Changing utilization of fixed capital: an element in long-term growth

A small but measurable part of the long-term rise in multifactor productivity can be attributed to the increased 'workweek' of fixed capital, which largely reflects the spread of multiple shifts

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The workweek of labor has gone down since the early part of this century, but what can be said about the "workweek" of fixed capital—that is, the number of hours per week that factories, retail stores, coal mines, and the like were utilized? According to estimates based on data from the Bureau of the Census, the Bureau of Labor Statistics, and other sources, the workweek of fixed capital in the nonfarm business sector increased from the late 1920's to the 1970's. Manufacturing plants in 1976 were in operation approximately 25 percent more hours per week than they were in 1929. In some nonmanufacturing industries—services and construction—average weekly hours of capital fell, but in others they rose—retail and wholesale trade, radio and TV broadcasting, and mining. An important part of the business stock of fixed capital experienced no changes in its weekly hours of operation—electric and gas utilities, telephone companies, and most transportation companies—because it tends to operate around the clock. These findings can help our understanding of the long-run growth of productivity and output, especially in light of what important investigations have told us about long-term growth. For example, it has been found that output has risen much faster than the weighted sum of all inputs or factors of production. This difference is a reflection of the growth of multifactor, or total factor, productivity. According to four major studies, productivity growth was an important part of output growth from 1948 to 1973: 32 percent as estimated by Dale Jorgenson; 54 percent by BLS; 56 percent by Edward Denison; and 62 percent by John Kendrick.[1] The pattern observed for the entire private economy has been apparent also for major industry divisions like manufacturing, for major manufacturing industries, and for earlier periods.

Economists disagree about what lies behind the long-run growth in productivity. They have given many different designations—besides multifactor productivity—to the difference between measured output growth and input growth, such as "technical progress" or the "residual." But whatever the name, economists have been disturbed that they have known so little about so large a part of output growth. Indeed, Moses Abramovitz, referring to this phenomenon almost 30 years ago, declared that the residual could be taken as "a measure of our ignorance about the causes of economic growth."[2] In presenting its new estimates of multifactor productivity in September 1983, BLS felt constrained to use the same characterization.

Measuring inputs

A corollary of the above is that the role of fixed capital in output growth, while important, has been overshadowed by the growth in productivity. To understand this requires an understanding of how contributions of inputs are measured. In studies of output growth, changes in each input or factor of production must be weighted by the importance of the factor in output. Not only is the weight of capital,

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or the share of output attributable to capital, much smaller than the labor share, but it must be divided among four broad kinds of capital—plant, equipment, inventories, and land. As for input changes, economists have typically measured fixed capital inputs by the stock of plant and equipment in place—or by the flow of services from such a stock. Changes in capital input from one point in time to another have been measured by changes in this stock or in the services it renders. An important implication of this kind of measurement of capital is that changes in the workweek of capital have not been reflected in capital input. With capital input so measured, the effect of a longer workweek of capital would be included in the change in productivity as conventionally measured.

Edward Denison has pioneered in his several studies of output growth and of the factors underlying productivity change. He attributed the growth of total factor productivity in the U.S. nonresidential business sector from 1948 to 1973 to three main influences: the shift of resources from farms to nonfarm uses; economies of scale due to the larger size of markets; and the increase in knowledge. Denison divided the last item into two main components: increased managerial experience and skill and increased scientific and technological knowledge. Some of these influences can be measured but others, like the increase in knowledge, cannot be; in Denison's system, as in most others, the increase in knowledge is a residual.

Not all investigators agree with Denison's explanations of productivity change. For example, many investigators have attempted to quantify the contribution of research and development, an influence that all concede to be important but the treatment of which has provoked much controversy. Denison, for example, remains deeply skeptical about attempts to measure R&D contributions to growth. Theodore Schultz, who was among the first to emphasize the role of education in growth, acknowledges that the relationship is poorly understood and not easily comprehended.

Extended use of capital

Under these circumstances, it is helpful if we can establish a close connection between a particular influence and productivity growth. A longer workweek of capital is a measurable influence whose effect on productivity growth is direct.

