Overinvestment in Public Sector Capital

Willis Peterson

There appears to be widespread agreement that more spending on education and infrastructure is a good thing. For the most part, this requires public investment. If the objective is to increase economic growth, allocating more resources to investment is, of course, necessary. However, given the resources available for adding to the stock of capital, economic growth will be maximized only if marginal rates of return on alternative forms of capital are equalized. The results presented here suggest that large differences exist in the marginal rates of return on various forms of capital. Of particular concern is the low estimated return on public capital relative to private capital.

Capital Measurement

In this study, capital is grouped two ways: private versus public, and non-human versus human. Each group sums to the same total. Public investment in science and education is used as an estimate of human capital. Public sector capital includes both human and nonhuman forms. Stocks of nonhuman capital include both private and public sources.

The main difficulty of measuring the stock of capital is the assessment of depreciation. When capital is used as an input in a production function, true depreciation should reflect the decline in its service flow as aging takes place. Theoretically, the market price of a capital item is the discounted present value of the sum of future service flows. This value declines as the item ages not only because of a decline in productivity, but also because it has fewer years of useful life remaining. A decrease in market value will occur even if the rate of service flow does not decline. Therefore, a measure of the service flow of capital based on current market value of the capital stock will understate the true service flow. Book value of capital also will

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The author is Professor of Applied Economics at the University of Minnesota, St. Paul.

understate its true service flow capacity because of the incentive by business firms to depreciate capital at the maximum allowable rate for income tax purposes.

The depreciation method adopted here is the "one horse shay" pattern. Under this method the service flow of a capital item is assumed to remain constant over its life and then fall to zero at the end. Although the true decrease in service flow of capital over time cannot be known, the one horse shay pattern of depreciation probably comes closer to the true pattern than the other two alternatives (Griliches 1963).

For private capital, 15 years is selected as the average life expectancy. Some capital, such as buildings, last longer while other items, such as certain machines and tools, have shorter life spans. But as an overall average, 15 years is not an unreasonable figure. The stock of private capital in year t (K^t) is constructed by summing real gross private domestic investment (GDI) over the preceding 15 years.

Capital constructed by public investment is estimated in a similar manner except its life span is assumed to be 20 years. Public investment by state and local governments and the federal government consists largely of buildings, infrastructure, education, and science, all of which should be somewhat more durable than machines.

Capital constructed by state and local governments is assumed to be the result of expenditures on education and highways, plus one-half of all other spending. The latter includes the following: libraries, hospitals, health, employment security administration, veteran's services, air transportation, water transport and terminals, parking facilities, transit subsidies, police and fire protection, correctional institutions, protective inspection and regulation, sewerage, natural resources, parks and recreation, housing and community development, solid waste management, financial administration, judicial and legal, general public buildings, other government administration, interest on debt, and other miscellaneous expenditures. Data on state and local government investment spending and gross private domestic investment are from the *Economic Report of the President* (1992, and back issues).

Capital constructed by the federal government is assumed to result from spending on public buildings, transportation, education, community development, land and water conservation and development, health research, river and harbor facilities, general science and space research, and other public works. Data on federal government expenditures are from the *Statistical Abstract*, various issues.

Stocks of human capital are estimated by aggregating the spending of state and local governments and the federal government on education,

science, and health research. The same 20-year life is assumed. The true stock of human capital is understated because the estimated stock does not include tuition payments, books and supplies, and forgone earnings of students. Data on these items do not exist.

Measuring capital as the sum of past investments implicitly takes quality change into account. If higher quality capital is more costly to produce, it will show up as more capital. On the other hand, any efficiency gains in the production of capital of a given quality would result in a higher rate of return. Conversely, an increase in the real cost of producing capital of a given quality, or a decrease in its quality for a given cost, will show up as a decrease in its rate of return.

To facilitate comparisons over time, GDP and the capital variables, except human capital, are expressed on a per worker basis. Because investment in education is not limited to members of the labor force, per worker figures on human capital are obtained by dividing the total stock of human capital by the population 5 years old and older. Per worker figures of the other capital variables are obtained by dividing the totals by the number of employed people in the country. All GDI and government spending figures are adjusted to constant 1987 prices before summing. The GDI figures are adjusted by the implicit price deflator for fixed investment. State and local government spending on highways is deflated by the Producer Price Index for construction materials. Educational expenditures are deflated by the Consumer Price Index for nonmedical services. And federal government investment spending is adjusted by an average of the preceding two indexes.

Capital Stocks

Estimated capital stocks per worker in thousands of 1987 dollars for selected years are presented in Table 1. In 1990, each U.S. worker on average is estimated to have had $123 thousand of capital at his/her disposal. Roughly 67 percent was from private investment and 33 percent from public sources. About 83 percent was nonhuman capital and 17 percent human capital, although, as mentioned, the human capital figure is a lower bound. In all categories, the 1990 per worker stocks were the largest that existed any year in the 1950–90 period, and presumably were the largest for any year in the history of the country.

