5

Physical Capital and the "Residual"

Physical Capital per Worker

The calculation of sector trends in labor input is difficult, but the problems encountered are trivial compared with those surrounding measures of physical capital. With respect to the latter, economists are not yet agreed on the "ideal" method; but even if they were, the paucity of data for early years makes it impossible to offer anything but rough impressions.

The capital input of any industry in a given year can be viewed as consisting of two parts. The first represents a "return" on the net stock of capital *used* in the industry; the second represents the value of the capital stock *used up* during the year, i.e., a properly calculated depreciation. The latter must be included as part of capital input because our output measure is gross of depreciation. We are interested in the capital used in an industry, regardless of industry ownership; therefore, some allowance must be made also for the return on and depreciation of rented capital.

The best available data source is the Internal Revenue Service *Statistics of Income*. Coverage here is limited to private enterprise; we therefore can make comparisons only for the modified sectors. This limitation is not a serious one because the full sector comparisons include real estate, and the relevance of residential real estate (especially owner-occupied) to the analysis of industry productivity trends is obscure.[1]

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[1]Studies of aggregate economic growth that do include the capital input of owner-occupied real estate, but neglect both the output and input aspects of the labor supplied by homeowners, may be misleading with respect to productivity analysis. Similarly, the fact that a significant portion of the gross product originating in households represents interest paid on consumer and personal loans makes it difficult to have an analysis of productivity in that "industry."

In order to get some preliminary notion of the effect of capital, we apply a return of 8 per cent per annum to the net stock of depreciable assets plus inventories in each industry.[2] The use of some other rate, e.g., 6 or 10 per cent, would not change our results significantly because the same rate is applied in every industry. This procedure seems preferable to using observed rates of profit in each industry because those rates are subject to monopoly elements, windfall gains and losses, and the distorting influences of the tax system. We next add current depreciation, as reported, recognizing that this measure falls far short of the ideal.

Finally, we add 70 per cent of net rent paid (rent paid minus rent received) to the capital input of each industry. The reason for not using 100 per cent is that a portion of the rent paid does not represent either a return on the capital stock or depreciation, but is used by the landlord to pay real estate taxes, management expenses, and so on. The figure of 70 per cent was arbitrarily chosen; but again, it should be noted that the use of a different figure would not alter the sector comparisons signicantly.[3]

Numerous additional assumptions are required to reach some degree of comparability between 1929 and 1960 (the latest data available). Given the speculative nature of some of these assumptions, only an impressionistic report of the results is warranted. It does seem clear that the goods* sector had more capital per worker in 1960 than did the service* sector. (The sector ratio of capital per worker was roughly 2 to 1). The goods* industries were also more capital-intensive in 1929, but not to the same extent. The Internal Revenue Service data suggest that the sector differential in rate of growth of capital input per worker may have been of the order of .5 to .6 per cent per annum, with most of the differential occurring after 1947.

If the differential rate of change of capital per worker was .6 per

[2]Stigler found the after-tax rate of return on capital in manufacturing averaged 7.2 per cent a year between 1939 and 1956. See George J. Stigler, *Capital and Rates of Return in Manufacturing*, Princeton University Press for National Bureau of Economic Research, 1963, p. 34.

[3]In fact, sector differentials in trends, as distinct from levels, are not changed significantly if rented capital is eliminated.

cent per annum, then it could explain only a small part of the observed differential trend in output per man, and would explain none of the differential in output per unit of labor input. A differential of only .6 per cent per annum implies that total capital was actually growing .16 per cent per annum faster in the service* than in the goods* sector, since employment was growing .76 per cent per annum faster in the service* sector.

If we combine the differential rates of growth of labor and capital (using 75-25 weights) and subtract from the differential rate of growth of output, we obtain a differential for output per unit of labor and capital combined of .51 per cent per annum.[4] This may be compared with the figure of .62 (Table 4), obtained by using gross product in current dollars to measure total factor input.

