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Total Capital and Economic Growth

An attempt is made via a growth accounting exercise to quantify the contributions of various factors to the growth of real product in the national economy and the business sector.[1] Following this discussion we analyze the implications of the increase in total capital productivity for rates of return on total capital when both income and capital are expressed in terms of current dollars. Rates of return on human and nonhuman capital are considered separately and in combination.

Contribution of Total and Intangible Capital to Economic Growth

The analysis in this section stems from the hypothesis suggested by Schultz and others, as recounted in chapter 1.[2] To state the analytical framework in its simplest form, income or product (Y) may be viewed as the product of the aggregate stock of total capital (K) and all the other

1. This section follows the general approach pioneered by Edward F. Denison, most recently elucidated in his *Accounting for United States Economic Growth, 1929–1969*, Washington, D. C., The Brookings Institution, 1974.

2. For further discussions of the concept of capital as income-producing capacity, see John W. Kendrick, "Theoretical Aspects of the Measurement of Capital," American Economic Association *Papers and Proceedings*, May 1961; and R. H. Parker and G. C. Harcourt, eds., *Readings in the Concept and Measurement of Income*, Cambridge at the University Press, 1969.

"residual" forces (R) which affect the productivity of aggregate capital. "R" can be computed as the quotient of Y and K to satisfy the identity

$$Y = R \cdot K. \tag{1}$$

When the income and stock variables are measured in current prices, R may be viewed as an average rate of return. When Y and K are measured in constant prices, R may be thought of as an average physical productivity variable reflecting the net effect of the noncapital forces that affect the movements of real product, discussed later. The identity may be further elaborated to highlight the separate contributions of tangible capital (K_1)—human and nonhuman (measured without allowance for quality change)—and the embodied intangible capital (K_2), as well as the net effect of the residual forces, as follows:

$$Y = K_1 \cdot (1 + K_2/K_1) \cdot R. \tag{2}$$

This formulation opens the way to estimating the contribution of intangible capital per unit of tangible capital to total tangible factor productivity, and thus testing the hypothesis I put forward in 1956 (see Preface). It would also provide a test of the Schultz hypothesis, although Schultz was referring to the growth of intangible human capital alone, whereas I include intangible nonhuman capital resulting from R&D as well, and place greater stress on the possible influence of residual, noncapital forces (see below). In this formulation, one divides both sides of equations (1) or (2) (with both Y and K expressed in constant prices) by the real stock of intangible capital:

$$Y/K_2 = K/K_2 \cdot R. \tag{3}$$

This formulation abstracts from changes in utilization rates of the real human and nonhuman stocks, although such adjustments could be added if wanted. A general limitation of all these formulations in terms of real stocks rather than services of the factors is the implicit assumption that the contribution to output (income) of each type of capital is proportionate to its value, i.e., that the productivity or net rates of return on the various types of capital are equal. We shall discuss this limitation further below. It should also be noted that, when product and capital are related on a gross basis, the relationship can be affected by changes in the capital mix with respect to durability.

Looking at 1929 and 1969 (Table 5-1), we note that real total gross capital stocks grew at an average annual rate of 2.4 per cent in the private domestic business economy, compared with a 3.4 per cent

Table 5-1. *Major Components of U.S. Economic Growth: Average Annual Percentage Rates of Change, 1929–1969 and Subperiods*

	Private Domestic Business Economy			National Economy		
	1929–69	1929–48	1948–69	1929–69	1929–48	1948–69
Real adjusted product	3.4	2.7	4.0	3.4	2.7	4.0
Real tangible capital	1.7	0.6	2.6	2.4	1.8	3.1
Real intangible capital	3.8	3.3	4.3	3.8	3.2	4.3
Real total capital	2.4	1.4	3.3	2.8	2.2	3.5
Ratio: Real total capital/ real tangible capital	0.7	0.8	0.6	0.4	0.4	0.4
Real tangible factor productivity	1.7	2.1	1.4	0.9	1.0	0.9
Total capital productivity (Residual factors)	1.0	1.3	0.7	0.5	0.6	0.5

NOTE: The capital estimates represent capital employed, but without adjustment for rates of utilization.

growth rate in real gross product. Thus, total capital accounted for about 70 per cent of the economic growth rate, while the 1.0 per cent a year rate of increase in the residual factors comprised by "total capital productivity" accounted for the other 30 per cent.

