Survey of the Factors Contributing to the Decline in U.S. Productivity Growth

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Since the first half of the nineteenth century, the secular rate of growth in real gross product per labor hour in the U.S. domestic business economy gradually accelerated from about 0.5 percent a year to a maximum average annual rate of 3.5 percent in the subperiod 1948–66 (see Table 1). Since then, it declined to about 1 percent during the period 1973–78, and then fell absolutely in 1979 and will probably drop again in 1980 due largely to cyclical influences and continuing oil price increases.

The declining trend-rate of productivity growth after 1966, and the absolute declines since 1978 have become an increasing matter of concern to policy-makers and informed citizens in the United States. Since productivity gains are the chief source of increases in real income per capita, the slowing has meant lesser gains in living standards. Since increases in factor productivity are an offset to increasing factor prices, the slowing has been a significant element in the acceleration of inflation in unit factor costs and product prices. Although overall productivity changes are only indirectly involved in balance-of-payments problems, the industries whose relative productivity growth has slowed the most have had the greatest difficulties in meeting foreign competition. Clearly, policies to promote productivity would be of considerable assistance in helping this country meet some of its more pressing economic problems.

As background for policy formulation, it is essential that we understand the chief sources of productivity growth, and thus the causes of the slowdown after 1966. A convenient and useful classification of sources of economic growth in general, and of productivity growth in particular, has been provided by Edward F. Denison, together with estimates of the percentage point contributions of the various sources from 1929 through 1976.[1] I have made use of his schema, with some modifications described below, as well as many of his estimates, supplemented by my own estimates for selected variables, and for all of them in the subperiod 1973–78 since most of his series end in 1976.

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[1] See Edward F. Denison, *Accounting for Slower Economic Growth: The United States in the 1970s* (Washington: The Brookings Institution, 1979). The estimates in this volume revise, extend and supplement those in his preceding work, *Accounting for United States Economic Growth, 1948–1969* (Washington: The Brookings Institution, 1974).

Table 1
Real Gross Product, Factor Inputs, and Productivity Ratios for Selected Subperiods, U.S. Domestic Business Economy: 1800-1973 (average annual percentage rates of change)

	1800-1855	1855-1890	1889-1919	1919-1948	1948-1973
Real gross product	4.2	4.0	3.9	3.0	3.8
Population	3.1	2.4	1.8	1.2	1.5
Real product per capita	1.1	1.6	2.1	1.8	2.3
Total tangible factor input	3.9	3.6	2.2	0.8	2.4
Labor	3.7	2.8	1.8	0.6	0.7
Capital	4.3	4.6	3.1	1.2	2.5
Total factor productivity ratio	0.3	0.3	1.7	2.2	2.4
Labor	0.5	1.1	2.0	2.4	3.1
Capital	-0.1	-0.6	0.7	1.6	1.3

NOTE: The weights for capital in each of the successive periods, beginning with 1800-1855, are as follows: 0.35, 0.45, 0.34, 0.26, 0.28. The weights for labor are 1.00 minus the weights of capital.

SOURCES: 1800-1890 based on Moses Abramovitz and Paul David, "Economic Growth in America: Historical Parables and Realities," Reprint no. 105, Center for Research in Economic Growth, Stanford University, 1973, tables 1 and 2; 1889-1973 from John W. Kendrick, *Productivity Trends in the United States* (Princeton, N.J.: Princeton University Press for the National Bureau of Economic Research, 1961); estimates for 1948 forward revised and extended by the author.

The Conceptual and Analytical Framework

The sources of growth in real gross product and productivity shown in Table 2 relate to the U.S. private domestic business economy, for which largely independent estimates of outputs and inputs can be constructed. The excluded general governments, personal (households and private nonprofit institutions), and rest-of-world sectors, for which real product is assumed to move with real factor costs, comprise only about 15 percent of GNP as estimated by the U.S. Department of Commerce. It should be noted, however, that if the opportunity costs of nonmarket economic activities are estimated, the share of the nonbusiness sectors in the expanded GNP estimates rises to about one-half. But since the imputations are based on input data, they do not make possible estimates of productivity changes in the nonmarket activities. In fact, some of the official deflators for GNP, mainly banking and selected services, are based on unit factor costs, thereby imparting a small downward bias to the official real product and productivity estimates, assuming that there has been some increase in productivity in these industries.[2]

[2] See John W. Kendrick, "Expanding Imputed Values in the National Income and Product Accounts," *The Review of Income and Wealth,* Series 25, no. 4, December 1979. As of 1973, GNP adjusted to include the additional imputations was almost 64 percent larger than the official estimates. Since 1939, imputed values have grown faster than official GNP, especially when both are measured in terms of real factor costs. The Department of Commerce is currently engaged in expanding its imputations.

Table 2
Sources of Growth in Real Gross Product, U.S. Domestic Business Economy Percentage Points, Selected Subperiods, 1948–1978

Sources	1948–66	1966–73	1973–78
	Average Annual Percentage Rates of Change		
Real Gross Product	3.9	3.5	2.4
Factor Input — Total	1.1	1.9	1.6
Labor	0.4	1.4	1.3
Capital	2.6	3.3	2.3
Real Product Per Unit of Labor	3.5	2.1	1.1
Capital/Labor Substitution	0.7	0.5	0.3
Total Factor Productivity	2.8	1.6	0.8
Sources of Total Factor Productivity Growth; (Percentage Point Contribution)			
Advances in Knowledge	1.4	1.1	0.8
R & D Stock	0.85	0.75	0.6
Informal	0.3	0.25	0.2
Rate of Diffusion	0.25	0.1	—
Changes in Labor Quality	0.6	0.4	0.7
Education & Training	0.6	0.7	0.8
Health	0.1	0.1	0.1
Age/Sex Composition	-0.1	-0.4	-0.2
Changes in Quality of Land	—	-0.1	-0.2
Resource Reallocations	0.8	0.7	0.3
Labor	0.4	0.2	0.1
Capital	0.4	0.5	0.2
Volume Changes	0.4	0.2	-0.1
Economies of Scale	0.4	0.3	0.2
Capacity Utilization Rate	—	-0.1	-0.3
Net Government Impact	—	-0.1	-0.3
Services to Business	0.1	0.1	0.1
Regulations	-0.1	-0.2	-0.4
Actual/Potential Efficiency, and *n.e.c.*	-0.4	-0.6	-0.4

n.e.c. = not elsewhere classified

SOURCE: John W. Kendrick, based in part on estimates by Edward F. Denison, *Accounting for United States Economic Growth, 1948–1969* (Brookings, 1974).

Denison used estimates of real national income instead of real gross product, and confined his analysis to the nonresidential business sector. The two aggregate measures show much the same movements, but removal of the residential sector results in a slightly higher productivity change since, in effect, the real income and product from residences parallel the real residential stock estimates.