It is possible that the Internal Revenue Service data understate the true differential. For illustrative purposes we have made some calculations assuming a much larger differential trend in capital per worker. Specifically, we have assumed that the differential rate of growth of capital per worker was equal to the differential rate of growth of output per worker, i.e., that output per unit of capital input grew at the same rate in both sectors. For 1929-61, this implies a sector differential in the rate of growth of capital per worker of 1.74 per cent per annum for the full sectors, and 1.30 per cent for the modified sectors; these are probably higher than the true differentials, and therefore provide outside estimates of the possible effect of capital.

Even if the differentials were as large as 1.7 and 1.3, the differential trend in output per unit of labor and capital combined would not be markedly different from that of output per unit of labor input alone. The reason is that capital input (as measured by factor shares) is typically only a small part of total input. If a frequently quoted figure of 25 per cent as capital's share of total input in each sector is used, we obtain the following differentials for output per unit of labor and capital combined.[5]

<div align="center">

Per Cent Change per Annum 1929-61

Goods minus service	+.50
Goods* minus service*	+.34

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[4] See equation (3), Appendix.

[5] Using equation (3), Appendix.

These results differ somewhat from those shown in Table 4 for output per unit of total factor input, but they confirm the earlier impression that trends in capital per worker can explain only a small part of the differential trend in output per man.

The "Residual" and Possible Biases in Output Measures

Differential trends in output per unit of labor and capital combined indicate the approximate importance of such factors as technological change and economies of scale. They may reflect also unequal biases in the measurement of sector output. There are many possible sources of these biases, and a full review of them is not possible here. A few words of caution may be in order, however, because of the importance of real output in the analysis of productivity.

The concepts and methods underlying the estimation of gross national product in constant dollars has been the subject of a number of important critiques.[6] The official estimates of real gross product by industry have appeared too recently to have received critical appraisal, but it is certain that many of the alleged shortcomings of the national total apply with particular force to particular industries.

As an example, the current treatment of government output (estimated from man-hours of input) is generally conceded to be inadequate and is defended principally in terms of the absence of a better alternative. The estimates of output in some of the service industries are obtained in much the same way as for government, and are not any more reliable or meaningful. Measures of real output in the finance and insurance industries are open to question, both with respect to the methods used in estimating output in current dollars (largely by imputation, since the services are not sold directly) and the methods used for deflation.

[6]See *A Critique of the United States Income and Product Accounts,* Studies in Income and Wealth 22, Princeton University Press for National Bureau of Economic Research, 1958.

While most of the biases in the measurement of real output change in the service sector point to an underestimate, it is possible that the figures for wholesale and retail trade overstate the rate of growth. The reason is that real output in trade is largely inferred from trends in deflated sales, with an implicit assumption that the amount of real services associated with a constant dollar's worth of sales has remained constant. If there has been a trend toward providing fewer services (e.g., credit, delivery), the output trends in trade are being overestimated. Some preliminary analysis of retail trade by David Schwartzman suggests that consumers now travel greater distances to stores, provide more of their own storage facilities, and buy more at each transaction. There has also been a significant increase in self-service. These changes may mean that real output in trade has increased less than the figures currently available imply.

In the goods sector, the deflation techniques used for construction have been under attack for some time, and most economists believe that the official figures underestimate the growth of real output in that industry. Failure to include quality improvements in the measures of manufacturing output are also being stressed with increasing frequency. The output measures for government enterprise probably understate the real rate of growth for some of the same reasons as they do for general government. One other minor point concerns the fact that the measures of real output used in this paper are based on measuring gross product in 1954 dollars. If the base-year prices were from some other year, the trend might look different.

We do not know whether the biases in the service sector are more or less serious than those in the goods sector or whether there are significant offsetting biases within each sector. Even a partial answer to this question could be obtained only after a thorough and detailed study of output. This preliminary survey has shown that not all of the differential change in output per man need be attributed to biases in the output measures. Indeed, if the biases were of such magnitude, we would have to conclude that output per unit of total input increased much faster in services than in goods.