We find that the workweek of fixed capital in manufacturing expanded during the 1930's and has continued to increase since, mainly as a result of increased shiftwork: the use of multiple shifts has been the dominant mode of factory production in the postwar period. For the nonfarm business sector, the workweek of fixed capital has also increased but much less than for manufacturing. However, it is significant that these overall changes in the weekly hours of fixed capital have been positive, unlike the changes in labor's workweek. Thus, a small but measurable part of the rise in multifactor productivity can be accounted for by a longer workweek of fixed capital. In a growth accounting framework, the contribution of plant and equipment can be thought of as somewhat greater than is apparent.

We should point out that there is a micro theory that underlies the practice of shift work. The number of hours per week a manufacturing plant or other business establishment operates is an aspect of a firm's investment decision. To achieve a given production level a firm, for example, can build a large plant operating a single shift or a smaller plant operating two shifts or more. Both of these aspects—the amount of capital and the scheduled number of weekly hours or shifts—are dimensions relevant to the measurement of fixed capital. Of course, a firm may also vary the number of shifts over the business cycle in response to changes in demand, but cyclical change is not the focus of this study.

Using multiple shifts is a form of economizing on fixed capital. The more capital intensive the production, the greater the incentive to use shifts. However, running late shifts usually entails increases in marginal costs, the most important of which is labor. As is well known, premiums are ordinarily paid for second and third shift work, although other costs may also be incurred, such as lighting and heating. In principle, firms produce at that point at which the savings on capital costs are equal to the added variable costs associated with late shifts. Limited managerial resources are frequently an influence restricting the number of hours of operation of a small business.

Changes in technology in which capital is substituted for labor and changes in relative prices that bring about the same result both have the effect of encouraging shift work. Declines in relative wage differentials for late shift work would have the same effect. Changes in consumer habits also affect hours of operation.

Improving efficiency

Although our focus is on changes in shiftwork, in principle it is possible to distinguish another kind of change in capital hours per week (or per year). That is, even with the shift pattern held constant, management may discover more efficient ways of operating machines longer hours, thereby reducing idle machine time and decreasing the need for additions to the stock of capital. Efficiency increases of this sort may come about in innumerable ways—by changing lot size, by using a superior lubricant on machines that reduces maintenance downtime, by discovering new uses for equipment not anticipated earlier, and the like. For manufacturing, we have been able to relate broad changes in this type of efficiency to changes in the workweek of capital attributable to increased shiftwork.

Nonfarm business

We estimated average weekly hours worked by fixed capital for 10 major industry groups in the private nonfarm business sector (excluding residential business and nonprofit organizations) and for all industries combined from 1929 to

1976.[3] Table 1 presents summary statistics in the form of average rates of change compounded annually. For the nonfarm business sector, average weekly hours of fixed capital increased at a rate of 0.18 percent from 1929 to 1976. Gross stocks of structures and equipment in these same industries rose at a rate of 2.24 percent per year, so that the growth in average weekly capital hours was 8 percent of the growth in the stock. Manufacturing accounted for most of the overall rise. The results in table 1 reflect the use of constant industry weights for fixed capital and are not the result of a changing industry mix.[4]

On the overall basis, there was little difference in the average rate of growth in weekly capital hours between prewar and postwar periods. The rise in hours was about 5 percent of the increase in the gross stock in the postwar years, reaching a peak of 7.7 percent in the decade 1959–69. The prewar picture is different, however, because the Great Depression and World War II held down the level of capital formation and thus capital stocks. From 1929 to 1948, the growth in average weekly hours was about as large as the growth of the stock itself.

Manufacturing. Average weekly hours of capital grew much more rapidly in manufacturing than in nonfarm business from 1929 to 1976: 0.47 percent versus 0.18 percent. In manufacturing, the rise was apparently much greater before 1948 than after: 0.60 percent versus 0.38 percent. It is important to note that the estimates are based on benchmarks for 1929 and 1976 and on interpolations made backward from 1976 to the early postwar period. The estimate of change from 1929 to the early postwar period is thus a residual.