Labor input is measured by employee hours paid for plus hours worked by proprietors and unpaid family workers. There are no internal weights, so relative labor shifts among occupations, industries, age-sex groups, and groupings based on educational attainment, show up as part of the explanation of productivity changes rather than as part of labor input. This treatment is the same as that in the official estimates of the U.S. Department of

Labor. It differs from that of Dale Jorgenson, who includes all of the shift-effects in labor input as a "quality" component; and from that of Edward Denison, who adjusts labor input for age-sex shifts and for amounts of education, but counts certain labor force shifts as part of the explanation of changes in output per unit of input. In the last analysis, it is not important whether qualitative changes are counted as part of input or as part of the explanation of productivity change so long as the contribution of each component variable is separately estimated.

Similarly, capital input is assumed to move proportionately to real gross capital stocks, without internal weights by type and by industry such as are employed by Jorgenson to obtain estimates of what he calls "quality" changes in capital. In my estimates, changes in the composition of capital as well as of labor affect productivity movements. Denison distinguishes only a few major types of capital in deriving his capital input estimates. Further, he uses a weighted average of real gross and net stocks to approximate the effects of aging on output-producing capacity of capital. In my estimates, changes in average age of fixed capital are a source of changes in productivity. None of us adjusts the stock estimates for changes in rates of utilization of capacity. I do not because capital carries a real cost to the owners regardless of intensity of use. Jorgenson formerly made an adjustment, but was persuaded by Denison that the data do not permit accurate adjustments for the entire business economy.[3] Thus, changes in rates of utilization of capacity are another source of changes in productivity as measured.

To weight labor and capital inputs together, Denison uses the shares of labor compensation and of property compensation (net of depreciation charges) in national income. However, Jorgenson has persuaded me that it is preferable to use the factor shares of *gross* national income, including depreciation in property compensation. This is more symmetrical since no allowance has been made for depreciation of human capital in the labor compensation portion of national income. Jorgenson argues that Denison's approach overweights labor in relation to capital.

The table shows both the conventional output (real gross product) per labor hour and the total factor productivity measures. Since the latter is the ratio of real gross product to a weighted average of labor and capital inputs, the reconciliation between the two measures is provided by the measure of the rate of substitution of capital for labor. This is computed as the difference between the growth rates of total factor input and of labor input; alternatively by the increase in capital per labor hour, weighted by the share of capital compensation in gross national income. It is one of the sources of growth in labor productivity.

It will be noted from the table that the sources of growth in total factor productivity are divided into seven main groupings. In the next section, each of these is discussed in some detail, and their contribution to the slowdown is

[3] See the exchanges between Denison and Jorgenson, et al, in the May 1972 Supplement to the *Survey of Current Business* 52, no. 5, pt. 2, "Issues in Growth Accounting."

detailed. Here, we quickly review how our classification of sources differs from the Denison schema. In the first place, Denison estimates the contribution of advances in technological knowledge, as applied to production, as a residual. Whereas we accept his estimates through 1966, thereafter we estimate it directly as described later. Further, we subdivide the estimates into three major components.

Under "changes in labor quality," we include the components which are included by Denison as aspects of labor input: effect of increased education and changes in labor force composition (age-sex mix). The effects of training have been added to those of education, and we have added another category "health and safety," changes in which are potentially significant although the estimates indicate contributions have been modest.

"Resource reallocations" capture the effects of shifts of labor and capital among uses and industries. Since Jorgenson weights factor inputs by occupation (or type of capital) and by industry as well as by age, sex, and educational categories of labor, the shift effects show up as "quality" changes in his input estimates. Denison includes the effects of intersectoral shifts of labor, but not of capital, which appears to be inconsistent. Given differential rates of factor remuneration among uses and industries, relative shifts of resources towards those with higher productivity as reflected in rates of compensation augment growth.

Both volume factors shown in Table 2 are also recognized by Denison. Opportunities for economies of scale, through greater specialization of personnel, equipment and plants, and a reduction in the real unit costs of overhead functions, are presumed to rise or fall with changes in growth rates. "Intensity of demand" is chiefly a cyclical influence on the behavior of annual data. It affects rates of change over subperiods to the extent that ratios of actual to potential real GNP differ significantly in the beginning and end years. My estimating methodology differs somewhat from Denison's. The degree of cyclical variability during subperiods also affects productivity growth, but chiefly through its effect on capital formation, human as well as nonhuman.

Next, we try to estimate the effects of governmental actions, beyond those already of influence on the previously discussed variables. Denison estimates the negative effects of regulations on productivity as measured. But governmental actions may also have positive effects on productivity. So we attempt to arrive at the *net* impact.

Finally, the residual contribution to growth is interpreted primarily to represent the effect of changes in the ratio of actual to potential labor efficiency, any other variables not captured in the other estimates, and, of course, the net effect of possible errors in all of the other variables contained in the table. Several subcategories of the residual are detailed in the table. The only one of these included by Denison is the effect of increasing crime.

Finally, it should be emphasized that all of the sources of productivity growth shown in the table are *proximate* determinants. The influence of basic, underlying factors, such as changes in social values, institutional forms and practices, and incentive systems, exert their impact through the immediate causal forces. In the discussion that follows, I refer to changes in some of the underlying forces that may have been responsible for changes in the proximate determinants. Unfortunately, quantitative analysis can only go so far in explaining first causes, and much of the discussion must remain speculative.

It must also be acknowledged that even the estimates of the contributions to productivity growth of the proximate sources are of varying quality. Some are quite firmly based, such as the effects of interindustry shifts and estimates of the contribution of increased educational attainment. Others, such as the impact of economies of scale, are more speculative.

The ensuing discussion of causal factors follows the order of Table 2. Attention is focused particularly on the changes in contributions of the determinants between the first subperiod, 1948–66, and the third, 1973–78. The boundary years of the subperiods have been picked to represent periods of high-level economic activity. Nevertheless, there is still some effect on rates of change of differences in rates of capacity utilization (see below).

Changes in the Capital/Labor Ratio

Lines 3 and 4 of the table show that from 1948 to 1966, capital grew at a 2.4 percent average annual rate faster than labor input. In the next subperiod, the growth of the real capital stock and input accelerated, but less than the pronounced acceleration of labor input that reflected the coming-of-age of the baby boom generation. In the 1973–78 subperiod, the rate of growth of labor input remained high, but there was a marked deceleration in the rate of capital formation and the increase in the capital/labor ratio slowed further to a 1.0 percent average annual rate. When the rate of change in the ratio is weighted by the property share of gross national income, approximately one-third in the base period, the resulting "substitution" of capital for labor is seen to drop from 0.7 percentage point in 1966–78 to 0.3 in 1973–78. The difference of 0.4 percentage point is a measure of the contribution of the declining growth of capital per unit of labor input to the 2.4 percentage point deceleration in real product per unit of labor. As noted above, the rate of capital/labor substitution is also the difference between the rates of growth of total factor input and of labor input, since the former is a weighted average of labor and capital inputs, and thus provides the reconciliation between labor productivity and total factor productivity (lines 5 and 7 of the Table).

