with no net pressure on asset markets. Empirical support for this position is claimed by Aschauer (1985), Evans (1985), Kormendi (1983), Plosser (1982), and Seater and Mariano (1985) but is denied by Feldstein (1982), Modigliani and Sterling (1986), and Poterba and Summers (1986).

However, even allowing for the possible impotence of public financial policy, government expenditure policies may have a substantial impact on aggregate variables such as output, interest rates, and private investment. The distinction between transitory and permanent government purchases of goods and services has been found to be important in determining the effect of public spending on output (Barro 1981) and interest rates (Barro 1987). In this context, temporary expansions of public expenditure, primarily associated with wartime, create an intertemporal scarcity of resources, drive up real interest rates, and stimulate an intertemporal substitution into current productive activity. Similarly, Aschauer (1987) presents evidence that a raised level of public net investment may significantly crowd out—on an ex ante basis—private net capital accumulation. Indeed, the hypothesis of complete crowding out cannot be rejected, suggesting that the national rate of net investment may not be affected along this channel.

Still, we might expect public investment policy to affect the level of private investment by altering the marginal product of private capital. New highways and modern power plants—components of a general economic infrastructure—are likely to heighten the productivity of private capital and, along neoclassical lines, spur expenditure on new plant and equipment. This paper looks for such an effect on the rate of return to capital and thereby complements the results in Aschauer (1987). The paper also investigates whether the overall level of public expenditure has explanatory power for private rates of return to capital. Along with estimates of the substitutability of government goods for private consumption goods obtained in Aschauer (1985) and Kormendi (1983), the results herein suggest the likelihood of a negative effect of higher government spending on the effective wealth of private sector agents.

Recent Behavior of the Return to Private Capital

We begin by examining the behavior of the rate of return to private capital held by nonfinancial corporations in the United States during the period 1953 to 1985. Two specific rates of return, gross and net of depreciation, are employed. These rates of return are calculated as the ratio of corporate profits (with inventory valuation adjustment and capital consumption adjustment) plus net interest to the net stock of fixed capital, land, and inventories. The net stock of fixed capital is computed along "perpetual inventory" lines by subtracting from the gross capital stock (cumulative investment minus discards) an estimate of cumulative depreciation. For private capital, the depreciation methodology is straight-line over 85% of the service lives as published in Bulletin F of the Treasury Department. The gross rate of return exceeds the net rate of return by the ratio of the capital consumption allowance to the net capital stock.

Note three aspects of these rates of return. First, the rates of return are limited to the nonfinancial corporate sector since published data on capital consumption allowances are confined to this category. Second, both the gross and net rates of return are pre-tax, with the exception that state and local property taxes are treated by the Commerce Department as a cost of production. Third, capital losses on the net financial assets held by corporations arising from inflation are ignored. The basic rationale for the second and third characteristics of these profit rates is that the attempt is to capture underlying technological relationships between the government spending variables and capital's marginal product.

The behavior of these rates of return during the period 1953 to 1985 is depicted in Figure 1. The average values of the gross and net rates were 15.2 and 9.4 percent, respectively, implying an average rate of physical depreci-

ation of 5.8 percent per year. Both rates achieved their maximum values of 18.4 (gross) and 13.0 (net) percent in 1965 and their minimum values of 12.2 (gross) and 5.6 (net) percent in 1982. Evidently, both rates of return exhibit a downward trend during the sample period. As the regressions in Table 1 indicate, before accounting for serial correlation and cyclical effects the trend lines are highly significant with the gross rate of return falling, on average, by 7.5 basis points per year and the net rate declining by a more substantial 12.2 basis points.

