Technological Gains and Their Uses:

A Review of Some Recent Economic Changes

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MORE THAN HALF A CENTURY HAS passed since the U. S. Commissioner of Labor officially reported that the era of rapid industrial advance had ended for the then-civilized world, that the future of the great industrial countries held no such opportunities as had the preceding 50 years for the creation of new tools and the profitable employment of the vast amounts of existing capital. Some new processes of manufacture could be expected, and these would act as an ameliorating influence, but the main task remaining was that of consolidating and utilizing the great technical discoveries of the 19th Century. The fallibility of extrapolated human judgments has perhaps never been more glaringly revealed than it is when we set the accomplishments of the last 50 years against these somber predictions. The economic gains of the United States in the first half of the 20th Century have exceeded those of any period in the history of our country and probably those of any period in the history of any modern industrial economy. Modes of production and industrial organization that were only adumbrated by the industrial arts of the 1890's have been developed to yield extraordinary harvests of economic goods. It is true that we have not used our resources, our equipment, and our skills with steady maximum effectiveness, nor have the ends to which we have devoted our energies always been those that would be sought in a world of peace and good will. But for extended periods we have been able to produce goods at rates and in amounts exceeding any previously recorded.

The Magnitude of Progress

The over-all gains of the years 1899–1945 may be defined in terms of national income, corrected to take account of changes in the purchasing power of the dollar, or in terms of physical output.[1] The former measure is the more comprehensive, but the two sets of records may be used as complementary and, in some degree, independent estimates. Conjointly, they indicate a four- to fivefold expansion, from the opening of the century to 1945, of the total stream of goods and services produced in the United States. The population of the country had increased, in the meantime, by 86 per cent. The average real income per capita of the population had been multiplied by two and one-half in less than half a century. This is a staggering gain, when set in contrast to the long periods of stagnation in human history and the slow pace of advance as men have gradually won control over the forces and resources of nature. Here was such an industrial revolution as the world had never known.

It is a notable fact that the gains of these years were not distributed evenly over time. From 1899 to 1914 the gain in real income per capita of the population was at a rate slightly less than 2 per cent a year. During the next 15 years, from 1914 to 1929, the rate of advance was one-third again as great. The 10 years from 1929 to 1939 were a period of retrogression, with real national income per head of the population actually declining. The war years from 1939 to 1945 brought an unprecedented gain, exceeding 6 per cent a year. A substantial part of the added income was used, of course, for purposes of national defense; consumer well-being did not advance at any such rate. But the figure reveals the extraordinary, and in good part unsuspected, potentialities of the industrial machine.

Factors Contributing to Progress

What were the conditions that made possible this striking advance? The work input is, of course, a major factor in determining the magnitude of the national output. Estimates of changes from time to time in the total work input must take account of changes in the total number of persons productively employed and in the average length of the working week. Relevant data are reasonably good for manufacturing and mining, less accurate for agriculture, and still less satisfactory for the wide variety of service industries. Over-all estimates based on these data indicate that the volume of work input in the United States in the decade 1919–28 was some 53 per cent greater than in the 10 years preceding 1899 and declined to 44 per cent above the base in the decade 1929-38. Substantial increases in the size of the working force had, in the 1930's, been in part offset by material reductions in the length of the work

[1] The series utilized are the national income estimates of Simon Kuznets (National Bureau of Economic Research) and of the U. S. Department of Commerce, and the production indexes of the National Bureau of Economic Research.

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week and by unemployment. The war years brought a sharp increase; the average for the seven years 1939–45 was about 82 per cent above the average for the 1889–98 base.