The figures in Table 1 compare favorably with Musgrave's estimates presented in the *Survey of Current Business* (U.S. Department of Commerce 1992). His 1990 estimate of net private capital converted to a per worker basis is $73.4 thousand, compared to $82.4 thousand in Table 1. (Both sets of figures are in constant 1987 dollars.) His gross private capital estimate is $122 thousand per worker. Thus

TABLE 1

ESTIMATED CAPITAL STOCKS PER WORKER
(Constant 1987 Dollars, Thousands)

	1950	1960	1970	1980	1990
Total Capital	43.6	68.5	86.2	109.0	123.0
Private Capital	33.8	54.5	63.3	74.6	82.4
Public Capital	9.8	14.0	22.9	34.4	40.6
Nonhuman Capital	39.9	62.2	74.7	90.3	101.6
Human Capital	3.7	6.3	11.5	18.7	21.4

Musgrave's estimates of private capital encompass those presented in Table 1.

Because Musgrave's government capital estimates exclude public investment in human capital, the *Survey of Current Business* figures for government capital are not comparable to the estimates of public capital shown in Table 1, which include both human and nonhuman forms. Subtracting human capital from public capital for 1990 in Table 1 yields a per worker estimate of $19.2 thousand. Musgrave's 1990 estimates for net and gross government capital converted to a per worker basis are $20.3 and $34.5 thousand respectively. Thus his net figure is close to the figure obtained in this study after subtracting human capital.

As shown by the numbers in Table 1, components of the total capital stock grew at varying rates over the 1950–90 period. Public capital increased relative to private capital, and human capital grew more rapidly than nonhuman. This can be seen more clearly from Table 2 which shows the average annual growth rates by decades of the figures in Table 1, plus real GDP per worker and employment. Total capital exhibited the most rapid growth during the 1950s, mainly due to the high rate of gross private domestic investment. The decade of the 1950s appears to be a catching-up period after the unusual circumstances of the preceding two decades—the Great Depression and World War II. Over the entire period, highest growth rates occurred in public capital and human capital. Public capital grew at a rate nearly twice that of private capital over the 1950–90 period. Lower rates of growth of the total and various components of the total stock of capital occurred in the 1980s than anytime during the post World War II era. Employment growth was the greatest during the 1970s as homemakers and baby boomers came into the labor force.

Capital Productivity

As shown in Table 2, during the 1950–90 period, total capital per worker increased at an annual rate that was nearly double the growth

TABLE 2

ANNUAL PERCENTAGE RATES OF GROWTH OF ESTIMATED CAPITAL PER WORKER, REAL GDP PER WORKER, AND EMPLOYMENT BY DECADES[a]

	1950–59	1960–69	1970–79	1980–90	1950–90
Total Capital	4.35	2.15	1.95	1.05	2.51
Private Capital	4.53	1.34	1.58	.764	1.98
Public Capital	3.60	4.89	4.24	1.64	3.95
Nonhuman Capital	4.27	1.66	1.86	.994	2.17
Human Capital	5.03	6.13	5.01	1.34	4.85
Real GDP	1.77	2.47	.388	1.98	1.16
Employment	.99	2.01	2.47	1.98	1.84

[a]Estimated by $\log X_t = A + bT$ where X_t is the item under consideration, T is time, and b is the annual percent rate of growth.

rate of real GDP per worker. This implies a decrease in the productivity of capital. At the same time, capital increased relative to labor. Therefore, labor productivity should have increased, which is consistent with the growth in real GDP per worker.

The productivity of capital is commonly gauged by its marginal rate of return, estimated here by a standard Cobb-Douglas production function. The constant returns to scale assumption is imposed because the observations are per country as opposed to per firm. Time series data are utilized, 1950 to 1990. To minimize the problem of multicollinearity, a common problem with time series data, the labor intensive form is utilized.

Output per unit of labor, Q/L, is real GDP divided by total employment. Three functions are estimated where inputs are defined as: (1) total capital per worker, (2) private and public capital per worker, and (3) nonhuman and human capital per worker. To test whether the coefficient on capital has changed over the 1950–90 period, decade-specific slope dummies were inserted in the function, using the 1950–59 decade as the reference dummy. None of the slope dummy coefficients was statistically significant at reasonable confidence intervals, suggesting a constant coefficient on capital over the 41-year period. This finding is consistent with the Cobb-Douglas functional form which stipulates constant coefficients in the face of changing relative prices and a changing input mix (Douglas 1948).