During the subperiod 1929–1948, real total capital accounted for a somewhat smaller proportion of the slower rate of economic growth than over the 40-year period as a whole. Between 1948 and 1969, on the other hand, it accounted for a higher proportion—over 80 per cent—of the faster growth rate.

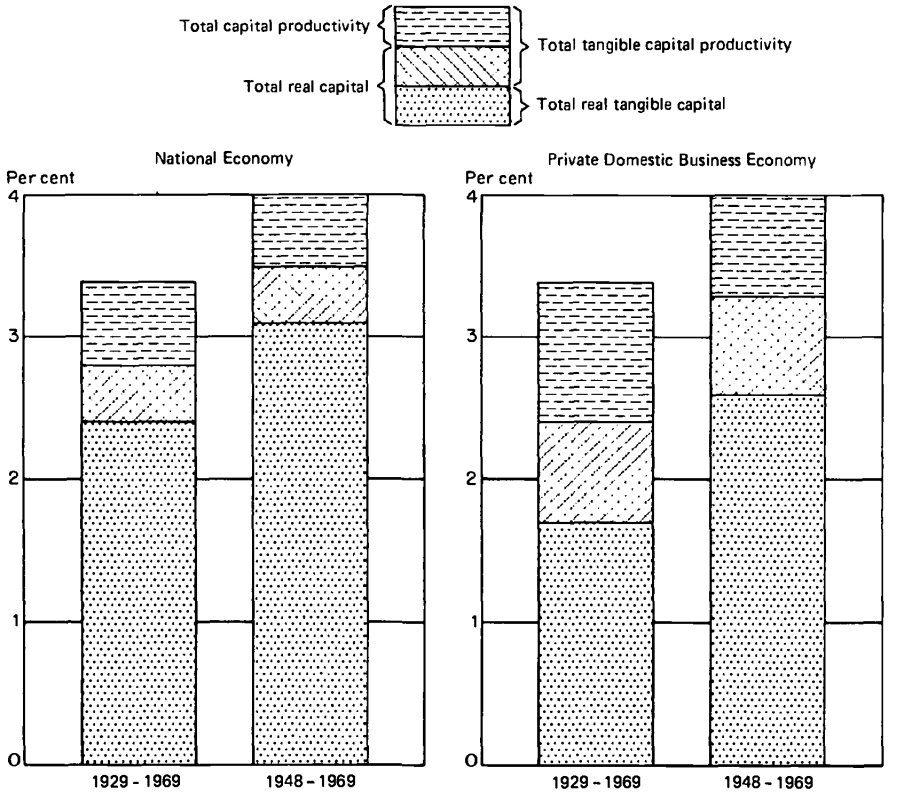
In regard to the national economy portion of Table 5-1, it is evident that real total capital accounted for an even higher proportion of aggregate economic growth than in the private domestic business economy. This was true in both subperiods and the entire 40-year span. As observed earlier, the lesser importance of total capital productivity in the economy as a whole was due to the method of estimating real product originating in the nonbusiness sectors without allowance for productivity advance.

Although real intangible capital grew at a much higher rate than real tangible capital stocks, its relative size was much smaller (about one-third in 1929), so that the contribution of its growth was smaller than that of the tangible capital—0.7 and 1.7 percentage points, respectively, over 1929–1969, as shown in the table for the private domestic business economy. This statement, again, assumes that the marginal productivity of the two categories of capital was the same, an assumption that will be examined later.

It is also of interest to consider the contribution of real intangible capital stock expansion to the growth of total tangible capital productivity. The latter variable is obtained by dividing real gross product by the real stocks of tangible capital, human and nonhuman. As shown in Table 5-1 for the business economy, productivity (item 6) rose at an average annual rate of 1.7 per cent from 1929 to 1969. This rate is lower than the 2.3 per cent reported in *Postwar Productivity Trends in the United States, 1948–1969,* since there labor input was measured in terms of weighted man-hours worked, which both rose less than the real stock of tangible human capital used in the measure shown here and had a larger weight. The contribution of intangible capital is measured by the growth in the ratio of real total capital (including intangible) to real tangible capital, assuming equal marginal productivity in the two types of capital.

