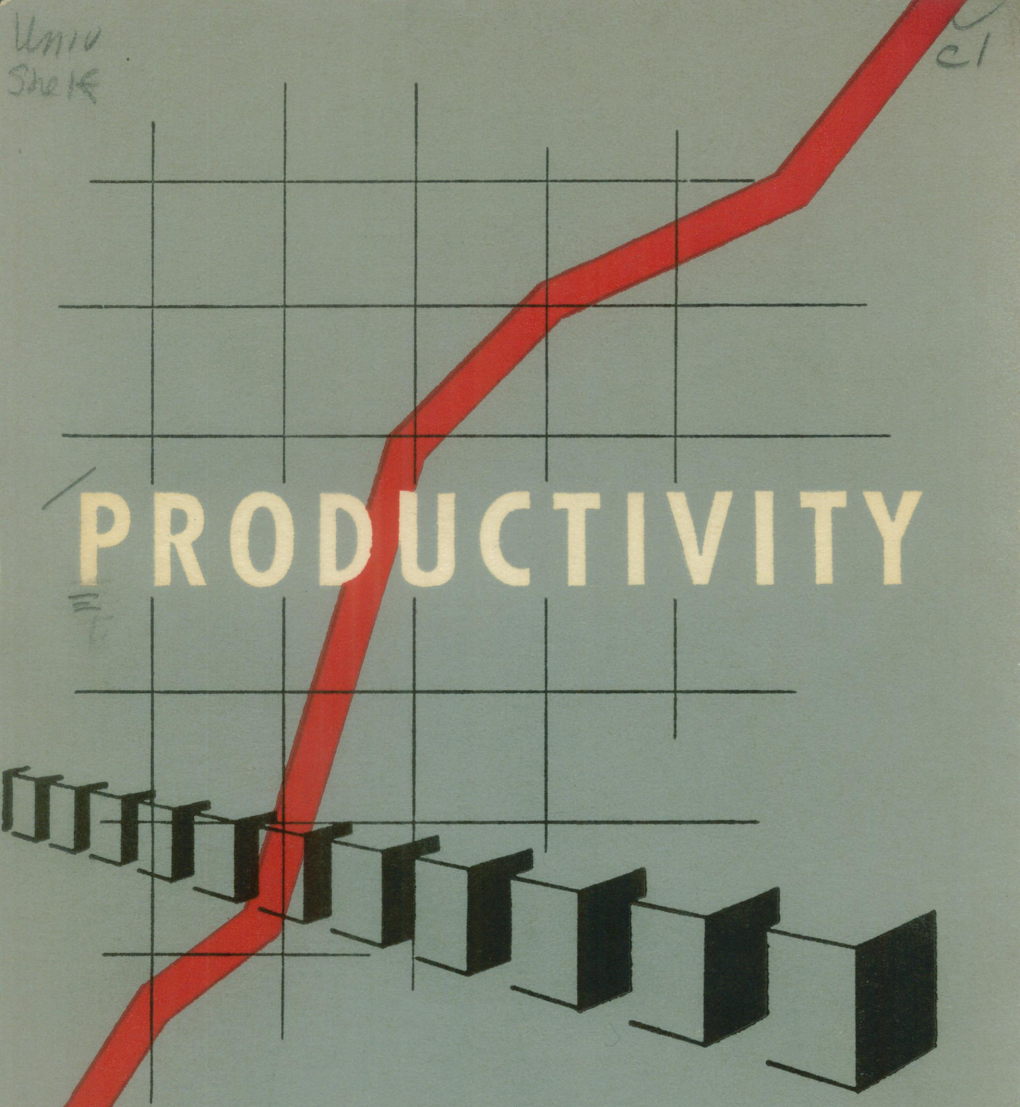

PRODUCTIVITY

by PETER O. STEINER
and WILLIAM GOLDNER

INSTITUTE OF INDUSTRIAL RELATIONS
UNIVERSITY OF CALIFORNIA, (BERKELEY)

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PETER O. STEINER and
WILLIAM GOLDNER,

Edited by Irving Bernstein,

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Foreword

THE INSTITUTE OF INDUSTRIAL RELATIONS of the University of California was created by the California Legislature for the purpose, among others, of conducting research and contributing to public information and understanding in the field of industrial relations. Governor Earl Warren in his "Annual Message to the Legislature" of January 3, 1949, declared that the Institute

> can be made . . . a practical means of bringing about better understanding in the field of industrial relations in California . . . We should now make increasingly practical use of the information that has been developed by the Institute . . .