Most analysts have accorded a significant role to the slowing growth of capital per worker or per hour in explaining the productivity slowdown. In particular, in a careful study, Randy Norsworthy of the Bureau of Labor Statistics also estimated that this variable contributed a 0.4 percentage point to the slowdown between the subperiods 1948–66 and 1973–78.[4] Robin Siegel

[4] From table prepared by J. R. Norsworthy for a meeting of the Society of Government Economists and Committee for Economic Development in Washington, March 1980.

has a somewhat larger contribution of 0.6 percentage point using the subperiods 1955–65 and 1973–78.[5] Since increasing amounts of capital per workers, apart from the increasing efficiency of capital due to technological progress discussed in the next section, raise the productivity of labor, it is clear that a slowing in the growth of capital relative to labor would retard the growth of labor productivity. It is well documented that after the 1973–75 recession, the recovery of private investment was quite sluggish. From 1948 through 1974, gross private domestic investment averaged 15.6 percent of GNP; in 1974–78 it fell to 14.1 percent. The private investment ratio averaged 7.4 percent in the earlier period, falling to 4.5 percent in 1974–78. The net private saving ratio fell somewhat less, but government deficits averaged much higher after 1974, further reducing the funds available for private investment. However, the large balance-of-payments deficits in 1977–78 augmented the funds available for domestic capital formation.

The decelerating growth of capital relative to labor after 1966, and particularly after 1973, was associated with significantly lower rates of return on investment, both before and after tax, after adjustment of profits to reflect the current replacement costs of inventories and depreciation charges on fixed capital.[6] During the eight-year period 1970–77, adjusted domestic after-tax profits to U.S. nonfinancial corporations averaged 4.25 percent of their gross domestic product, compared with a 7.75 percent average for 1947–69. Computed as a rate of return on net worth the 1970–77 average was 3.55 percent compared with 5.90 for the 1947–69 period. Both as incentive and as a source of funds (after dividend payouts, which declined less), the lower profit rates must have depressed investment.

Accelerating inflation was a major cause of lower profit rates. Terborgh hypothesized that business executives were slow to adapt pricing policies to reflect fully the impact of inflation on costs, particularly the current replacement costs of inventories and capital consumed when books reflected lower acquisition costs, and that boards of directors based dividend declarations on the overstated book profits. More important, in my view, has been the use of macro-economic policies to prevent prices from rising as much as unit costs in high-level years such as 1966, 1969, 1973–74 (and again in 1978–80). This has squeezed profit margins and brought on recessions that reduced capacity utilization, further depressing inducements to invest.

The decline in measured rates of return also reflects the growing proportion of business capital stocks required by governmental regulations, primarily environmental and health/safety. Denison estimates that the percentage grew from 0.25 in 1969 to 1.53 in 1973 and 2.58 in 1975.[7] This means

[5] Robin Siegel, "Why Has Productivity Slowed Down?," *Data Resources U.S. Review*, March 1979, cited by Eli Shapiro, "Policies for Productivity Growth," (Bryn Mawr, PA.: The American College, 1979), p. 3.

[6] The estimates are from George Terborgh, *Corporate Earning Power in the Seventies: A Disaster* (Washington: Machinery and Allied Products Institute, August 1977). See also Herman I. Liebling, *U.S. Corporate Profitability and Capital Formation: Are Rates of Return Sufficient?* (Elmsford, N.Y.: Pergamon Press, Fall 1979).

[7] Edward F. Denison, *Accounting for Slower Economic Growth*, p. 58.

that the real net stock available for the production of measured output grew by 0.3 percentage point less than the total 1969–73, and by 0.5 less 1973–75, with the percentage continuing to rise thereafter.

Another factor which slowed the rate of substitution of capital for labor was the large increase after 1973 in the price of energy, particularly petroleum products. In an influential article, Jorgenson and Hudson argued that capital goods and energy are complements with a low elasticity of substitution between them, but with a high elasticity of substitution between capital plus energy and labor.[8] Thus, the huge energy price increase in 1974 promoted substitution of labor for capital, and in many industries, speeded-up the obsolescence of energy-intensive equipment, and slowed the growth of labor productivity. Denison argues that Jorgenson and Hudson, and also Rasche and Totom,[9] overestimated this effect, but it does seem plausible that the energy price increase played a role in slowing the growth of the capital/labor ratio.

Another contributor to lower capital formation which has been generally overlooked was the relative increase in prices of structures and equipment beginning in 1970, and especially after 1974.[10] This would not only reduce expected rates of return, but it accentuated the effect of a lower current dollar investment rate on real capital stock growth. The jobs tax credit, instituted in late 1975, by subsidizing employment, would also have tended to increase employment relative to capital formation. But the effect of this particular measure must have been small, given the size of the program.

Finally, the many developments accentuating business uncertainty after 1965 — war, accelerating inflation, price controls, recessions, OPEC actions, and domestic regulations of various types — tended to increase risk premiums and reduce investment demand, particularly for longer lived capital goods.

Advances in Technological Knowledge

Over the long run, by far the most important source of productivity growth is advances in technological knowledge applied to productive processes and instruments. Cost-reducing innovations in the ways and means of production are particularly important, but even the development of new products for sale to consumers and governments as well as to producers affect productivity indirectly through the learning-curve effect although GNP estimates do not adequately reflect the gains in welfare due to new and improved goods and services.

Denison estimates advances in knowledge and n.e.c. as a residual after

[8] Edward A. Hudson and Dale W. Jorgenson, "Energy Prices and the U.S. Economy, 1972–1976," *Data Resources U.S. Review*, September 1978, pp. 1.24–1.37.

[9] Robert H. Rasche and John A. Tatom, "The Effects of the New Energy Regime on Economic Capacity, Production, and Prices," Federal Reserve Bank of St. Louis *Review*, vol. 59 (May, 1977), cited in Denison, *Accounting for Slower Economic Growth*, p. 141.

[10] See Denison, *Accounting for Slower Economic Growth*, p. 56.

accounting for all other significant sources of growth. Prior to the 1970s, he considers the net effect of sources not elsewhere classified to be negligible. Thus, his estimate of a 1.4 percentage point contribution of the residual 1948–66 would signify that advances in knowledge accounted for half of the growth in total factor productivity as we measure it. Although we accept his estimate of the residual as indicative of advances in knowledge through 1966, thereafter we estimate it independently as described below. By so doing, we avoid the dilemma faced by Denison when his residual turned negative after 1973, although other evidence indicates that technology continued to advance, even if at a slower pace than in the first two decades after World War II.

First, we estimate the technological progress directly attributable to outlays for research and development (R & D). For the past half century or so, most inventions and innovational developments have emanated from formal R & D activities of teams of scientists and engineers employed by industrial laboratories, and to a lesser extent from university and governmental R & D performance — although universities and other nonprofit institutions perform the bulk of basic research, which comprises less than 10 percent of the total.