In a recent article, Feldstein and Summers (1977) investigated the behavior of similar rates of return and presented evidence that the downward trend apparent in the raw data disappeared upon accounting for serial correlation and cyclical effects. The results in Table 1 indicate that while the estimates of the trend are reduced in both cases, only the gross rate of return has a trend estimate which becomes insignificantly different from zero at conventional levels. Indeed, the trend estimate in the net return case still implies a strong negative movement in the rate of return on the order of 7.5 basis points per year. This difference in trend behavior shows up in a strong positive trend in the implied depreciation rate of capital of 4.6 basis points per year (associated t-statistic = 9.426). On the other hand, the similarity in the response of both rates of return to cyclical factors implies that the depreciation rate is not affected, to any significant degree, by movements in the capacity utilization rate. This last result suggests that there is a basic deficiency in the depreciation methodology utilized by the Department of Commerce as we would expect true economic depreciation to be positively related to intensity of use of the capital stock.

Thus, some evidence of a falling return to private capital over the sample period remains even after controlling for serial correlation and the cyclical variability of capacity utilization. In the next section we consider the possibility that the public capital stock may play a leading role in explaining this trend in the nation's rate of profit.

Public Capital, Public Spending, and the Rate of Return

We now focus on the importance of public sector capital accumulation to the rate of return to private capital. Consider, as a benchmark, a neoclassical production technology for aggregate output with employment, private capital, and public capital as factor inputs. We may write the marginal product of capital as

$$r_t = \frac{\partial f}{\partial k}(n_t, k_t, k_t^g) \cdot g(u_t, t) \tag{1}$$

where $r_t \equiv$ marginal product of private capital, $n_t \equiv$ aggregate employment, $k_t \equiv$ private net captial stock, $k_t \equiv$ public net capital stock, and $u_t \equiv$ tech-

nological shock. Further, assuming that the primitive function f(·) is linearly homogenous in its arguments allows us to invoke Euler's theorem and write

$$r_t = h(n_t/k_t, k_t^g/k_t) \cdot g(u_t, t). \tag{2}$$

The fundamental hypothesis of interest is that the public capital stock is productive and complements the private capital stock in the sense that an increase in public capital—holding fixed private factors of production—raises the marginal product of private capital, or $\partial h(\cdot)/\partial(k_t^g/k_t) > 0$. We estimate the following approximation to (2):

$$r_t = \beta_0 + \beta_1 t + \beta_2 \ln(n_t/k_t) + \beta_3 \ln(k_t^g/k_t) + \beta_4 cu_t + z_t \tag{3}$$

where $r_t \equiv$ alternatively the gross and net rate of return to private capital, n_t, k_t, k_t^g are defined as before, and $cu_t \equiv$ capacity utilization rate. The aggregate employment variable is total employment while the net public capital stock variable is obtained along perpetual inventory lines comparable to that of net private capital. The results of estimating equation (3) by ordinary least squares, as well as by first order autoregressive and instrumental variables techniques, are contained in Table 2. In all regressions, the signs of the estimated coefficients are in accordance with the neoclassical argument that a higher private capital-labor ratio tends to depress the rate of return to capital as well as the hypothesis that a higher level of public capital, given the levels of employment and private capital, raises the rate or return. As a specific case, focus on the ordinary least squares results. Holding fixed the level of employment, a one percent increase in the private capital stock (and hence in the capital-labor ratio) would lower the gross and net rates of return by $-(\hat{\beta}_2 + \hat{\beta}_3)/r$ percent, or by 38.4 and 38.1 basis points, respectively. A one percent increase in the public capital stock, relative to its private counterpart, would raise the gross and net rates of return by $\hat{\beta}_3/\bar{r}$ percent, or alternatively by 19.1 and 21.4 basis points. Public capital appears to be of comparable importance to private capital in determining the profitability of the nation's private stock of plant and machinery.

The introduction of the capital-labor and public-private capital ratios only slightly diminishes the role of cyclical factors in the movement in the return to capital. A one percentage point increase in the capacity utilization rate from its sample average value of 81.9 percent raises the gross rate of return by 15.1 basis points and the net rate of return by 14.8 points. Cyclical factors clearly appear to affect the profitability of capital in a positive fashion.