Via this approach, the relative growth of real intangible capital contributed 0.7 percentage point, or 41 per cent, to the 1.7 per cent growth rate of total tangible factor productivity over 1929–1969. The 0.8 per cent rate of growth represented a somewhat smaller proportion of a

Chart 5-1. *Components of Economic Growth, Average Annual Percentage Rates of Change*



higher rate of productivity advance from 1929 to 1948, and the 0.6 per cent rate from 1948 to 1969, a somewhat greater proportion of a lower rate of productivity advance. (See Chart 5-1.)

From these calculations it would appear that other, noncapital factors accounted for more than half of the increase in total tangible factor productivity since 1929. Apart from the cyclical influence of changing rates of capacity utilization, which would have little or no influence on comparisons between the peak years 1929 and 1969, the chief noncapital factors may be listed as follows: (1) economies of scale; (2) improved economic efficiency, i.e., a pattern of production conforming more closely to the community's preferences due to institutional and other changes; (3) changing average inherent quality of natural and human resources, including the effect of a changing mix; (4) changing efficiency of labor relative to the potential of given technolo-

gies, including the effect of a downward trend in average hours worked per week and per year, and changing values and incentives; (5) in the case of the business economy, an increase in unmeasured governmental inputs relative to real private costs (inputs); and (6) possible errors in the estimates and limitations of methodology.

It is beyond the scope of this study to attempt quantifying the individual and net effects of these forces. As roughly estimated by Denison, however, some of them have had a significant positive effect. Yet, as specified in an earlier analysis by the author,[3] Denison attributed a greater relative effect on growth and on tangible factor productivity (as we measure it) than we have to increases in average education and advances in knowledge.

It is quite possible (and, I suspect, probable) that we have underestimated the contribution of intangible capital formation to productivity advance and thus to economic growth in the United States. In the first place, the magnitude and growth rate of real intangible capital may be understated by our estimates. The probability of some upward bias in the price deflators for intangible investments has already been alluded to, which imparts downward bias to the real investment and stock estimates. Some intangible investments and stock are not included in the estimates, such as informal R&D, and learning-by-doing. It must also be noted that our formal R&D stock represents the pool of knowledge which is drawn on for current production, but does not include the accumulated R&D embodied in the stock of tangible nonhuman capital used in current production. Inclusion of the latter would raise the amount of intangible capital, but it is not certain what it would do to the rate of growth.

Secondly, the growth of intangible stocks in relation to tangible stocks, in real terms, does not tell the whole story. Even if the two types of capital grew at the same rate, productivity would probably continue to rise. The annual R&D that replaces previous with new productive knowledge would increase the productivity of new capital goods and of retrained workers even if it merely replaced capital goods and workers retired during the year.

Further, the marginal productivity and rate of return for intangible capital may be higher than for tangible capital. If so, this would proportionately increase the estimated contribution of intangible capital to growth. For example, assuming that the rate of return on intangible capital was twice that on tangible capital in 1929 (instead of equal on a

3. See John W. Kendrick, "The Treatment of Intangible Resources as Capital," *Review of Income and Wealth*, March 1972, pp. 109–125 (especially pp. 123–124). Note that Denison did not estimate the contribution of investments in health, safety, and mobility separately.

stock one-third the size, but one with a 2.1 per cent higher average annual growth rate), then the relative growth of real intangible capital would have contributed 1.4 of the 1.7 percentage point growth rate in total tangible capital productivity, or 82 per cent. The computations in the following section of this chapter substantiate the view that the return on intangible capital has been higher than on tangible capital; they show rates of return on human capital consistently above those on nonhuman capital (in 1929 the gross rate was approximately 27 per cent higher), and a much higher ratio of intangible to total capital for human than for nonhuman capital. If we assume the same differential between rates of return on intangible and tangible capital, the relative growth of the former in real terms would have contributed 0.9 of the 1.7 percentage point growth rate in total tangible capital productivity, or more than half.

Also, as stressed by Nelson,[4] growth accounting assumes a high degree of substitutability among inputs, whereas there is actually a high degree of complementarity in the growth process. For example, technological progress resulting from R&D and its embodiment in tangible capital is indispensable in increasing demand for more highly educated workers and thus in sustaining the rate of return on an expanding volume of educational activity. And all of the intangible investments help to sustain the tangible investment demand curve, so that capital outlays can absorb the rising volume of saving generated by a growing economy without the decline in rates of return predicted by Keynes. It is the interaction of the various inputs in the growth process that are difficult to quantify and to partition among individual factors.