To estimate the stock of knowledge applicable to production, we cumulated real R & D outlays, with due allowance for the gestation and developmental periods between the commencement of projects and their commercial application, and for the mortality experience of process and product innovations. To the real R & D stock estimates obtained by this "perpetual inventory" approach, we applied the estimated base period social rate of return to R & D investments in order to obtain the contribution to national income and product.[11]

For decades the ratio of R & D to GNP rose, reaching a high point of 3.0 percent in 1964, before levelling out and then declining for a decade to 2.2 percent in the latter 1970s. As a result, the rate of growth of the real R & D stocks decelerated sharply from almost 10 percent per annum 1948–66 to less than 5 percent 1973–78. The estimated contribution to productivity growth fell from near 0.9 to around 0.6 percentage point between the two periods. Objections have been made that our estimates include government-financed R & D, much of which goes for defense and space, as well as R & D for development of new and improved products generally. But there are frequently civilian applications of defense and space technology. New and improved products directly increase productivity if they are producers' goods, and indirectly all product development enhances productivity through the learning-curve effect noted above. By our procedure, changes in the composition of R & D may be viewed as affecting its productivity and rate of return.

[11] My methods for estimating the contributions of R & D, and of other variables, are described in more detail in John W. Kendrick, "Productivity Trends and the Recent Slowdown: Historical Perspective, Causal Factors, and Policy Option," in William Fellner, Ed., *Contemporary Economic Problems 1979* (Washington: American Enterprise Institute, 1979), pp. 17–69.

It is true that the drop of the R & D ratio after the latter 1960s was due to the cut-back of government funding. But even the business-financed R & D ratio levelled out for a decade, and the growth of that part of the real stock also decelerated, though not as sharply as the total.

There is a reciprocal relationship between business investments in R & D and in the fixed capital goods that embody new technology. Given the lower rates of return and higher risk premiums in the 1970s, it is not surprising that managements cutback increases in R & D, as well as in plant and equipment outlays. But since one result of successful R & D is to shift business investment demand curves upwards offsetting the tendency towards diminishing returns, the reduced growth of R & D outlays probably contributed to the lower profit margins of the 1970s compared with the 1960s. It should also be noted that the increased impact of regulations in the 1970s undoubtedly diverted a portion of R & D activity from projects that would enhance productivity growth as measured to projects required to meet regulatory objectives. In estimating the contribution of R & D to growth, we use a somewhat smaller rate of return for the 1970s than the 1948–69 period, but it was, of course, applied to a larger base.

Inventive and innovative activity not captured by the R & D statistics also contributes significantly to productivity gains. This includes the work of lone-wolf and part-time inventors, but mainly the many small improvements in technology made by managers and workers in plants and offices, particularly during the "shake-down" phase of innovation. Our estimates assume that the contribution of informal innovative activity moves proportionately to that of formal R & D, which sets the pace in terms of major innovations that feed into the informal activity. The absolute contribution of this element was estimated at 0.3 percentage point during 1948–66, obtained by subtracting the R & D contribution together with that of the rapidity of diffusion of innovation, described next.

Best practices in technology and productivity of progressive firms and plants are usually well ahead of the average in most industries. Average productivity is favorably affected by a narrowing of the gap through more rapid diffusion of technological innovations. Since cost-reducing innovations are generally embodied in new capital goods, the average age of fixed capital goods is an important indicator of possible changes in the rate of diffusion. A weighted average of Bureau of Economic Analysis estimates of the average ages of structures and equipment, after rising from 1929 to 1947, fell by almost three years from 1948–66, by about one year from 1966–73, and then rose slightly between 1973 and 1978 reflecting the lower real capital formation of recent years. We estimated that this contributed over 0.2 of a percentage point to the slowdown between the 1947–66 and 1973–78 subperiods. Denison estimates that the slowing rate of diffusion would have contributed 0.1 percentage point at most to the slowdown (through 1976)[12], but there are

[12] See Denison, *Accounting for Slower Economic Growth,* pp. 57–58.

other reasons for believing that a slower rate of diffusion was a more significant element than he suggests.

There is evidence that environmental and land-use regulations have delayed new plant construction and lengthened the average period of construction, which also contributed to the decline in productivity of contract construction, noted below. Regulations affecting the introduction of drugs and other new products appear to have slowed down this type of innovation. Also, the Revenue Act of 1969, by substantially increasing the taxation of capital gains sharply reduced equity investment in small companies, which contributed disproportionately to innovation in the past. The reduction of capital gains taxes by the Steiger amendment to the Revenue Act of 1978 has increased the flow of risk capital for new firms since its enactment.

In sum, the contribution of advances in knowledge declined by 0.6 of a percentage point between 1948–66 and 1973–78, accounting for about one-fourth of the deceleration in the growth of real product per hour. Corroborative evidence on the importance of this factor is the decline in the total number of domestic patents issued annually by the U.S. Patent and Trademark Office from a double peak of 54,636 in 1966 and 55,979 in 1971 to 41,452 in 1977. Patents issued to foreign applicants continued to rise.[13]

Changes in the Quality of Labor

Of the several factors affecting labor quality shown in the table, the most important is education and training. This element interacts with technological progress, of course, since the educational system produces the scientists, engineers, and managers who are involved in invention and innovation, as well as the other members of the labor force who must operate an increasingly complex technology of production. On the other hand, the advances in knowledge and know-how that emerge from R & D and informal invention and innovation are transmitted through education and training, including learning on the job.

Denison prepared careful estimates of the contribution of increased education to growth on the basis of data on earnings differentials of workers with different levels of educational attainment, after adjustment for the effects of differing family backgrounds and ability. His estimate of 0.5 percentage point for the period 1948–66 is almost the same as mine based on a different approach. I estimated the total real stock of educational capital embodied in employed persons, and multiplied by my estimate of the average rate of return on human capital (12.5 percent in 1948–66, and 12.0 percent after 1966).[14] Estimates of the real stock and contribution of capital resulting from training programs (not included by Denison) add another 0.1 to the esti-

[13] *Science Indicators 1978* (Washington: National Science Board, 1979), Table 4-17, p. 218.

[14] Kendrick, "Expanding Imputed Values," p. 40. For a description of my various capital estimates, see *The Formation and Stocks of Total Capital* (New York: National Bureau of Economic Research, 1976).

mate. Both Denison and I calculate that the contribution of education (plus training, in my estimates) increased in the subsequent subperiods, although the increase obtained by Denison in his most recent work is somewhat larger than mine. The increase is consistent with the GNP estimates which show that the proportion devoted to public and private educational outlays has continued to rise. The estimates do not reflect changes in the quality of education and efficacy of the learning process. In this regard, the downward trend in average Scholastic Aptitude Test scores since the early 1960s is disturbing.

The average health status of persons engaged in production also affects productivity through changes in vitality, life expectancy, and time lost due to illness. The rising proportion of GNP devoted to health and medical outlays has resulted in increases in "health capital" per person that have contributed 0.1 percentage point to productivity gains in each subperiod.[15] My estimates count only half of medical outlays as being productivity-related. Other evidence on the health status of Americans, such as the upward trend in life expectancy, confirms the impression that this has been a positive factor.