As noted, the results in Table 1 suggest—at least for the case of the net rate of return—that even after taking consideration of serial correlation and cyclical effects there is a downward trend in the profitability of capital. The

introduction of the additional variables in Table 2 to help explain the rate of return changes the previous picture in a dramatic fashion. There is now a tendency for the gross and net rates of return to rise on the order of fifty basis points per year. This would imply a neutral rate of technical change of $(\hat{\beta}_1/\bar{r})x100$ percent per year, or 3.29 percent for the gross rate of return and 5.43 percent for the net rate of return. These point estimates are clearly too high given the average growth rate of real gross national product of 3.2 percent during this period. Nevertheless, the more reasonable value of 2 percent per year falls within the 95 percent confidence intervals for estimates of both rates of return.

The values of the Durbin-Watson statistic lie within the inconclusive range of the test at the 5% level. To account for the possibility of serial correlation, equation (3) was reestimated with a first order autocorrelation correction. The estimated value of the autocorrelation coefficient was relatively low and statistically insignificant at the 10% level for both rates of return. Furthermore, the estimated coefficients and standard errors remained nearly unaltered.

A troubling aspect of the estimation, particularly for the coefficient of the employment-private capital variable, is the possible simultaneity bias arising from the joint determination of employment and the rates of return. Treating the employment-capital variable as potentially endogenous, the equation was again reestimated by instrumental variables, with the trend value of employment, relative to the private capital stock, and time taken as instruments. The results are contained in the last two rows of Table 2. This aspect of simultaneity evidently is not a matter of particular concern.

Thus, it seems clear that the rate of return to private capital is strongly and positively related to the public capital stock. This offers a clue to solving the mystery of the downward trend in the profit rate over the sample period. For as can be noted from Figure 2, the ratio of public to private net capital stocks has fallen persistently since 1964, from a peak of .840 in that year to .564 in 1985. Given the employment-private capital ratio, this implies that gross and net rates of return to private capital have been depressed, relative to the level which would have arisen if the public capital ratio had been steady.

Table 3 contains estimates of expanded rate of return equations where the ratio of total government expenditure on goods and services to the private net capital stock has been added to the list of regressors. The introduction of this variable has no discernable impact on the estimated coefficients of the original variables, and its own estimated coefficient is of negligible statistical importance. Even taking the coefficient estimates as valid, the results suggest that a one percent increase in the level of government expenditure relative to the capital stock would raise the gross rate of return by only 1.2 basis points and the net rate of return by 1.4 points.

The evidence presented here suggests the importance of distinguishing not only between the financial and real elements of fiscal policy, but between various sorts of government spending as well. Specifically, while public capital boosts the profitability of private plant and equipment, the overall flow of government spending has little or no such impact.

Conclusion

The analysis of the effects of fiscal policies on aggregate economic variables may roughly be placed into financial and real categories. The newclassical or equilibrium approach to fiscal policy is often characterized, and criticized, as implying the "irrelevance" of budgetary policies on economic outcomes. Such characterization and criticism is inaccurate. While adherents to this approach typically claim such irrelevance for the particular lump sum financial policy pursued by the government, broad scope remains for fiscal policy effectiveness along real channels including distorting taxation and public expenditure policies.

Indeed, this paper has presented evidence which suggests that while the overall level of government spending on goods and services may not affect the marginal product of capital—more specifically, the return to capital—the accumulation of capital goods by the public sector does have such an effect. The elasticity of the rate of return to capital—gross or net of physical depreciation—with respect to public capital is strongly positive and of comparable magnitude to the corresponding elasticity with respect to private capital. Furthermore, the introduction of public capital, relative to private capital, and the private capital to labor ratio accounts for much of the visual downward trend in the profit rate in the United States over recent years.

References

Aschauer, D.A. "Fiscal Policy and Aggregate Demand," *American Economic Review,* 75, March 1985, 117-127.

_____. "Net Private Investment and Public Expenditure in the United States, 1953-84," FRB Chicago *Staff Memoranda,* September 1984.

Balance Sheets for the United States Economy 1946-85, Board of Governors of the Federal Reserve System, 1986.