In addition to the growth accounting exercise described above, we also experimented with statistically fitting production functions of the Cobb-Douglas and other (nonhomogeneous) varieties. The dependent variable was real gross product (private domestic business economy), and the independent variables were real gross utilized stocks of nonhuman tangibles, nonhuman intangibles, human tangibles, and human intangibles—separately and combined into total tangibles and intangibles and, alternatively, into human and nonhuman stocks. The coefficients of correlation were generally very high, reflecting good predictive power of the equations. But the output elasticities indicated by the coefficients frequently were not plausible, and were unstable depending on the specification of the function. For that reason we do not report the results here. It should be noted, however, that the nonhomogeneous functions yielded better results than the homogeneous Cobb-Douglas function.

4. See Richard R. Nelson, "Recent Exercises in Growth Accounting: New Understanding or Dead End?," *American Economic Review*, June 1973.

Rates of Return on Capital

In order to obtain the measures of capital productivity discussed above, product is related to capital in real constant dollar terms. When product (income) is related to capital in current prices, however, the result can be viewed as the percentage rate of return on capital. The difference in movement between the productivity and rate of return measures is due significantly to the relative movements of the implicit price deflators for product and capital. Thus, in chapter 4 we saw that total capital productivity (the reciprocal of the capital coefficient) rose by an average 0.5 per cent a year in the domestic economy from 1929 to 1969, while the implicit price deflator for capital rose by 0.4 per cent a year more than the product price deflator. Consequently, the ratio of product to capital in current prices rose by only 0.1 per cent a year on the average. This is the chief reason why the rates of return on total capital discussed in this section show relatively little change between 1929 and 1969, in contrast to the significant increases in average capital productivity discussed above. There are, however, several other adjustments necessary in order to make explicit the rate of return implications of the capital productivity estimates, although their net effect is small compared with the movement in relative prices of capital and product.

First, from the gross product estimates in current prices, indirect business taxes (less subsidies) and the statistical discrepancy must be deducted in order to obtain gross factor income. Also, in order to obtain estimates of net as well as of gross rates of return, as presented below, capital consumption allowances must be deducted from gross factor income and divided by net rather than gross capital stocks. Actually, since capital consumption reserves and allowances have not changed much as percentages of gross stocks and gross product, respectively, gross and net rates of return show much the same movements, although the levels differ somewhat, particularly as to the human and nonhuman components.

Finally, to be consistent with property returns (which are calculated after allowance for maintenance expenses), we have also deducted estimates of the maintenance costs of human beings from labor compensation, gross and net of depreciation. As described in the appendix in detail, human maintenance cost calculations are based on minimum budget estimates for families of various sizes, farm and nonfarm, and for institutional populations, with allowance for increases in average planes of living over the period. Since personal consumption expenditures have increased less than national income and labor compensation, labor returns less maintenance costs have risen more than

gross returns, although the levels and derived rates are much lower, of course.

Since the net property return on nonhuman capital in the nonbusiness sectors was imputed by applying interest rates to the stock estimates, we concentrate our analysis on the private business sector, where the compensation estimates are independent of the stock estimates. We shall also look further at returns in the total domestic economy, since there at least the labor returns are independent of the human stock estimates.

AVERAGE RATES OF RETURN

As shown in Table 5-2 for peak cycle years, the average rate of return on total gross capital employed in the private business sector was 10.2 per cent in 1929. The lower return in 1937 reflects the less than full recovery of that year: even though human capital is measured only for the employed work force, return is affected by hours of work, and the nonhuman capital stock is all counted as employed, so that average

Table 5-2. *Gross and Net Rates of Return on Capital Employed, by Major Type, U.S. Domestic Economy and Business Sector, Peak Years, 1929–1969* (percentage)