One means of achieving this objective is through popular pamphlets which can be made available to labor organizations, management, government officials, the schools and universities, and the general public. Those pamphlets already published (a list appears on the preceding page) have achieved a wide distribution among these groups. At a more technical level, a substantial list of monographs and journal articles have also been published. These publications are available to interested persons upon request.

The American economy has expanded its output tremendously during the last century largely because of the increasing productivity of our industrial system. At the present time, the length of the workweek, the level of wage rates, and the output of industry for peaceful and military purposes are related to the productivity of our economy. It is appropriate, therefore, that we know something of the details of this pervasive and influential force that underlies our economic progress. As Professor Steiner and Mr. Goldner point out, productivity is no simple concept; it summarizes the effects of many forces acting in concert. Increased skills and effort, improved machines and plant layouts, better qualities of raw materials, and more imaginative direction and management—all of these contribute to the increased efficiency of our production and provide the basis for an increased amount of reward. A most fundamental problem is how the rewards of increasing productivity may be shared by the major segments of the economy.

The Institute expresses appreciation to the following for their reviews and constructive criticism of the manuscript: At the University of California, Dr. George A. Pettit, Assistant to the President, Professors Robert Dorfman, Robert A. Gordon, and Van Dusen Kennedy; from the industrial relations community-at-large, William H. Smith, Director, Department of Research and Analysis, San Francisco Employers Council, Jay Darwin, Northern California Attorney for the National CIO, and Max D. Kossoris, Regional Director, U. S. Bureau of Labor Statistics.

The cover design is the work of Robert Eustachy, and the illustrations are by Bernard Seaman. Mrs. Anne P. Cook assisted with the editing. The viewpoint expressed is that of the authors.

E. T. GRETHER, *Director*
Northern Division
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Southern Division

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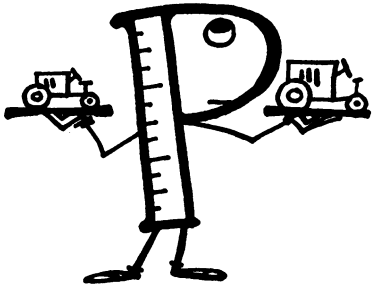
PART 3

Productivity and Industrial Relations

I. Introduction

THE STANDARD OF LIVING in the United States is the highest man has ever known, and Americans are justifiably proud of that fact. The dream of all workingmen, higher pay and shorter hours, has been increasingly achieved in the course of our history. Much of the credit for these accomplishments is often attributed to "productivity."



What does "productivity" mean? How is "productivity" measured? How does it affect our output, our wages, our standard of living? These are some of the questions this pamphlet endeavors to answer.

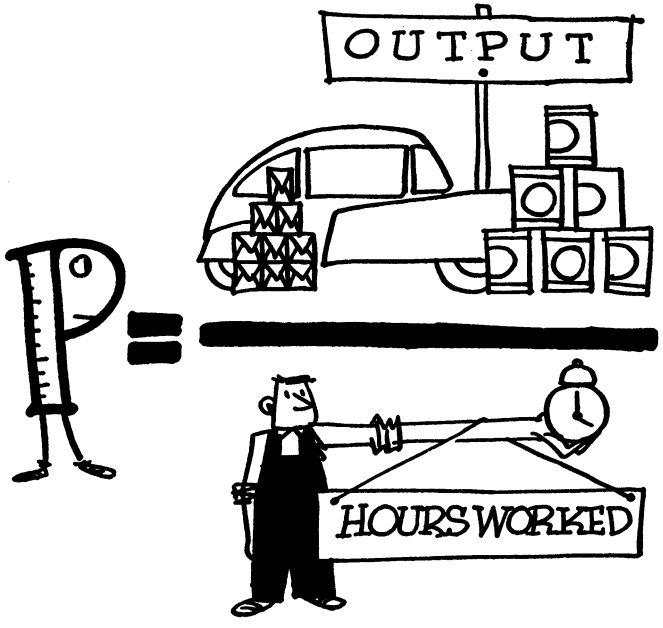
The term "productivity" is often used in connection with the broadest kinds of issues. It is heard in discussions of collective bargaining, of wage policy, of inflation, and even in controversies on international affairs and the "cold war." While this pamphlet will not be able to examine fully all of these broader issues, it will attempt

to suggest why the concept of "productivity" is involved in such matters.