Barro, R. J., "Output Effects of Government Purchases," *Journal of Political Economy,* 89, December 1981, 1086-1121.

_____. "Government Spending, Interest Rates, Prices, and Budget Deficits in the United Kingdom, 1707-1918," forthcoming,

Journal of Monetary Economics, 1987. *Economic Report of the President,* U.S. Government Printing Office, Washington D.C., 1987.

Economic Report of the President, U.S Government Printing Office, Washington, D.C., 1987.

Evans, P. "Do Large Budget Deficits Produce High Interest Rates?" *American Economic Review,* 75, March 1985, 68-87.

Feldstein, M., "Government Deficits and Aggregate Demand," *Journal of Monetary Economics,* 9, January 1982, 1-20.

Kormendi, R. C. "Government Debt, Government Spending, and Private Sector Behavior," *American Economic Review,* 73, December 1983, 994-1010.

Modigliani, F., and A. Sterling, "Government Debt, Government Spending and Private Sector Behavior: A Comment," *American Economic Review,* 76, December 1986.

Musgrave, J. "Fixed Reproducible Tangible Wealth in the United States: Revised Estimates," *Survey of Current Business,* January 1986, 51-62.

_____. "Fixed Reproducible Tangible Wealth in the United States: 1982-85," *Survey of Current Business,* August 1986, 36-89.

National Income and Product Accounts of the United States, 1929-82, U.S. Government Printing Office, Washington D.C., 1986.

Plosser, C. I., "Government Financing Decisions and Asset Returns," *Journal of Monetary Economics,* 9, May 1982, 325-52.

Poterba, J. M., and L. M. Summers, "Finite Lifetimes and the Savings Effects of Budget Deficits," forthcoming, *Journal of Monetary Economics,* 1987.

Seater, J. J. and R. S. Mariano, "New Tests of the Life Cycle and Tax Discounting Hypotheses," *Journal of Monetary Economics,* 15, March 1985, 195-215.

Data Appendix

The raw data on the net fixed capital stocks are contained in Musgrave (1986 a, b), Tables 8 and 15. The year-end published data are converted to a mid-year average value for construction of rates of return.

The data on gross and net capital income are found in the *National Income and Product Accounts,* Table 1.16 (lines 20, 27 ,35).

The land and inventory data are from *Balance Sheets for the U.S. Economy 1946-85,* pp. 21-25.

The capacity utilization rate, overall government spending (goods and services), and employment (total civilian labor force) are taken from the *Economic Report of the President* (1987).