Since capital is measured as a stock, the marginal products are marginal rates of return (MRR). They are also social rather than private returns since output is gross of taxes. Estimated MRRs for the various capital measures for each of the four decades are presented

TABLE 3

ESTIMATED MARGINAL RATES OF RETURN ON CAPITAL BY DECADES
(Percent Per Year)

	1950–59	1960–69	1970–79	1980–90
Total Capital	23.8	21.0	18.1	15.8
Private Capital	28.6	25.7	24.2	22.1
Public Capital	17.7	14.5	7.7	7.0
Nonhuman Capital	21.3	19.3	17.5	15.7
Human Capital	41.7	29.0	18.0	13.8

in Table 3. Marginal rates of return on total capital and its components were the highest during the 1950s and have declined over each of the following three decades. Although the rate of return on human capital was nearly double the return on nonhuman capital during the 1950s, the 1980s figures suggest that the rate of return on human capital has fallen more and was less than the marginal return on nonhuman capital during the 1980s. Similarly the return on public capital has fallen relative to the return on private capital. These results are not unexpected since the stocks of both human and public capital have grown relative to those of nonhuman and private capital.

Although there are no studies directly comparable to this one, the results obtained here are not unreasonable, nor are they out of line with previous findings. The 15.8 percent estimated marginal rate of return on all capital during the 1980s compares closely with the 15 percent rule-of-thumb commonly used as the social opportunity cost of capital. Also the 13.8 percent marginal return on human capital for the 1980s is close to what one obtains when calculating the returns to investment in education using earnings differentials from census data. In a 1989 study using international data, the marginal rate of return on capital for the developed countries was reported to be 15 percent (Peterson 1989). Finally, in a recent study, Summers also reports a decline of the social rate of return on capital in the private sector over the 1950–1987 period (Summers 1990). However, the low estimated returns to private capital reported in the Summers study, 6.4 percent during the 1980s, are not plausible. Investment should not occur when the rate of return on capital is less than the interest rate on loan funds.

Labor Productivity

The marginal product of labor also is estimated from the production functions. Marginal products of labor for the four decades are shown below in Table 4.

TABLE 4

ESTIMATED MARGINAL PRODUCTS OF LABOR
(Constant 1987 Dollars, Thousands)

Period	Marginal Products
1950–59	14.7
1960–69	18.2
1970–79	20.2
1980–90	21.2

Although the marginal product of labor has continued to increase over time, the difference between each succeeding decade has become smaller. The greatest growth in labor productivity occurred during the 1950s. The continued increase in the stock of capital per worker over the period which increases labor's marginal product has been offset in part by the decrease in capital productivity.

Conclusion

The relative decline in the estimated marginal rates of return on human and public capital to levels below the return to nonhuman and private capital is cause for concern, particularly if one takes seriously the call for an increase in spending on education and infrastructure. This is not to deny the enormous contribution to economic growth of inframarginal investments in education and infrastructure. But we are talking here about investments at the margin.

The relative increase in the stocks of public and human capital along with the decline in their marginal rates of return below the returns to private and nonhuman capital suggest the existence of an imbalance in the optimal mix of capital. These results suggest that policies that encourage the relative growth of private and nonhuman capital would do the most to stimulate economic growth and reduce unemployment. Such policies might include greater reliance on expenditure taxes and less on income taxes, and/or a reinstatement of the investment credit provision in the income tax code. It is commonly assumed that higher rates of economic growth depend upon an increased investment in education and infrastructure. Thus the implications of the results reported here run counter to conventional wisdom. Yet it might be noted that higher rates of economic growth do not necessarily require larger stocks of public sector and human capital. During the 1960s the growth rate of real GDP per worker was over twice the rates of the 1970s and 1980s. However, in 1960, estimated

per worker stocks of public sector and human capital were about one-third 1990 stocks in real terms (Table 1). Also, GDP growth in the 1970s was relatively low while the growth rates of public sector and human capital remained high (Table 2).

Granted, society may have objectives other than, or in addition to, higher rates of economic growth, such as full employment and a more equal distribution of income. In this case, the marginal rate of return on capital is not the only criterion for resource allocation policy (Harberger 1971). But again it might be noted that the relative increase in the stocks of human and public sector capital has not prevented the trend towards less equality of incomes, nor of higher rates of unemployment in the 1990s than prevailed in the 1950s and 1960s.

What does the future hold in store? Will future generations be worse off, as some have suggested? As long as gross investment per worker exceeds depreciation, the per worker stock of capital will continue to grow. Unless the marginal rate of return decreases at a faster rate, total output per worker will increase. One would not expect marginal rates of return on capital to decrease indefinitely. At some point, owners of capital will seek higher returns in other countries. When, or if, this occurs, the marginal rate of return on capital and capital per worker should stabilize, along with output per worker. Thus future generations need not be worse off than current or past generations. But the evidence does suggest that future generations will not be getting better off at as rapid a rate as past generations. Even if the rate of investment increases during the mid to late 1990s, capital stocks take much longer to respond. Thus the immediate prospects for higher, sustained economic growth do not look promising. Future generations will bear the consequences of the investment slowdown of the 1980s, particularly in private and nonhuman capital.

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