Productivity also has an important effect on the atmosphere and processes of labor-management relations. Union agreements covering minimum production standards, piece rates, and incentive wage systems directly involve productivity. Similarly, the use of constant year-to-year wage changes, usually called improvement factors, reflect the direct application of economy-wide productivity gains to the wage bargain. The most important implications of these industrial relations policies, frequently overlooked, are summarized in the last part of this pamphlet.

PART 1

The Concept of Productivity and Its Measurement



II. What Is Productivity?

THOUGH THE TERMS "productivity," "workers' productivity," and "the productivity of labor" are in everyday use, their meaning is not always clear. This chapter will define what productivity is and what it is not. The agencies which measure productivity have a clear idea what they mean by productivity, and it is their definitions which will be cited.

1. PRODUCTION VS. PRODUCTIVITY

Everybody knows what we mean by physical production: the number of units of output produced in a given period by a worker, plant, firm, or the nation's economy.

Productivity differs from "production" because it concerns not *how much* is produced but rather *how efficiently* production is carried on. Efficiency is measured by counting how much output is achieved for each unit of input.

What do we mean by input? A typical product is a combination of raw materials, machinery, workers' time, power, and many other factors. Each of these is called an input. Input items are combined in the manufacturing process into products or output. Should the unit of input be one worker, or one hour of labor time, or one machine,

or a ton of raw materials, or a kilowatt hour of electricity? Any of these could be a unit of input even though each is different. It is necessary to choose some yardstick of input which is commonly understood and universally present in all production. For this reason the input factor which is most frequently taken as the yardstick is a man-hour of working time.

The reasons for selecting labor time as the unit of input are: first, it is present in all production; second, because we are a society of men, not machines, we are especially interested in how man's efforts are used; third, better statistical records exist for employment and hours worked than for most other factors that serve as inputs.

2. CALCULATING PRODUCTIVITY

Productivity is usually measured by dividing output in physical units by man-hours worked. Thus it is the following ratio:

$$\text{Productivity} = \frac{\text{Units of output}}{\text{Man-hours worked}}$$

As mentioned above, productivity could be measured as, say, output per kilowatt-hour of electric power, or output per ton of some particular raw material. These would be different measures of productivity and they are not generally used.

3. WHAT CAUSES PRODUCTIVITY TO CHANGE

The fact that the conventional yardstick of input is a man-hour of labor time does not mean that measures of productivity are related solely to the efforts of labor. This may be illustrated by the following example.

In a certain plant in 1939, 1,000,000 units of output were produced using 25,000 man-hours of labor. In the same plant in 1946, output was 1,500,000 units through the use of 30,000 man-hours of labor. Calculating productivity from these figures, we get:

$$\text{Productivity in 1939} = \frac{1{,}000{,}000 \text{ units}}{25{,}000 \text{ man-hours}} = 40 \text{ units per man-hour}$$

$$\text{Productivity in 1946} = \frac{1{,}500{,}000 \text{ units}}{30{,}000 \text{ man-hours}} = 50 \text{ units per man-hour}$$

This increase in productivity between 1939 and 1946 might have come about in any of the following ways:

1) The workers may have become more highly skilled, or they may have "worked harder."
2) The company may have increased the number of machines per worker, or it may have found better machines which enabled workers of the same skill to increase their hourly production.
3) The quality of raw materials may have improved so that less output had to be rejected. Thus, less time and effort

was lost in handling materials. Similarly, the proportions of various raw materials involved may have changed and permitted use of less labor and more machinery.

4) The organization of production may have been changed to make it more efficient. For example, an assembly line may have been introduced, with consequent saving of time and effort. Or, as a result of better purchasing procedures or methods of material handling, adequate supplies of raw materials may have been on hand, eliminating bottlenecks in the flow of production.
5) The increase in output may have resulted from operating at capacity. Neither men nor machines stood idle for lack of production orders.