The effect of a changing age-sex composition of the work force is estimated by Denison in terms of 10 groups. The different average earnings of each may be interpreted as reflecting in part different levels of experience and thus of "learning by doing." The decline in the contribution of this factor from -0.1 in 1948–66 to -0.4 in 1966–73 reflects the bulge of youthful entrants into the labor force beginning in the mid-1960s, and the accelerated increase in female labor force participation. The effect of these shifts was diminishing in the 1973–78 subperiod (and will be reversed in the 1980s).

Changes in Quality of Land

Eventual deterioration in the average quality of land and other domestic natural resources as production grows has long been recognized by economists as a potential source of declining productivity. In U.S. economic history, this tendency has been much more than counteracted by technological progress, and productivity in agriculture and mining exhibited above-average productivity gains up until the latter 1960s. Since then, productivity growth has decelerated somewhat in agriculture, and productivity in mineral industries declined absolutely after 1970. In farming, production expanded onto less desirable lands in the 1970s, and in mining there is evidence of deterioration of ores, and, in the case of oil, an increasing proportion of production has come from reserves that are much more costly to exploit.

Part of the deviation of productivity from past trends has been due to increased regulation, particularly by OSHA. We estimate that about half of the poorer performance is attributable to the deterioration of natural resources. But given the relatively small weight of extractive industries in gross private domestic business product, this reduced the overall rate of pro-

[15] Ibid., p. 41.

ductivity advance by only 0.1 percentage point from 1966–73, and 0.2 from 1973–78. The impact may well be greater in the future, however, as the United States seeks to achieve greater energy independence.[16]

Resource Reallocations

The shift of resources of given types from uses, firms, industries, and regions with lower rates of remuneration to those with higher rates increases real product and productivity. Labor and capital may be employed at less than their equilibrium prices for various reasons — lack of information, or various impediments to mobility, such as regulations, restrictive practices of firms and unions, and the monetary or psychic costs of movement.

It is relatively simple to estimate the effects of inner-industry shifts of resources by calculating what real product per unit of input would have been with an unchanging composition of labor (or capital) and comparing that with the actual productivity numbers. That type of computation with respect to labor productivity has been made in the U.S. Department of Commerce (see Table 3), with the result that 0.4 percentage point of the slowdown in growth of real product per hour between the subperiods 1950–66 and 1973–77 was due to the change in structural shift effects. The effects are due not only to shifts among industries with different levels of real product per hour in the base period, but also to the changing weights accorded the differential rates of productivity change in the various industries. This type of disaggregated analysis has been carried further by Lester Thurow, who has sought to analyze the causes of retardation of productivity growth in particular industries.[17]

In our schema, not all of the inter-industry shift effect is applicable, since some of the differences in levels of real product per hour are due to differences in average educational levels and in age-sex mix, which have already been accounted for. Accordingly, we follow Denison who estimates the effects of two major shifts that increase economic efficiency — the relative shifts of persons out of farming into the nonfarm sector, and of nonfarm self-employment into employee status. Because of the low value-added per hour of those who shift, the compositional changes (particularly out of farming) have had significant effects in the past. Between 1948–66 and 1973–78, however, the positive contribution of these shifts fell by 0.3 percentage point as the opportunities for further favorable reallocations dwindled.

While Denison does not do so, it seems to me that symmetry requires an estimate to be made of the effects of relative shifts of capital among types and industries with differing rates of return. Professors Jorgenson and Gollop,

[16] See E. F. Renshaw, "Productivity" in the Joint Economic Committee print, *U.S. Economic Growth from 1976 to 1986: Prospects, Problems and Patterns*, vol. 1, *Productivity* (October 1, 1976). Denison mentions the declining quality of land, but does not attempt to estimate the effect.

[17] Lester C. Thurow, "The U.S. Productivity Problem," *Data Resources U.S. Review*, August 1979, cited in Shapiro, "Policies for Productivity Growth," pp. 8–10.

Table 3
Average Annual Rates of Growth in Output Per Labor Hour Paid, U.S. Domestic Business Economy (Percent)

Sector	(1) 1950-66	(2) 1966-73	(3) 1973-77	Changes (2)-(1)	(3)-(2)
Agriculture	5.9	5.4	4.2	-0.5	-0.8
Mining	4.5	2.0	-4.4	-2.5	-6.4
Construction	2.9	-2.2	-0.8	-5.1	1.4
Manufacturing					
Durable Goods	2.6	1.9	1.3	-0.7	-0.6
Nondurable Goods	3.3	3.2	2.6	-0.1	-0.6
Transportation	3.7	2.9	2.1	-0.8	-0.8
Communications	5.3	4.8	6.8	-0.5	2.0
Utilities	6.1	4.0	1.0	-2.1	-3.0
Wholesale Trade	3.3	3.9	0.3	0.6	-3.6
Retail Trade	2.5	2.2	1.0	-0.3	-1.2
Finance, Insurance, etc.	0.8	-0.2	0.6	-1.0	0.8
Services	1.7	1.9	0.4	0.2	-1.5
Weighted productivity growth within major sectors	2.8	2.0	1.2	-0.8	-0.8
Unweighted average growth, Total business economy	3.4	2.3	1.4	-1.1	-0.9
Structural shift effect	0.6	0.3	0.2	-0.3	-0.1

SOURCE: U.S. Department of Commerce, Office of the Chief Economist.

using estimates for several types of capital in more than 50 industry groups, found that reallocations added 0.4 percentage point to growth in 1948–66, and somewhat more in the subsequent subperiod.[18] Using estimates for 31 industry groups in 1973–78, I found that the contribution declined to 0.2 point.

It does not appear that the degree of concentration of industry, nor of unionization of workers, changed significantly over the period 1948–78. Some economists claim, however, that with accelerating inflation changes in relative prices have served less effectively as signals for movement of resources. It is also possible that labor mobility may have been reduced somewhat by the growth of pension plans and other fringe benefits that are not vested in the workers.

Volume Changes

Productivity is affected by secular, cyclical, and erratic changes in output. Economies of scale as output grows secularly reflect increasing specialization of personnel, equipment, plants, and producing units, indivisibilities, and the spreading of overhead-type functions over increasing volume. Based

[18] Frank M. Gollop and Dale W. Jorgenson, "U.S. Productivity Growth by Industry, 1947–73," in John W. Kendrick and Beatrice N. Vaccara, eds., *New Developments in Productivity Measurement and Analysis* (Chicago: University of Chicago Press, 1980), pp. 17–136.

on Denison's rough estimating procedure that relates the gains from scale economies to the rate of growth of real product, their contributions declined from 0.4 percentage point during 1948–66 to 0.2 during 1973–78.