Actual output had grown much more rapidly than had the volume of work input, for the effectiveness of productive effort had increased sharply. In manufacturing, the gain in productivity between 1899 and 1945 approximated 250 per cent; in agriculture, 100 per cent; in mining, 300 per cent. These figures relate, of course, to the situation at the end of the period in question. In defining average conditions over the whole period we may break up the total national income of the United States for the 47 years from 1899 to 1945 and get a rough but useful indication of the shares attributable to the actual labor input, at pre-existing levels of effectiveness, and to enhanced productivity. In dollars of 1929 purchasing power, the aggregate national income of the United States for these 47 years amounted to about 3,151 billions. The labor input of these years, operating at 1889–98 levels of productivity, would have created an aggregate income of 1,667 billions. The increment due to the increased effectiveness with which our resources were utilized amounted to about 1,484 billions, or 47 per cent of the total. This is an impressive figure. Almost one-half of all the goods and services that have been at our disposal for consumption, for the expansion of our industrial plant, and for war purposes since the turn of the century came into being because of increased efficiency in the use of productive resources. We should think our living meager indeed if we had to relinquish overnight half of the real income now at our disposal, yet half of all we have had since 1899 is an increment due to enhanced productivity.

A major factor contributing to this amazing increase in the effectiveness with which human energy is applied to the satisfaction of material wants was, of course, the extended use of improved technology. This comprehends not only the actual amount of capital equipment but also the quality of capital equipment and the technical knowledge that may enhance productive efficiency without adding to the dollar value of invested capital. In agriculture and animal husbandry new and better strains were developed. Techniques of factory organization were improved. The quality of labor was raised, with higher educational attainments and more general acquaintance with mechanical equipment. The shortening of the work week, while it reduced the work input, contributed to an increase in output per hour worked. These various factors played their roles in the great spurt in industrial efficiency that marked the last half century.

The Uses of Economic Gains

When man masters more effective methods of satisfying his wants, several choices are open to him. He must choose between more economic goods and more leisure. To the extent that he chooses more economic goods, he must choose between physical goods and intangible services, and, within the category of physical goods, between those that minister directly to his wants and instrumental goods that may swell future supplies of consumption goods. Finally, he may by choice or compulsion use his productive resources for the purposes of offensive or defensive war.

The division of economic gains, as between voluntary leisure and more economic goods, may be approximated on the basis of changes in the length of the work week, account being taken of the relation of hours worked to man-hour productivity. The estimates relate to the increments of potential output after 1899, the base year. During the first 40 years of this century a constantly expanding portion of our potential gain in national output was allocated to leisure. By 1929 the part of the gain since 1899 so allocated amounted to some 10 per cent, and by the close of the next decade the figure had advanced to 22 per cent. This was materially reduced during the war, but by 1946 had increased again. Taking account of all economic activities, it is reasonably accurate to say that in 1946 about 15 per cent of the potential increment in economic goods and services was foregone, in order that men might work shorter hours.

I turn now to the portion of our energy and resources that we chose to devote to productive purposes. Parts of this were wasted in war; some parts, squandered through involuntary idleness, never reached fruition; some we devoted to the direct satisfaction of our wants; and others we used to build up our industrial equipment and our homes. Here again, estimates giving the approximate distribution of the potential fruits of our productive resources are useful if we recognize the margins of error involved. Let us first consider how the aggregate for this period was divided.

I have cited the total national income of the 47 years, 1899–1945. This would have been something over 6 per cent greater had there been no unemployment in these years. We thus have a potential national income aggregate for this period of about 3,371 billions of dollars (of 1929 purchasing power), distributed approximately as follows:[2]

	Amount in 1929 dollars (billions)		Distribution (%)	
For consumer goods and services	2,836		84	
Consumer materials		1,878		56
Consumer services		958		28
For capital formation (net)	195		6	
For war consumption	120		4	
Lost through unemployment	220		6	
Total	3,371		100	

[2] These estimates and allocations are based on *National product since 1869* and *National product in wartime*, by Simon Kuznets (National Bureau of Economic Research); *Survey of current business* (U. S. Department of Commerce); and *The economic almanac for 1946–47* (National Industrial Conference Board).

Perhaps the outstanding fact revealed by this summary is that we lost through unemployment and war, together, 10 per cent of the potential real income of these 47 years.[3] Unemployment alone accounted for a loss equal to the combined output of any two of the best years we have had in the last half century, prior to 1941; war wastes (including only actual war consumption and not those parts of governmental war expenditure used to feed and clothe men in the armed forces, or those elements that went into plants and equipment presumably useful for peacetime purposes) accounted for a loss equal to the total output of such a good year as 1942.