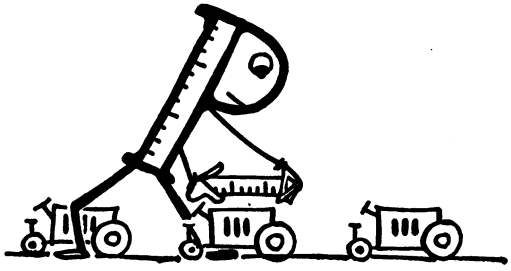
Actually the increase in productivity probably occurred not as a result of one of the factors alone, but as a result of several of them. For instance, between 1939 and 1946, the developments resulting from the wartime economy may have laid the groundwork for higher productivity in the future. The building of a new plant, the redesigning of the production process, the spread of skills to workers who previously had none—all of these improvements have left a legacy in that particular plant which is now taking effect. Furthermore, it is the combination of these factors and others which results in productivity increases in individual plants and throughout the economy. It is not possible to isolate the effect of individual factors on the increase in output per man-hour.

In sum: *productivity, even when reported in terms of man-hours, does not reflect the efforts of labor alone, but includes all elements which can contribute to more efficient use of labor-time in production.*

III. How Is Productivity Measured?

1. THE LEVEL AT WHICH MEASUREMENT OCCURS

PRODUCTIVITY MEASURES may be computed at virtually all levels of productive activity. The most convenient place is at the job level where output can usually be easily defined and records of output and man-hours are frequently available. Measurement at the job level is



of substantial interest to the job foreman or plant manager. Because it focuses on a specific job, however, it is particularly subject to the effects of unusual factors, such as temporary bottlenecks, variation in individual work performance, and climatic changes. Notwithstanding, work performance records are a kind of productivity

measurement carried on in countless business enterprises.

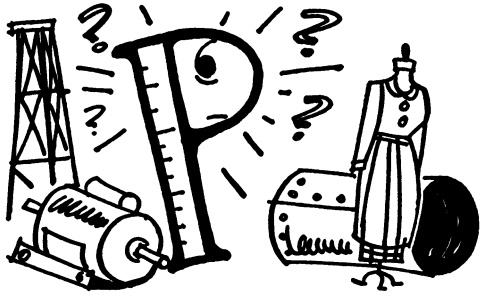
At the plant level, productivity measurement generally proceeds by calculating the ratio of plant output to the total number of man-hours worked. At this level, output measurement becomes more complex. Many plants produce a variety of products and combining production figures on different items raises problems. Another difficulty arises because total man-hours worked includes not only direct labor but also supervisory, clerical, maintenance, and administrative labor. Further, it is not always easy to segregate the portion of total man-hours that is concerned with current production from that chargeable to past or future production.

The U. S. Bureau of Labor Statistics compiles indexes of productivity at the industry level. Here, the problems of measurement are intensified and several complex techniques have been developed to obtain accurate and consistent data. Fortunately, some of the irregular factors present at the job and plant level may cancel each other out. As the coverage of the measures increases, they become of interest to a wide group of people and have greater applicability to general problems.

Despite this interest, productivity indexes are available for only a limited number of industries. The primary limitation is the inadequacy of physical production data on a measurable and comparable basis. Industries producing a relatively homogeneous product are heavily represented. Sugar refining, flour, fertilizers, glass, meat packing, and petroleum refining have a large proportion of production in simple, continuously flowing, identical

units of output. Even where the end product is differentiated but measurable in distinct units, productivity indexes can be calculated. For example, basic steel, autos, boots and shoes, and canning and preserving are industries of this type.

Industries like men's and women's clothing, fabricated metal products, and electrical machinery are among those



for which industry-wide measures are unavailable. The variety of products, many made to special order, and the different kinds of units which are produced make it very difficult to obtain statistics of production that directly measure the output of these industries.

Productivity at even broader levels is of greatest interest to most economic analysts. They often seek measures of productivity for groups of industries such as, for example, Manufacturing, Transportation, and Trade which are important sectors of the economy. These measurements are usually obtained by averaging data for individual industries. Sometimes they are computed directly

for the broad sectors where general production data are available.

Occasionally, a still broader outlook is required and productivity is measured at the national level. We then have to use data on Gross National Product, which is the nation's output of goods and services in terms of its market value. In order to reduce Gross National Product to physical output quantities, these data have to be adjusted by complex price series. Fortunately, the U. S. Department of Commerce has done a large part of this job. We now have fairly satisfactory measurements that apply to the American economy as a whole.