I use a simpler method than does Denison for estimating the effects of the cycle on productivity in the first and last years of the subperiods over which growth rates are calculated. Denison uses a complex regression procedure whereby he attempts to estimate the cyclical component of annual productivity changes from the movements of the nonlabor share of factor income. I base my estimate on the effect of changes in the ratio of actual to potential real GNP between the end years of subperiods on the rates of utilization of the relatively fixed component of real factor inputs (estimated at around 40 percent). Using the revised estimates by the Council of Economic Advisers in its 1979 Annual Report, I find a negligible effect of the cycle between 1948 and 1966, -0.1 percent for 1966–73, and -0.3 for 1973–78. Denison finds a small positive effect for 1948–66, a much larger negative effect for 1966–73, and between 1973 and 1976 he finds the effect already to be positive. He had not extended his potential real income and product estimates through 1978 in his most recent published work.[19]

Irregular or erratic factors refer to changes in weather, strike activity, and civil disturbances (not to mention wars). These may have a perceptible influence on annual changes, but Denison's estimates of the effects of the first two factors listed above indicate that the effects over the subperiods used in our analysis were negligible, and they are omitted from the table.

Net Government Impact

Some investigators analyze the negative impact of general governments on productivity, without taking account of the public services rendered to business and the community at large. We attempted to assess the positive services in terms of the growth of governmental inputs relative to business inputs (since government output data are fragmentary). On this basis, it appears that the government contribution to business productivity has been about 0.1 in the subperiods surveyed, somewhat less than pre-1948.

Denison estimates that the negative impacts of environmental, health, and safety regulations — which increase business inputs and costs without increasing measured outputs — reduced productivity growth by 0.13 during 1967–73, and 0.35 during 1973–76. We have rounded his estimates up to -0.2 and -0.4, since there are other types of regulations, although those evaluated by Denison have the most important impact on business, and since our subperiods are a bit larger than those he covered. Although Denison's estimates begin in 1967, it appears that regulatory burdens were increasing in prior years. For example, the numbers of pages of regulations published in the Federal Register gradually increased from 3,450 in 1937 (the first year of

[19] Denison, *Accounting for Slower Economic Growth*, Appendix I, "Effects of Varying Intensity of Demand on Output per Unit of Input," pp. 176–189.

publication) to 60,221 in 1975. We have entered a -0.1 percentage point impact for the subperiod 1948–66. It was probably even greater in the 1929–48 period, when New Deal economic programs burgeoned.

Residual

The residual, or difference between rates of change in productivity and in the explanatory variables offered above, has been modestly negative in all three subperiods. We interpret the residual as reflecting chiefly changes in the ratio of actual to potential labor efficiency at given levels of technology. A couple of elements affecting this ratio can be measured. For one thing, the hours estimates of the Bureau of Labor Statistics, which we use, consist 90 percent of hours paid for rather than hours worked. The downward trend of the ratio of hours worked to hours paid for, reflecting the increasing proportion of paid holidays, vacation, and sick leave, and in some cases sabbatical leaves, has been estimated by BLS to have reduced measured productivity growth in the several subperiods by about 0.1 percentage point.

There has also been a trend towards more unproductive time of workers when at work — for "breaks," the conduct of personal business, and the like. Based on a small sample, the Survey Research Center of the University of Michigan reported that the ratio of time actually worked to time at the workplace by married men was 2 percent lower in 1974–76 than in 1965–66, and even more so for married women.[20] I would guess that the average annual contribution of about -0.2 during this period of heightened social ferment was greater than it was before or after. The mere process of back-casting suggests the trend must have been less in earlier years. But more data are needed to assess the trend since 1973.

There is considerable speculation that the efficiency of hours actually worked may have declined in relation to the kind of standards or norms used in work measurement studies. There is no doubt that restrictive work rules and practices exist in many industries, but data are not available to indicate whether their negative impact has increased. Labor efficiency may also have been adversely affected since the early 1960s by some negative social tendencies, such as growing drug use and crime (see below), loosening of the work ethic, increased questioning of materialism and of various social institutions, including business. But there is no way to assess the net impact of these tendencies. My impression is that they peaked during the era of the Vietnam conflict. The fact that there is no trend in the residual suggests that their impact has not increased, or if it has, that it has been offset by other, positive developments.

The residual also includes possible effects on unit costs of changes in the social and institutional environment not captured by the proximate determinants already discussed. An example is the increase in dishonesty and crime,

[20] F. Stafford and G. Duncan, "The Use of Time and Technology by Households in the United States," (July 1977), Table 4.

which Denison estimates to have reduced productivity growth by 0.03 percentage point a year, on average, during the period 1958–75 spanned by his estimates. Other examples are changes in the degree of competitive pressures in product and factor markets (which has a cyclical component), changes in managerial efficiency, and deviations in the allocation of workers among jobs from an optimum. Finally, the residual reflects errors in the estimates of output, inputs and the impacts of explanatory variables to the extent that they are not offsetting. The small size of the final residual indicates that omitted variables and estimating errors had largely offsetting effects.

Recapitulation

The statistical explanation of the rates of productivity change in the several subperiods automatically provides a quantification of the sources of the slowdown. As may be calculated from Table 2, the 2.4 percentage point deceleration in the growth rate of real product per hour was accounted for by reduced contributions of five groups of explanatory variables, each of which contributed 0.4 to 0.6 percentage point: substitution of capital for labor, advances in technological knowledge, resource reallocations, volume changes, and the combined effect of changes in quality of natural resources and the net impact of governmental programs. Labor quality showed a minor 0.1 point increase, and the residual showed the same negative impact in both subperiods.

Concluding Comments

This concluding section offers some interpretative comments concerning the various sets of causal factors, with some reference to policy implications.

A review of the determinants makes clear the dominant role of total capital formation and the resulting growth of real capital per unit of labor. This includes not only the conventional tangible investment in structures, equipment, inventories and natural resource development, but also the "intangible" investments in R & D, education and training, health and safety, and mobility. The complementarity of these various types of investment is high. R & D raises rates of return on and demand for the tangible capital goods in which it is embodied, and tangible investment helps diffuse new technology and raise labor productivity. Technological progress upgrades the demand for labor, while the scientists, engineers and managers produced by the educational system create the inventions and innovations. Investments in health and safety improve the quality of the labor force, and increase the rate of return on human capital, particularly education, while the educational system plays a role in medical research as well as education, and in diffusing health information. Mobility is essential for labor and capital to adapt to changes in demand and supply conditions arising from technological and other dynamic forces, and thus maximize income and product. When one form of investment lags, as has R & D since the mid-1960s, the effectiveness of other types is reduced. Ideally, the principle of equi-marginal rates of return, equal to the marginal cost of funds, should be used to allocate investment among the various types and uses. More research is needed to permit better estimates of rates of return, particularly on intangible investments.

Each of the several types of investment is undertaken by both the private and public sectors. It is interesting that investments in education, training, health and safety continued to rise strongly in the 1970s, propelled by government programs directed toward welfare goals. This contrasts with the sharp cutback in government funding of R & D beginning in the latter 1960s, which created rising unemployment of scientists and engineers. The latter experience suggests the need for federal science policy involving fairly regular increases in aggregate R & D outlays, even if gradual compositional changes are considered desirable.