Ninety per cent of the potential real income of the 47 years we are surveying was actually realized in goods and services suitable for the direct satisfaction of wants and the expansion of our plant and equipment (residences being here included with equipment), 84 per cent of the total going to the first use—the production of consumer goods and services, and 6 per cent to the second. This division represents a very heavy preponderance indeed of expenditures designed to satisfy immediate wants. The 6 per cent[4] devoted to capital formation falls far short of the corresponding average of 15 per cent for the 30 years from 1869 to 1898. The estimates for the last three decades of the 19th Century are subject to a wider margin of error than are figures for recent years, but the difference far exceeds any possible margin attributable to errors of measurement. Two world wars and a protracted depression cut deeply into the resources that would otherwise have been devoted to plant extension, new machines, public works, and homes. It is quite possible that improvements in the quality of capital goods would, in any case, have reduced somewhat the proportion of national income devoted to capital formation, but the pronounced drop we have noted reflects the economic casualties of a sorely troubled period, as well as possible secular tendencies.

This aggregative view of the division of national product during the past 47 years reveals substantial losses due to involuntary idleness, wasteful consumption in war, heavy emphasis upon the satisfaction of consumer wants, and sharply reduced emphasis upon the extension of our industrial plant, our equipment, and our housing. We may better appraise some aspects of this division if we examine the disposition of the increment of output attributable to advancing productivity.

I have presented above an estimate of approximately 1,500 billions of dollars of 1929 purchasing power as the increment due to productivity gains between 1899 and 1945. To what uses did we put this extraordinary addition to our national output? Since producers and consumers do not themselves distinguish between such an increment and the basic production that would have been achieved without productivity gains, it is impossible to give a definitive answer to this question. However, if we may assume that the maintenance of existing consumption standards constitutes a first claim on the income of subsequent periods—an assumption that is strongly warranted—we may give a reasonable answer. On this assumption we obtain the following division:

Uses of incremental output due to productivity gains (1899–1945)	Amount (in billions of dollars of 1929 purchasing power)	Distribution (%)
For enhancement of living standards (consumer uses)	1,169	79
For net additions to capital equipment	195	13
For war consumption	120	8

As will be seen, the elevation of living standards through greater day-by-day consumption was the primary use to which the gains of enhanced efficiency were put. The source of the extraordinary gain in living standards in the United States since the turn of the century is to be found in greater productivity of effort, not in an increase in the work input. The varied new products and services that entered into the consumption patterns of American citizens within the last few decades were superimposed upon the elements of earlier consumption; they did not in any essential way replace them. Automobiles, radios, electrical appliances, and a diversity of other new consumer goods constituted, in the main, additions to the components of consumption of 1900. These additions came from the great increment of output that higher productivity made possible. By long-term standards this may not have been the best allocation of our new resources. Some needed improvements of industrial plant were not made; transportation networks were not modernized; archaic conditions persisted in most large cities, in the face of the requirements of the automobile age and the air age; housing was inadequate to the needs of a growing population; slum clearance lagged; and educational facilities fell behind our needs. A wiser people might have made better use of the extraordinary largesse of fortune, but this was our choice.

The advance in well-being over the last half century was not, of course, uniform, or even in its incidence, but there was probably no element in the economy that failed to register substantial gains. The division of these gains among producing and consuming groups cannot be traced in detail here, but it is possible to define some of the chief advances and some of the lags of the last 50 years. Because the record of change is an irregular one, with variations from decade to decade in the rates

[3] Potential real income here means the income that would have been realized had we used, productively, the labor force at our disposal. It is actual income plus the amount lost through unemployment and does not include income voluntarily foregone through shortening of working hours.

[4] Net capital formation constituted 6.2 per cent of the aggregate real national income (3,151 billions, in 1929 dollars) of the period 1899–1945. For the 30 years, 1869–98, net capital formation averaged 15 per cent of real national income (see Simon Kuznets. *National product since 1869*).

of gain for different economic groups, the movements will be noted by periods since 1899.