Table 1. Growth rates in fixed capital and in average weekly capital hours, nonfarm business and manufacturing, 1929–76

[Average percent per year]

Period	Capital	Hours	Capital + hours	Hours as percentage of capital[1]
Nonfarm business:				
1929–76	2.24	0.18	2.42	8.0
1929–48	.15	.18	.33	120.0
1948–76	3.68	.19	3.87	5.2
1948–59	3.25	.11	3.36	3.4
1959–69	3.91	.30	4.21	7.7
1969–76	4.02	.17	4.19	4.2
Manufacturing:				
1929–76	2.30	.47	2.77	20.4
1929–48	1.00	.60	1.60	60.0
1948–76	3.19	.38	3.57	11.9
1948–59	3.39	.22	3.61	6.5
1959–69	3.11	.58	3.69	18.6
1969–76	2.99	.36	3.35	12.0
(1969–79	3.44	.36	3.80	10.5)

[1]Column 2 divided by column 1 × 100.

SOURCES: Capital: Gross stocks of plant and equipment in 1972 prices from John C. Musgrave, "Fixed Capital Stocks in the United States: Revised Estimates," *Survey of Current Business*, February 1981, p. 59, table 3, and "Fixed Reproducible Tangible Wealth in the United States, 1979–82," *Survey of Current Business*, August 1983, p. 62, table 3. Totals for manufacturing and nonfarm nonmanufacturing combined were reduced by plant and equipment stocks of nonprofit organizations (unpublished Bureau of Economic Analysis estimates). Data exclude residential capital.

From 1948 to 1976, the average rate of increase in average weekly plant hours constituted 11.9 percent of the average rate of increase in the capital stock. This percentage was least in the 1948–59 period (6.5 percent) and greatest in the 1959–69 period (18.6 percent). Note the difference in growth rates for the stock alone and for the stock plus hours. The latter shows a slight acceleration when growth rates over successive decades are compared (3.61, 3.69, and 3.80).[5]

The rise in average weekly plant hours from 1929 to 1976 would be much greater if not for the fact that a good part of manufacturing fixed capital has always operated on a 24-hour basis throughout the year. (Examples: petroleum refining, industrial chemicals, pig iron, and steel). With the omission of continuous industries as well as those industries that have typically operated only a single shift (apparel, shoes) the rise in weekly capital hours over the 47-year period comes to .60 percent per year as against .47 percent.

The pattern of change in some of the well-known capital ratios is altered somewhat when we take account of changes in average weekly hours of capital. For example, from 1948 to 1976 capital-output ratios in manufacturing declined at an annual rate of 0.3 percent but rose at a rate of 0.1 percent when stocks are adjusted for changes in average weekly hours. Over this period, the capital-labor ratio without adjustment for changing capital hours rose 3.3 percent and with the adjustment, 3.7 percent. (Labor is measured by BLS estimates of hours worked by all persons in manufacturing.)

The longer workweek of capital appears to be a response to the increased capital intensity of production in the postwar years and the desire by management to economize on capital through multiple shift work. This trend was accompanied by—and itself was a cause of—the long-term trend in manufacturing production toward large firms and away from small firms. Owners of small firms put in long hours on average but they apparently value their leisure, because they tend not to use late shifts. Also the trend in wage differentials for night work—since the late 1950's—has fostered shift work because these differentials have not kept pace with straight-time earnings generally.[6] In fact, from the end of World War II to the end of the 1950's a rising trend in wage differentials held down the rise of weekly hours of capital.

Nonmanufacturing. A large part of the nonmanufacturing sector (70 percent) works around the clock—public utilities, petroleum and natural gas, hotels, and hospitals—and thus contributes nothing to the overall change in hours. The other industries show mixed trends. From 1929 to 1976, capital hours increased in coal mining because underground coal mining became more capital intensive and because strip mining, in which capital hours tend to be quite long, accounted for a rising share of coal production. Retail store hours increased as shopping habits changed. The long store hours maintained by chain organizations make it difficult for small proprietors to compete; this is doubtless a signif-

icant factor in the fairly steady decline in the importance of the small retailer. With more of the labor force now employed on evening and night shifts, television and radio stations broadcast longer hours than formerly.

Our general approach to estimating weekly capital hours could not capture the spread of large computers since the 1950's. Computers have taken the place of conventional office equipment like typewriters, calculating machines, addressing machines, and so on. Large computers, moreover, are worked very long hours because of their high cost. Consequently, we set up a synthetic industry consisting of all the office equipment in the economy, including computers. The weight of this industry has increased but remains small. According to our estimates, the fixed capital in this industry experienced a rise of 133 percent (3.1 percent per year) in average weekly hours from 1948 to 1976. However, technological trends may be putting an end to this development and possibly reversing it. The spread of the small computer, which is much lower in cost, has weakened if not eliminated the incentive to economize on capital.