The chief problem with respect to private business investment was the declining rates of return in the 1970s, after adjustment for inflation effects, and the higher risk premiums associated with OPEC actions, accelerating inflation, recession, increased regulatory burdens and other controls. The fact that productivity growth also slowed down significantly in most other industrialized countries after 1973 suggests that the common factor of accelerating inflation in general, and the huge rise in oil prices that created its own distorting effects as well as triggering accelerated inflation in most countries, was particularly important in reducing the growth of capital per worker and adversely affecting other productivity determinants. Capital/labor substitution was lower after 1973 in most OECD countries than it was in the preceding decade or two.[21]

The relationship between inflation and productivity is, of course, an inverse one. While inflation impairs productivity growth, so does a retardation of the latter variable accelerate inflation through stronger cost-push. Certainly, policies to stimulate investment and otherwise spur productivity are a fundamental avenue of attack on inflation.

Since another of the papers at this conference deals with policy, I will not try to treat systematically the options available to stimulate investment. Of the tax options for so doing, I would give priority to price-indexing depreciation. A less familiar approach would be to reduce the relative price increase in capital goods industries, one aspect of which would be to target productivity-enhancing measures on the capital goods industries, particularly construction. Government can also promote investment by reducing uncertainties, particularly with respect to its own policies and actions. This brings us to a second grouping of causal forces.

Government most directly affects productivity growth through its own measures which affect business positively or negatively, and through its responsibility for relatively full employment and stable growth. With respect to the latter, skillful use of macroeconomic policies to contain economic con-

[21] Cf. *Productivity Trends in the OECD Area* (Paris: Organization for Economic Cooperation and Development, 8 October 1979, restricted).

tractions to a narrow scope and thus achieve more stable growth obviously tends to augment the rate of growth by increasing the volume of investments over the cycle. Further, the focusing of government policies in all relevant areas on promoting the growth of productivity and real product would increase the gains from economies of scale.

Reducing the inflation rate, as called for in the Humphrey-Hawkins Act of 1978, would have a positive effect on investment and productivity. As stated in the 1979 Annual Report of the Council of Economic Advisers published in the *Economic Report of the President*, p. 117:

> Perhaps the most important single contribution to this objective (increasing investment) would be lower inflation. Expectations that the inflation rate would decline steadily over the next 5 years would directly attack one of the obstacles to the recovery of business investment, since the uncertainty faced by business has been a major deterrent to investment planning. Indirectly, reduced inflation would have even larger effects on financial markets. With declining inflation, we could look forward confidently to a marked fall in short- and long-term interest rates, to strongly rising stock prices, and hence to a reduction in the cost of both debt and equity capital.

In my book, this will require further experimentation with and refinement of incomes policies to supplement traditional monetary and fiscal policies to reduce price inflation.

With regard to the net impact of government actions, the priority issue at this point is to minimize the negative effect of social regulations. Many recommendations have been made towards this end, and the Regulatory Council and the Regulatory Analysis Review Group were set up in the executive branch to coordinate and rationalize the regulatory process. It is important that these efforts plus outside analyses continue to try to increase the cost-effectiveness of those regulations that are in the public interest.[22] The positive impact of government resources used to promote business productivity can obviously be enhanced by increasing the productivity of government agencies. Beyond this, cost-benefit criteria for public investments, both in infrastructure required by business and the community at large and in capital goods that would reduce unit costs of public services, should be applied in order to ensure an adequate volume of public investment. Unfortunately, economy drives often cut out desirable capital projects that would yield a net return above cost over their lifetimes.

It would be highly desirable for the federal government to expand the staff of its National Productivity Council, which is now composed of two

[22] For example, Henry G. Grabowski and John M. Vernon, *The Impact of Regulation on Innovation* (Washington: National Academy of Sciences, 1979); and *Environmental, Health, and Safety Regulations*, Draft Report of an Advisory Subcommittee of the Domestic Policy Review Committee (Washington: National Technical Information Services, PG 290405, December 1978).

persons, so that it can do an effective job of coordinating and monitoring policies and programs of the many agencies that affect productivity, coordinate and perform research and analysis, and initiate proposals for the President to improve the nation's productivity growth rate. It is hoped that the Council, which succeeded the National Center for Productivity and Quality of Working Life in October 1978, will do on a continuing basis the kind of job the authors of the papers for this conference are doing on an ad hoc basis.

The remaining causal forces are less amenable to direct government influence. These have to do with changes in the composition of outputs and inputs, and in the ratio of actual to potential efficiency with given technology. Resource reallocations result from changes in the composition of final demand due to changes in income, relative prices, and tastes; and to changes in technology, and in the relative prices of resource inputs. The efficiency of the price system in product and factor markets depends, of course, on the legal and institutional framework, and on the enforcement of the antitrust laws and on the efficacy of economic regulations in simulating the results of competition. The degree of mobility of resources in response to price signals and associated incentives depends primarily on the self-interest of workers and property-owners, but can be influenced to some extent by public policies in the areas of manpower and finance.

Changes in the composition of the labor force (primarily the age-sex mix) primarily reflect demographic variables, but are also influenced to some degree by government policies relating to education, training, unemployment, retirement and immigration. The domestic natural resource base of the economy is largely given, but the patterns of its use are amenable to policy influence.

Changes in labor efficiency in the business sector reflect an interaction of the values and attitudes of workers and their representatives and the management practices and pay systems designed to elicit optimal performance under given technology, the rapid learning of new job content, and the eliciting of innovative cost-reducing ideas from all levels of workers. Labor laws and manpower programs can influence performance. An example of a constructive development in recent years has been a program of the Federal Mediation and Conciliation Service to aid companies and unions in establishing joint labor-management productivity teams to promote improvements in productivity. Whether governments should play a role in influencing attitudes towards work is a moot point.

In conclusion, this review of the determinants of productivity growth reveals the great scope and complexity of the subject. It makes clear that policies to promote productivity must be developed and instituted on many fronts. In October, I prepared a paper for the American Council on Education that contained around 100 proposals for accelerating the rate of U.S. productivity growth.[23] Some of these which I had drawn from the reports of

[23] John W. Kendrick, *Policies to Promote Productivity Growth* (Washington: American Council on Education, April 1980).

the subcommittees of the Domestic Policy Review Group were subsequently included in the President's industrial innovation initiatives.[24] But all of the proposed changes in tax laws and many of the other recommendations are still available for possible action. Much remains to be done to promote a much more vigorous growth of productivity in the 1980s than in the 1970s.

[24] Fact Sheet on "The President's Industrial Innovation Initiatives" (Washington: The White House, October 31, 1979).

Discussion

Lester C. Thurow*

According to Kendrick the dominant factor in declining productivity growth is a slowdown in capital formation or more accurately a slowdown in the rate of growth of the capital-labor ratio. This is an area where it is necessary to be accurate since the slowdown in the rate of growth of the capital-labor ratio springs not from a slowdown in the proportion of the GNP devoted to capital formation but from a speedup in the rate of growth of the labor force.