	Gross			Net		
Year	Total	Human	Nonhuman	Total	Human	Nonhuman
			Private Domestic Business Economy			
1929	10.2	11.7	9.2	10.0	10.1	10.0
1937	9.3	11.3	7.8	9.2	9.6	8.9
1948	12.1	12.2	12.0	13.4	12.6	14.2
1953	12.1	13.5	10.8	13.1	14.8	11.4
1957	11.4	12.7	10.1	11.6	13.4	9.9
1960	11.0	12.3	9.7	11.0	12.9	9.2
1969	10.8	11.7	9.9	10.6	12.2	8.9
			Total Domestic Economy			
1929	9.1	11.5	8.1	8.3	9.8	7.6
1937	8.2	11.2	6.8	7.5	9.4	6.5
1948	9.3	11.7	8.1	9.1	11.8	7.7
1953	9.5	12.7	7.9	9.2	13.3	6.9
1957	9.2	11.9	7.8	8.3	12.0	6.4
1960	9.1	11.6	7.7	8.1	11.6	6.2
1969	9.4	11.1	8.3	8.5	11.2	6.7

rates of utilization affect rates of return. The highest rates of return were realized in 1948 and 1953, at 12.1 per cent. Later the rate of return declined slowly over subsequent cycle peaks. The 10.8 per cent return in 1969 was only modestly above the rate reached forty years earlier.

The rate of return on human capital remained above that on nonhuman and total capital throughout the period, although the difference was minor when the latter peaked in 1948. The difference was smaller in 1969 than in 1929, since the rate of return on human capital was the same in both years (at 11.7 per cent), while the rate for nonhuman capital rose (from 9.2 per cent to 9.9 per cent).

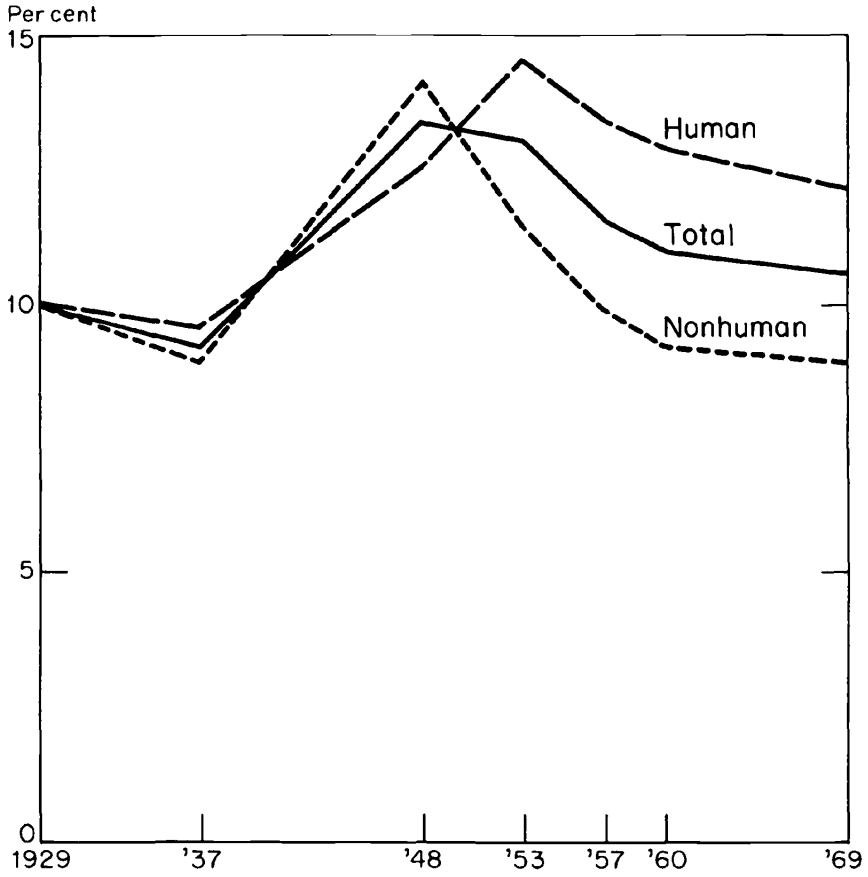
Note also that the decline in the rate of return between 1929 and 1937 was sharper for nonhuman capital than for human capital, for reasons indicated above. Further, while the rate of return on nonhuman capital was at a high in 1948, the rate for human capital peaked in 1953. Finally, whereas the latter continued its gradual decline, the former was slightly higher in 1969 than in 1960, possibly due to higher rates of utilization of fixed plant capacity in the later year. In fact, adjustment for differences in utilization rates would probably make the rates of return on nonhuman capital at least as stable as those on human capital.