Significance of results

A growth accounting framework is one way in which we can evaluate the long-term rise in average weekly capital hours. In such a framework, the contribution made by a factor to the growth in output depends on how important it is and on its rate of growth (or decline). The importance of a factor in a particular industry or broad sector depends on the income or output it produces, but a host of questions may be raised as to how this should be done. Measuring changes in inputs is no less difficult. Persons interested in a discussion of some of the new techniques for measuring the importance of and change in inputs, especially capital inputs, should refer to BLS Bulletin 2178. For our purposes, a simple approach should suffice, and it is illustrated in table 2.

We used 1962 weights—a midpoint—to weight the changes in inputs from 1948 to 1976. The labor weight reflects the share of employee compensation in gross product originating in manufacturing; after certain adjustments, the balance is allocated to capital. In 1962, labor accounted for 68.6 percent of the weight, with the balance allocated to plant, equipment, inventories, and land. For labor input changes, we used BLS data, but for changes in fixed capital inputs we followed essentially the procedure employed by Edward Denison and John Kendrick: changes in real gross stocks of fixed capital as estimated by the Bureau of Economic Analysis.[7] We also used Bureau of Economic Analysis estimates of manufacturers' real inventories. Average rates of growth compounded annually are shown in table 2.

The last column gives the contribution to output growth and is obtained by multiplying the first column (in decimal form) by the second column. All inputs combined contributed 1.46 percentage points to growth, which is considerably less than the output growth of 3.49 percent from 1948 to 1976. The difference reflects the growth of multifactor, or total factor, productivity.

Table 2. Contribution to the growth of manufacturing output: labor input, capital input, and multifactor productivity, 1948–76

[In percent]

Item	1962 weight	Average annual growth rate	Contribution to output growth[1] (percentage points)
Labor input	68.6	0.58	0.40
Capital input	31.4	3.34	1.06
Plant	9.8	1.66	.16
Equipment	14.1	4.67	.66
Inventories	6.1	3.59	.22
Land	1.4	1.76	.02
Total input[2]	100.0	—	1.46
Manufacturing output	—	3.49	3.49
Multifactor productivity	—	—	[3]2.03
Multifactor productivity based on BLS figures[4]	—	—	(1.97)

[1]Column 1 (× .01) times column 2.

[2]Total input = labor input + total capital input.

[3]Based on indexes of multifactor productivity, BLS Bulletin 2178, table 10, p. 24.

[4]SOURCES: Weights: BLS Bulletin 2178, table 6, p. 20, and table C–29, p. 64. Growth rates reflect basic data from the following: labor—indexes of hours of all persons, BLS Bulletin 2178, p. 24; plant and equipment—gross stocks from Musgrave, "Fixed Capital Stocks in the United States," p. 59; inventories—Bureau of Economic Analysis, *The National Income and Product Accounts of the United States*, 1929–76, pp. 223–26, table 5.11, line 6; land—BLS Bulletin 2178, table C–28, p. 64; output—BLS Bulletin 2178, table 10, p. 24.

Changes in fixed capital inputs were large over this period, but we want to account for the fact that average weekly hours of capital also increased substantially over these years. As table 1 indicates, the growth in average weekly hours of capital was 11.9 percent of the growth in the fixed capital stock. If the contribution of plant and equipment to output growth is increased by 11.9 percent, it is raised by .098 percentage points. This is our estimate of the contribution of longer capital hours to output growth in manufacturing over the 28-year period. As measured in table 2, the effect of longer average weekly hours of capital is included in the 2.03-percentage-point increase in multifactor productivity. The .098-percentage points constitute 5 percent of multifactor productivity growth and 2.8 percent of the 3.49-percentage-point rise in manufacturing output growth.

The importance of rising capital hours has not been constant over the postwar period. Here is a view of how this importance changed in contributing to the annual growth rate of productivity in manufacturing:[8]

	1929-48	*1948-76*	*1948-59*	*1959-69*	*1969-79*
Contribution of productivity change to rise in output	1.67	2.03	1.63	2.09	1.61
Effect of longer workweek of capital	0.07	0.10	0.06	0.20	0.11

The contribution of longer capital hours was greatest from 1959 to 1969, when the contribution was largest not only in absolute terms but also in relative terms—approximately 10 percent. However, when *rates of change* in productivity

growth are considered, the importance of longer capital hours is enhanced. Thus, the rise in the rate of growth of multifactor productivity from 1948–59 to 1959–69 was 0.46 percentage points (2.09 minus 1.63) and of this, longer capital hours accounted for .14 percentage points (.20 minus .06) or 30 percent.