Using the three periods from 1948 to 1965, 1966 to 1972, and 1973 to 1979, plant and equipment investment rose from 9.5 percent of the GNP in the first period to 10.3 percent of the GNP in both of the next two periods. Plant and equipment investment is up, not down. But the rate of growth of manhours of work in the private business economy has accelerated dramatically. Manhours of work were growing 0.4 percent per year from 1948 to 1965, 1.1 percent per year from 1965 to 1972, and 2.1 percent per year from 1972 to 1979. To equip a labor force that was growing more than five times as fast in the last period as in the first period, the fraction of GNP devoted to plant and equipment investment would have had to have risen dramatically. It didn't.

The fact that it didn't, however, does not prove that there is an economic problem that needs to be solved. The market was calling for a slowdown in the rate of growth of the capital-labor ratio. If you look at the relative prices of labor (as measured by total compensation per full-time equivalent employee) and capital (as measured by the implicit price deflator for private and equipment investment), the price of labor was rising 2.7 percent per year from 1948 to 1965 relative to that of capital. Labor was becoming expensive; capital was becoming cheap.

But in the third period of time the price of labor was rising only 0.7 percent per year relative to that of capital. Thus relative prices were changing four times as fast in the first period as in the third. Using a simple Cobb-Douglas simulation with an elasticity of output of capital of 0.3, this slowdown would have reduced the rate of growth of labor productivity (due to the slowdown in growth of the capital-labor ratio) by 0.6 percent per year.

But a rising purchasing price is only one element of the total gross cost of capital. Capital investments must be financed and need energy. If energy

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costs are added into the analyses, the price of labor was rising 2.9 percent per year relative to that of capital in the 1948 to 1965 period since energy costs were falling. But in the third period the price of labor was *falling* 2.9 percent per year relative to that of capital since energy costs were skyrocketing. If interest rates and energy costs are both included, the price of labor was rising 1.1 percent relative to capital in the first period but *falling* 4.2 percent in the third period. Obviously the latter calls for a reduction in the optimum capital-labor ratio and a reduction in the optimum level of productivity. Capital is becoming expensive; labor is becoming cheap.

Looking at the relative prices of labor and capital, it is not at all clear that there is an "economic" productivity problem. A slowdown in productivity growth is exactly what the market is calling for and what is to be desired in a period when massive numbers of new workers need to be introduced into the labor force. These new workers lower wages and stop capital formation from rising, but that is what they are supposed to do in a supply and demand world.

A second major source of the productivity slowdown in Kendrick's analysis is an adverse shift in the industrial mix. But here again this adverse shift does not indicate a market failure. It merely indicates the end of an era when agriculture was declining rapidly and the beginning of an era when the service industries are growing rapidly.

Using the industrial breakdown provided by Kendrick, agriculture entered 1948 with a level of labor productivity just 40 percent of the national average. Every worker moved from agriculture to industry represented a 60 percent gain in productivity. And millions of workers were moved. From 1948 to 1965, 9.1 billion manhours were moved from agriculture to industry. And from 1965 to 1972 another 1.8 billion manhours were released. But in the period from 1972 to 1978, only 0.1 billion manhours were released. Movements from agriculture to industry had stopped and agriculture had become a small industry in regard to employment. But when this movement stopped, agriculture ceased being a major source of productivity gains.

Conversely in 1948 services had a level of productivity that was 96 percent that of the national average. Service industries were growing, but the growth did not represent any huge net drain on aggregate productivity. But service productivity growth was slow after WWII and by 1978 service productivity was only 62 percent of the national average. Thus a worker moved into services in 1978 represented a 38 percent decline in productivity. And millions of workers were moved. From 1972 to 1978, 5.7 billion manhours or 35 percent of the growth in hours of work went into services. This represented a large reduction in national productivity growth.

Where did the workers go in services? Forty-two percent of the workers went into health care (mostly nursing homes) and 27 percent into business services (consulting, lawyers, accountants). Presumably businesses were rational in their purchases of business services and the elderly need to be washed and bathed. No market failure was occurring.

Together the agriculture-service effect explains about 22 percent of the national decline in productivity growth from the first to the third period. But there is nothing that can or should be done about this source of the decline.

The decline in extractive industries explains about 10 percent of the national decline in productivity, but this is almost all accounted for by depletion in the oil industry — less oil found per well drilled. Kendrick finds declining land (agriculture) productivity, but this is a statistical artifact due to the corn blight and the re-introduction of millions of low productivity areas back into production with the removal of crop controls. These two factors caused agriculture productivity to decline from 1972 to 1973 and to reach only 1972 levels in 1974. But since 1974, agriculture productivity has grown faster than it did from 1948 to 1972. Thus there was a one-shot decline in agriculture productivity that shows up in growth accounting but it is not a cause for policy concern.

Construction productivity has now been falling for 15 years and accounts for about 17 percent of the decline in national productivity. This is a genuine mystery that is not cleared up by growth accounting. For example, while constant dollar output only grew 58 percent from 1954 to 1977, construction materials grew 133 percent. Do you really believe that the average building uses twice as many materials now?

Kendrick points to declining expenditures on R&D as one of the sources of the productivity decline. I am skeptical because of the timing. R&D expenditures peaked as a percent of GNP in the mid-1960s, but they did not really start to decline until the early 1970s. The productivity decline started much earlier and there must be a substantial time lag between R&D expenditures and measured productivity.

Once again looking at Kendrick's table on industrial productivity growth, you can see that there has been a sharp decline in the rate of growth of productivity in the utility industry. Here again the decline is easily understood as a rational market reaction. In electrical utilities, most of the manpower is located in the distribution network and marginal labor costs are well below average labor costs. Thus in periods where electricity consumption is growing very rapidly, utility productivity growth is very high. But in periods when electricity consumption is not growing or falling, utility productivity slows down or falls. This pattern can be seen by looking at the year-to-year changes in utility productivity. It is a direct function of the rate of growth of utility output. But slower growth in energy consumption is not only being called for by relative prices but is a national policy. Thus no one wants to reverse the slowdown in utility productivity growth. If anything, policies will make productivity growth even slower.

Finally there is the crime and social unrest item referred to by Kendrick. Since 1972, the U.S. economy has added 150,000 private protective service workers. These are pure negative productivity (they guard existing output rather than producing new output) as far as the indexes are concerned, but once again they are not irrational.

When you add up all of these factors, you have to ask seriously whether there is an "economic" productivity problem. Productivity growth has slowed down, but this is in response to market factors that do not indicate imperfections or failures.

What then is the productivity problem? To some extent, it is geopolitical (we do not want our standard of living to fall behind that of our industrial neighbors) and to some extent it is political (we find it difficult to operate a society where real standards of living are not rising), but it is not economic. As a result, plans to accelerate the rate of growth of productivity have to approach the problem from this perspective. We won't accelerate productivity growth by improving the performance of the market, but by introducing market "imperfections" that make the economy grow faster than individual private decision-making or the market would dictate.