On a net basis, the average return on total capital was 0.2 percentage point below the gross rate of return in both 1929 and 1969. The close correspondence between the rates on gross and net bases indicates that the ratio of annual depreciation to accumulated depreciation reserves was not greatly different from the ratio of net factor income (excluding maintenance) to the value of net capital stock. (See Chart 5-2.)

The pattern of movement of the net rates of return is similar to that of the gross rate, despite possible changes in the average durability of capital. Net rates rose above gross rates in the early postwar period, however, peaking in 1948 at 13.4 per cent. The net rate then declined gradually over the successive cycle peaks to 10.6 per cent in 1969, modestly above 1929, like the gross rate.

Taking rates of return on human and nonhuman capital separately, we note that here the pattern of net rates deviated somewhat from the pattern of the gross rates. In the case of human capital, the net rate of return at 10.1 per cent was well below the gross rate of 11.7 per cent, and quite close to the 10.0 per cent rate of return on nonhuman capital in 1929. By 1948, the net rate at 12.6 per cent exceeded the gross rate and remained higher, although the net rate also declined gradually from its peak in 1953 in subsequent cycle peak years. It should be recalled that no imputation was made for the value of leisure time in calculating the returns on human capital. On the other hand, human

Chart 5-2. *Net Rates of Return on Total Capital, by Type, Peak Years, 1929–1969, U.S. Private Domestic Business Economy*



labor may involve disutilities which are not involved in the use of nonhuman capital.[5]

Conversely, the net rate of return on nonhuman capital was above the gross rate in 1929 and remained above it through 1953. After the peak of 1948, however, it fell more than the gross rate, and dropped below it in 1957 and succeeding peak years. The 1969 net rate of return on nonhuman capital, at 8.9 per cent, was below the 1929 rate, whereas the gross rate of return of 9.9 per cent was above the corresponding 1929 rate.

5. I am indebted to Robert Eisner, member of the staff reading committee, for these observations.

It is of interest to examine some variant return measures we do not deem significant enough to be featured in the text table. First, consider the gross rate of return on human capital *before* deduction of estimated maintenance costs. In 1929, the gross return, at 22.1 per cent, was almost twice as great as the return after adjustment for maintenance and remained at much the same level during the postwar period 1948 through 1957. Thereafter, however, it declined gradually to 19.7 per cent in 1969, while the adjusted rate that year was the same as in 1929. The relative rise in the adjusted rate, as noted earlier, is due to the smaller increase in consumption per capita—used to adjust maintenance estimates—than in income per capita. The fact that the adjusted rate is much closer to the rate of return on nonhuman capital helps support the theoretical arguments for adjusting human as well as property returns to exclude maintenance expenses.

Another variant is the rate of return on "utilized" human capital. Here, in addition to eliminating that portion embodied in persons not formally employed, we further adjusted the human capital denominator to the proportion of total available hours at work. This results in a much higher gross rate of return for 1929—26.9 per cent (after adjustment for maintenance). The rate of return was even higher in the postwar period—at 32.5 per cent in 1969—because of the decline in average hours worked per year after 1929. But since we did not adjust nonhuman capital for percentage of time utilized, it is not symmetrical to make that adjustment for human capital. Also, it can be argued theoretically that calculations should be, and are, made on the basis of returns to total capital embodied in the factors of production employed, rather than on that portion of useful capital actually utilized.

Finally, at the other extreme, one can estimate the rate of return on total human capital, including that embodied in persons who are not in the labor force at all or are unemployed. This, of course, produces a lower gross rate of return (excluding maintenance)—6.9 per cent in 1929, rising to 8.4 per cent in 1969. But this alternative does not seem appropriate, either, except from a very broad social viewpoint. Even then, an opportunity cost should be estimated for those not employed in market activities, which then produces circularity in estimating rates of return.

It was to minimize the influence of imputations that we concentrated on the private domestic business economy, since the estimates shown for the domestic economy in our table are influenced by the returns on nonbusiness property, which are imputed. The rates of return on human capital, unaffected by imputations, are a bit lower for the total domestic economy than for the business sector on both gross and net bases over the whole period. This means that rates of return in

the nonbusiness sectors are lower. Further, between 1929 and 1969 there was a small relative decline in the nonbusiness sectors, suggesting that the increase in average labor compensation is smaller than in the business sector over the four decades as a whole. But the pattern of movement between peak years is quite similar.