The years from 1899 to 1914 were marked by substantial but not spectacular advances in productivity. Consumers benefited from a cumulative drop in fabricational costs. Farmers, favored by steadily rising prices for their products, were among the immediate gainers. Salaries and other fixed incomes lagged somewhat in the general price advance. Wage earners participated in the general forward movement but made no differential gains. The share of rent in the national income declined slightly, that of dividends increased, that of interest held constant.

The next 15 years, to 1929, brought a great increase in industrial productivity and added a very large increment to the stream of disposable goods and services. Although farmers reaped large rewards during World War I, they fell behind in the 1920's. This was a period of substantial gains for two main groups in the economy: ownership and management, and industrial wage earners. The fruits of enhanced productivity were more narrowly restricted in their distribution than in the years preceding 1914; factors of production most strategically placed to reap the first benefits realized the greatest relative gains. Lower real costs were not reflected commensurately in final selling prices. It is true that producing and consuming groups in general improved their status in these years. So great were the productivity gains that, after allowing for the dissipations of war, for unsound foreign loans and for the bonanza profits of speculators, a substantial surplus remained to support a broad advance in living standards. But the benefits accruing to the great body of consumers were well below our economic potential. We had not learned fully to utilize, to the general advantage, the great new productive powers at our command.

The 1930's brought further technical improvements and accelerated gains in industrial efficiency, but the productivity increment ceased to expand and, indeed, contracted in these years. Terms of exchange moved again against farmers and in favor of industrial wage earners. Employed workers gained materially in rewards per unit of time worked, but the aggregate amount flowing to wage earners was reduced by wide and persistent unemployment. This was a decade of rich but unrealized potentialities.

The record of the most recent period, dating from the outbreak of war in 1939, is an unfinished story. A great surge of new output expanded the disposal surplus. A large portion of this was devoted to war purposes; a still larger portion went to swell the stream of consumer goods and services. Farmers and other primary producers reaped the first gains; industrial labor followed. Real incomes declined for many professional and salaried groups. The relative shares of dividends, interest, and rent in national income were reduced. The year 1946 is bringing further sharp fluctuations in the distribution of income and is reversing some earlier movements. The share of wages and salaries has fallen while that of dividends and interest has advanced. Certain of the most recent tendencies are in the direction of earlier relations, but the period of observation is too short to support firm conclusions concerning the trends of postwar years.

The history of industrial progress in the United States during the 20th Century is, in summary, one of great gains, but of gains that fell short of potentialities. It is a record of productive resources in part misapplied, with inadequate attention to the maintenance and extension of instruments of production and the more durable instruments of the good life—homes, schools, utilities, and cities adapted to the needs of the modern age. There were improvements in the economic fortunes of all producing and consuming groups, but the advances were uneven and irregular. Farmers and other primary producers, industrial labor, salaried and professional workers, recipients of income from property, in turn, moved ahead and lagged behind. If we set economic rewards against contributions of working time, the most sustained gains have been won by industrial labor. General living standards have risen materially, but gains potential in the great technical advances of the 20th Century have been as yet inadequately realized by the mass of consumers. In part, the gains have been lost through war and unemployment; in part, they have gone to strategically placed groups of primary producers, fabricators, distributors, or wage earners. The one prime method of transmitting the benefits of industrial progress to consumers at large—prompt price reduction commensurate with declines in real costs—has not as yet been adopted as generally or applied as broadly as the necessities of a dynamic industrial system require.

Greater advances than those of the last 50 years impend, and a productivity increment of massive proportions is within our grasp, but this increment can be realized to the full only if it is widely shared. The 1920's and the 1930's—both periods of great technical improvements—provide illuminating examples of productivity gains restricted too narrowly in their incidence. In widely different ways they represent paths we must not follow again. One lesson to be drawn from the records of industrial change in the United States in the 20th Century, with its peaks of extraordinary achievement and its valleys of depression, is that in a modern industrial system diversion of the fruits of advancing productivity to restricted groups brings them only short-lived benefits and curtails the gains accruing to the economy at large. If we are to combine economic progress with a greater measure of industrial stability than we have yet achieved, we must learn this lesson and have the wit to apply it.