The above tabulation shows also that the contribution of longer capital hours was important in the deceleration of productivity growth in manufacturing from 1959–69 to 1969–79, accounting for almost one-fifth. The effect of a lower rate of capacity utilization[9] is quite important in the productivity change from 1959–69 to 1969–79 in manufacturing. When this is combined with the capital hours effect, we can account for more than two-fifths of the productivity slowdown in manufacturing over this period.

Table 3 is like table 2 except that it covers the entire nonfarm business sector (excluding residential business and nonprofit organizations). The annual contribution of plant and equipment to output growth is 1.08 percentage points (.35 plus .73). This is increased by 5.2 percent, which is the ratio of the average change in fixed capital hours to the average change in the stock of fixed capital, as shown in table 1. This yields .056 percentage points, which is almost 4 percent of the change in multifactor productivity, or about 1.5 percent of the output change.

These capital hours effects—expressed either as percentage points or as proportions of productivity and output growth—are smaller for nonfarm business as a whole than for manufacturing. If they seem small in an absolute sense it should be recalled that the entire change in productivity in the private nonfarm sector from 1948 to 1981 was 1.5 percent per year, as may be seen in table 4. Table 4 illustrates two other points. First, the specific influences that "explain" productivity growth account for only 40 percent of that growth from 1948 to 1981. Second, influences normally thought to be extremely important—like research and development—account for only 13 percent of productivity growth over this period. It is against these magnitudes that we should view the effect of the change in weekly hours of fixed capital.

Table 3. Contribution to the growth of private nonfarm business output: labor input, capital input, and multifactor productivity, 1948–76

Item	1962 weight	Average annual growth rate	Contribution to growth[1] (percentage points)
Labor input	65.0	1.14	0.74
Capital input	35.0	[2]3.74	1.31
Plant	12.7	2.74	.35
Equipment	15.0	4.86	.73
Inventories	3.8	3.75	.14
Land	3.6	2.47	.09
Total input[3]	100.0	—	2.05
Total output[4]	—	3.47	3.47
Multifactor productivity[5]	—	—	1.42

[1]Column 1 (× .01) times column 2.

[2]Obtained implicitly by dividing column 3 by column 1.

[3]Total input = labor input + total capital input.

[4]Total output = real gross product of nonfarm business minus housing.

[5]Multifactor productivity = output growth minus total input growth.

SOURCES: Weights: BLS Bulletin 2178, table 6, p. 20, adjusted by author to exclude rental residential capital (table C–22), p. 52. Growth rates: labor—indexes of hours of all persons in private nonfarm business, BLS Bulletin 2178, p. 23; plant and equipment—BEA gross stocks in constant dollars for nonfarm business (Musgrave, "Fixed Capital Stocks in the United States," p. 59) less capital stock of nonprofit organizations (unpublished BEA data); inventories—BEA, *The National Income and Product Accounts of the United States*, 1929–76, table 5.11, line 3, pp. 223–26; land—indexes, BLS Bulletin 2178, table C–20, p. 62.

Table 4. Sources of multifactor productivity change in private business, 1948–1981

Source	Change (percentage points)	Distribution (in percent)
Shifts of labor off farms	0.1	7
Changes in composition of labor force[1]	.4	27
Research and development	.2	13
Hours worked in lieu of hours paid	−.1	−7
Total of above factors	.6	40
Unexplained	.9	60
Multifactor productivity	1.5	100

[1]Chiefly education.

SOURCE: BLS Bulletin 2178, p. 31.