The rates of return on nonhuman capital are at a distinctly lower level for the whole domestic economy than for the business sector, particularly on a net basis. This reflects the use of interest rates to impute returns in the nonbusiness sectors.

The rates of return on total capital in the domestic economy average about 3 percentage points less than the rates in the business sector. It is interesting to observe how stable the overall rates of return were during the period under review in the domestic economy as a whole—moving between 9.0 and 9.5 per cent in all peak years, except for the lower rate recorded in 1937.

All series, for both the domestic economy and business sector, show decreases in rates of return between peak years and the subsequent troughs, particularly on a net basis. The drops were drastic in the contractions of the 1930s, but mild since World War II. The mildest was the 1960–1961 contraction, when the net rate of return on total capital employed in the business sector fell only from 10.97 per cent to 10.73 per cent.

INCREMENTAL RATES OF RETURN

Additional information can be obtained by calculating and interpreting incremental rates of return. On a year-to-year basis, changes in income in relation to changes in capital stock are too erratic and too heavily influenced by cyclical forces to reveal underlying tendencies. These problems can be overcome to a significant degree by averaging factor compensation and the associated stock over successive cycles, and then calculating ratios of the increments, as shown in Table 5-3 for the private domestic business economy.

Average rates of return for the cycle averages are also shown in the table, since these are related to the incremental rates. That is, when the incremental rate is above the average rate in the preceding period, the average rate is pulled up, and vice versa. It will be noted that, except for the cycle average 1929–1937, which included the Great Depression, the average rates of return for the cycle averages showed even less variation than those for the peak years. Like the peak year rates, the cycle average rates show a declining tendency since the end of World War II.

With regard to incremental *net* rates of return, which are more

Table 5-3. *Average Incremental Gross and Net Rates of Return on Capital Employed, by Major Type, U.S. Private Domestic Business Economy, Cycle Averages, 1929–1969*

Cycle	Net			Gross		
	Total	Human	Nonhuman	Total	Human	Nonhuman
A. Average Percentage Rates of Return						
1929–37	6.9	7.9	6.3	8.1	10.7	6.4
1937–48	14.1	14.7	14.0	12.3	13.6	11.2
1948–53	12.9	13.3	12.6	12.0	12.6	11.3
1953–60[a]	11.8	13.4	10.3	11.4	12.6	10.2
1960–69	11.2	12.5	10.0	11.2	12.0	10.3
B. Incremental Percentage Rates of Return (over Previous Cycle)						
1937–48	26.1	23.0	33.3	19.4	17.1	22.6
1948–53	11.7	12.0	10.9	11.6	11.6	11.6
1953–60	8.8	13.4	4.5	10.2	12.4	7.7
1960–69	10.4	11.3	9.6	10.7	11.0	10.6

[a]The cycles 1953–57 and 1957–60 have been combined for these computations.

relevant to investment decisions than the gross rates, we first look at the rates for total capital. Between the depressed 1929–1937 period and the years between 1937 and 1948, dominated by the war and postwar boom, the incremental rate of return was, of course, abnormally high. In 1948–1953 it was 11.7 per cent, dropped to 8.8 per cent in the slightly depressed 1953–1960 period, and recovered to 10.4 per cent during 1960–1969.

Except for the initial high rate of 1937–1948, the incremental rates of total capital reflected above-average rates for human capital and below-average rates for nonhuman capital. The incremental rate of return on human capital was slightly over 12 per cent in both 1948–1953 and 1953–1960, receding a bit to 11.3 per cent during 1960–1969. For nonhuman capital, the rate was 10.9 per cent in 1948–1953, plummeting to 4.5 per cent during 1953–1960 as capacity utilization rates fell significantly, and recovering to 9.6 per cent in the 1960–1969 period. The latter rate was still 1.7 percentage points below the corresponding rate of return on human capital, however,

The incremental gross rates of return showed much the same patterns, as indicated in Table 5-3.

Thus, not only have the average rates of return been higher for human than nonhuman capital, but, since World War II, the incremental rates have been significantly higher as well. This suggests that there has been pronounced underinvestment in human capital in recent decades—a conclusion that supports the findings of other students of human capital, notably Schultz, with regard to particular types of human investment. It is all the more significant when the nonpecuniary returns to human investment are taken into account, together with the consideration that the maintenance outlays deducted from our compensation estimates also yield current satisfactions.