Figure 1
Rate of return to private capital

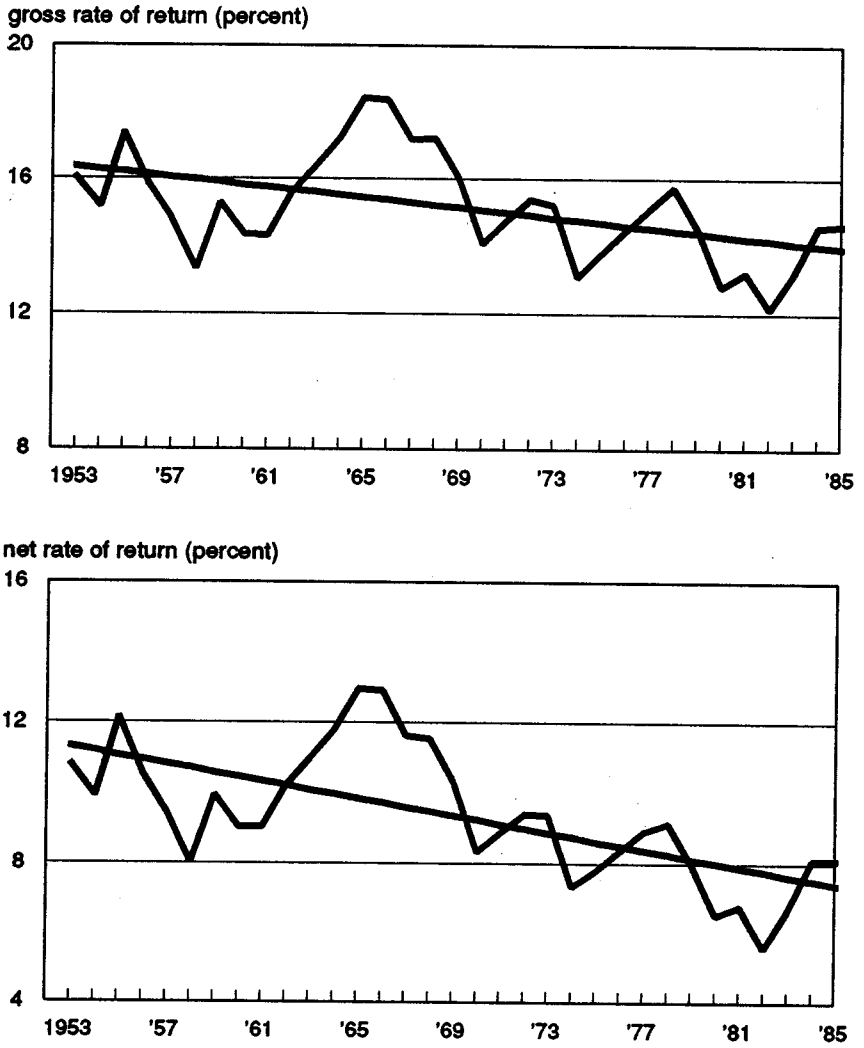

Figure 2
Ratio of public to private capital stocks (1982$)

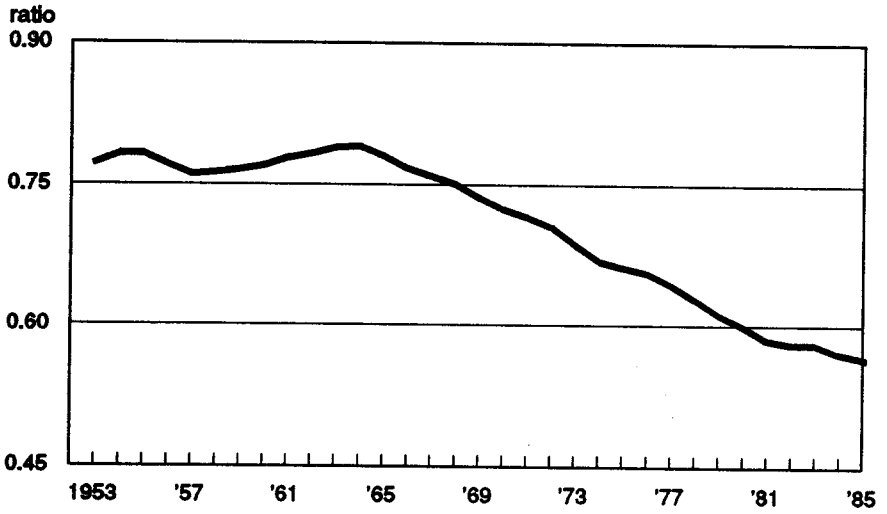

Table 1
Rate of Return to Private Capital

	const	time	cu	p	DW	R^2	SSE
rg	.203 (11.301)	-.00075 (-2.901)	-	-	.696	.214	.006
rn	.178 (9.639)	-.00122 (-4.623)	-	-	.634	.408	.007
rg	.006 (.183)	-.00028 (-1.229)	.201 (6.053)	.386 (2.251)	-	.775	.002
rn	-.015 (-.424)	-.00075 (-2.976)	.196 (5.951)	.455 (2.755)	-	.843	.002