Whether a growth accounting framework is the best way to view a phenomenon like a longer workweek of fixed capital is open to question. Would the increase in the stock of capital during the postwar years have been as large as it was if not for the possibilities for increased shift work in noncontinuous industries? Over the period analyzed, capital has been substituted for labor for two principal reasons. First, the cost of labor has gone up more than the cost of capital.[10] Second, it is very likely that the trend of technology has been labor-saving and capital-using. The potential for late-shift work has been one of the factors reducing the cost of capital and this in turn has fostered more capital-intensive methods of production than would have otherwise prevailed.[11]

Late-shift work in manufacturing has been adopted on a broad scale in the postwar period in this country. Many factors affect the decision about where to locate a new plant. Our results suggest that at the margin, the potential for economizing on capital must have been a factor of some importance in the location of new plants. The movement of capital to the South—not to mention to foreign countries—probably occurred not only because of lower wage scales in the South and elsewhere but also because of the greater possibilities for using capital more efficiently than was possible on the basis of a single shift. Late-shift potential is probably also a reason business has moved factories out of cities into nonmetropolitan areas since the mid-1960's.

Implications for future

The future of shift work will be governed by the same underlying forces that have always been operative, such as the capital intensity of production and the additional costs

of operating late shifts. These influences are not necessarily constant. The development of large mainframe computers provided a strong incentive to economize on such capital through shift work. However, with the development of minicomputers, that incentive to economize is greatly lessened. A technology in which small computers predominate will entail much less shift work than one in which large computers are the dominant type.

Robots are an innovation very much in the news at present even though their current importance in the Nation's capital stock must be characterized as tiny. Although evening and night wage differentials in this country are rather small in relation to average wages, robots have the potential for increasing shift work because they will greatly reduce the wage differential that must be paid for evening and night work. Indeed, firms that now work a single shift may find it economical to operate on weekends because robots would eliminate much of the time-and-a-half for overtime now required for Saturday and Sunday labor.

Improving our understanding of how fixed capital is utilized should provide a stronger basis for public policy regarding capital formation. The gross saving rate of the United States appears to be low when compared to that of other countries. Many factors are at work here, among them the nature and size of social insurance systems. But to the extent a country utilizes its capital as intensively as the United States, it will have a lower rate of gross saving than a country that does not do so. □

———*FOOTNOTES*———

[1] *Trends in Multifactor Productivity, 1948–81,* Bulletin 2178 (Bureau of Labor Statistics, 1983), pp. 73–80.

[2] Moses Abramovitz, *Resource and Output Trends in the United States Since 1870* (New York, National Bureau of Economic Research, 1956), p. 10.

[3] Statistically, it was a manageable undertaking because of the reasonably good data for manufacturing and a few minor industries and because the public utilities, which operate continuously, were assumed to have experienced no change in their hours for the period covered. The stock of capital in these groups with good or reasonably good data accounted for about 80 percent of the capital in the universe covered. For some industries, such as services and construction, we used proxies based on the workweek of labor, while for others we had to use judgment.

[4] Suppose there were two industries, one of which always operated its capital around the clock, while the other always operated 40 hours a week. If the capital stock of the former industry grew more rapidly than that of the latter, the average workweek of the combined stock would show a rise if weights are permitted to vary.

[5] The estimates of average weekly manufacturing plant hours were extended to 1979 through the use of data on employment by shift as shown in BLS Area Wage Surveys, the basic source for the interpolations in manufacturing. Estimating details may be found in Foss, *Changing Utilization of Fixed Capital* p. 32 ff.

[6] The relative decline in late-shift wage differentials was pointed out by Charles O'Connor in "Late shift employment in manufacturing industries," *Monthly Labor Review*, November 1970, p. 37.

[7] Denison actually uses both net and gross stocks, with the latter weighted by 3 and the former by 1. From 1948 to 1973, movements in the two are fairly similar.

[8] The 1929–48 estimates are by the author, based mainly on John Kendrick's data. Indexes of labor input and total output: John Kendrick, *Productivity Trends in the United States* (Princeton, NJ, Princeton University Press for the National Bureau of Economic Research, 1961) p. 464. Gross capital stocks and inventories: Bureau of Economic Analysis. Weights for 1929–48 are from *Productivity Trends*, p. 453.

[9] See Bureau of Labor Statistics Bulletin 2178 , p. 28.

[10] Many studies have pointed this out. In Bulletin 2178 (p. 21) the BLS points to a 3-percent per annum decline in the price of capital services relative to that of labor in the private business sector from 1948 to 1981.

[11] This point is given considerable stress by Roger Betancourt and Christopher Clague in their recent book, *Capital Utilization: A Theoretical and Empirical Analysis* (New York, Cambridge University Press, 1981).