Table 2
Rate of Return to Private Capital and Public Capital

		const	time	ln(n/k)	ln(k^g/k)	cu	p	DW	R^2	SSE
rg	OLS	1.490 (2.569)	.005 (3.171)	.171 (2.643)	.191 (4.547)	.151 (4.381)	-	1.551	.840	.0013
rn	OLS	1.455 (2.599)	.005 (3.125)	.170 (2.732)	.214 (5.273)	.148 (4.461)	-	1.473	.894	.0012
rg	FOAC	1.465 (2.107)	.005 (2.650)	.167 (2.158)	.198 (3.947)	.141 (3.767)	.220 (1.169)	-	.849	.0012
rn	FOAC	1.403 (2.044)	.005 (2.521)	.164 (2.142)	.219 (4.439)	.140 (3.839)	.254 (1.364)	-	.902	.0011
rg	IV	1.705 (2.782)	.005 (3.350)	.195 (2.851)	.202 (4.668)	.143 (4.057)	-	.841	-	.0013
rn	IV	1.762 (2.969)	.005 (3.461)	.205 (3.095)	.230 (5.481)	.137 (4.017)	-	.894	-	.0012

Table 3

Rate of Return to Private Capital, Public Capital, and Government Spending

		const	time	ln(n/k)	ln(k^g/k)	ln(g/k)	cu	p	DW	R^2	SSE
rg	OLS	1.429 (2.379)	.005 (3.048)	.163 (2.413)	.178 (3.533)	.012 (.497)	.149 (4.242)	-	1.568	.842	.0012
rn	OLS	1.384 (2.392)	.005 (2.997)	.161 (2.479)	.198 (4.093)	.014 (.602)	.146 (4.319)	-	1.499	.895	.0012
rg	FOAC	1.419 (1.988)	.005 (2.586)	.161 (2.014)	.188 (3.253)	.009 (.342)	.141 (3.699)	.207 (1.081)	-	.849	.0012
rn	FOAC	1.354 (1.931)	.005 (2.471)	.158 (2.033)	.208 (3.696)	.011 (.398)	.139 (3.778)	.237 (1.245)	-	.902	.0011
rg	IV	1.653 (2.594)	.005 (3.224)	.188 (2.626)	.191 (3.679)	.010 (.405)	.142 (3.945)	-	-	.842	.0013
rn	IV	1.703 (2.768)	.005 (3.332)	.197 (2.850)	.218 (4.333)	.011 (.465)	.135 (3.907)	-	-	.895	.0012

Appendix
Data Used in this Study

	rg	rn	k^g/k	g/k	k/n	cu
53	.160	.108	.773	.362	17873.8	.893
54	.152	.099	.784	.316	18877.2	.801
55	.174	.122	.782	.291	18999.2	.870
56	.158	.105	.771	.280	19317.6	.861
57	.148	.095	.761	.282	20062.9	.836
58	.133	.080	.763	.287	21024.7	.750
59	.153	.100	.766	.281	21056.5	.816
60	.144	.090	.770	.277	21263.3	.801
61	.143	.090	.778	.286	21842.5	.773
62	.156	.103	.783	.292	22069.0	.814
63	.164	.110	.789	.289	22437.7	.835
64	.172	.118	.790	.285	22743.3	.856
65	.184	.130	.780	.280	23250.0	.895
66	.184	.116	.767	.289	23892.7	.911
67	.172	.115	.759	.298	24635.1	.867
68	.172	.103	.750	.295	25294.1	.870
69	.160	.083	.736	.278	25902.6	.867
70	.141	.089	.724	.259	26841.0	.792
71	.154	.094	.716	.248	27664.8	.774
72	.152	.094	.705	.241	27716.1	.828
73	.131	.073	.686	.227	27973.5	.870
74	.145	.078	.669	.221	28696.6	.826
75	.151	.084	.661	.219	29988.0	.723
76	.157	.089	.565	.214	29694.1	.774
77	.146	.092	.643	.210	29419.4	.814
78	.128	.080	.628	.208	29213.9	.842
79	.132	.065	.611	.201	29594.6	.846
80	.128	.065	.599	.198	30579.8	.793
81	.132	.068	.585	.194	31281.9	.783
82	.122	.056	.580	.194	32366.1	.703
83	.132	.067	.579	.193	32508.3	.740
84	.146	.081	.571	.195	31937.7	.805
85	.146	.081	.564	.202	32285.6	.801