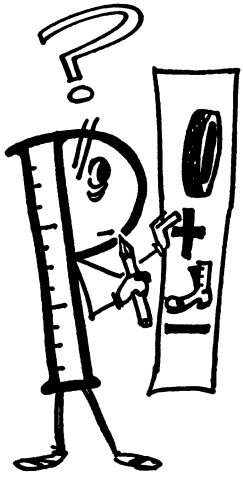
The several levels at which productivity is measured make comparisons of the data difficult. Output per man-hour at the job level may be used to compare one worker with another, or a group of workers with other groups. But measures obtained at one level cannot meaningfully be compared with those of other levels.

2. MEASURING PHYSICAL OUTPUT

The chief problem at all levels is measuring physical output. There is the least difficulty in the case of a plant that is making a single product. Output can be determined by simply adding up each day's production of the finished item. Even here there may be a problem if the quality of the product is changing. If a plant makes many different products, or if we are concerned with the productivity of an industry or, say, the manufacturing sector, it is impossible to add up output of

different goods. We cannot, for example, add automobiles and cotton cloth and men's shoes. Neither can we use dollar value without introducing price changes into the measure of productivity.

The solution to this problem lies in the construction of an index number of physical production. Index numbers of output are specially constructed to measure *changes* in output without introducing changes in price. If we know the level of production in, say, 1939, and we use an index number to measure the changes that have occurred since then, we can estimate the current level of production. Most index numbers relate to a base year, which is a year when economic relationships are fairly normal or when statistical information is complete. Productivity indexes frequently use 1939 as a base year primarily because that was the year of the last prewar Census of Manufacturers, and because it was more nearly normal than the previous years of the thirties. The period 1947–49 will soon become a similar bench-mark from which more recent changes in production may be measured.



The process of computing index numbers is complex and cannot be described here. However, we can by a simple example indicate the kind of computation that is

made. The following hypothetical data represent three items of production in 1939 and 1946:

Commodity	*1939*	*1946*	*Per cent Change*
Cotton cloth	20,000,000 yds.	30,000,000 yds.	+50
Cement	60,000 tons	75,000 tons	+25
Apple cider	100,000 barrels	115,000 barrels	+15

In this example output has increased for each of the commodities. It is greater by 10,000,000 yards of cotton cloth, by 15,000 tons of cement, and by 15,000 barrels of apple cider. In terms of percentage changes, output went up between 15 per cent and 50 per cent. Since this range is large we may prefer to describe the change *on the average*. If the three commodities are considered equally important, the average production increased $\frac{50+25+15}{3} = 30$ per cent. However, it is unlikely that the commodities are of equal value, and hence some weighting of the commodities is necessary. If, for example, apple cider is of lesser importance we would not count the percentage change in its production as heavily as that of the other items.

Index numbers are computed on the same principle as the above example. Changes in the production of specific commodities are expressed in percentage form and these are combined into an over-all measure of change by weighting each commodity by its relative importance.

Another index of physical production that is some-

times used, particularly at the sector or economy-wide level, is based on value figures adjusted for price changes. For example, sales figures for a given industry combine the effects of changes in output and changes in prices. If such figures are adjusted for changes in the price level, we will have an approximation to the change in output. This process, called statistical deflation, is often used and is evidenced by such phrases as "in constant dollars," in "purchasing power dollars" or "in terms of 1939 prices." The statistical difficulties in finding the price index that adjusts the values properly are very great, and the results should only be taken as approximations. This is the method used in computing productivity measures for the whole economy where Gross National Product *in constant dollars* per man-hour is taken as the measure of productivity.

As a result of the difficulties in combining outputs, virtually all calculations of productivity depend upon production data that are derived either by construction of an index of output or by deflation of a value series. The resulting productivity measures are focused on the percentage change in productivity and not upon actual levels of output per man-hour. If output per man-hour in 1948 was 110 (1939 = 100), then productivity has increased 10 per cent from 1939 to 1948. It does not reveal the number of units of output produced per man-hour in either year.

Every measure of productivity is some kind of an *average*. The farther away from the job level the greater is the averaging—of many products and plants at the

industry level; of many industries in addition at the sector level. The measure of productivity in manufacturing, for example, is an average of changes in a great variety of products, in 458 industries, and in about 350,000 establishments. Productivity measures are not precise statements of specific facts; they summarize the general drift of the changes in productivity of the many plants and products involved.

PART 2

The Facts about Productivity and Their Interpretation

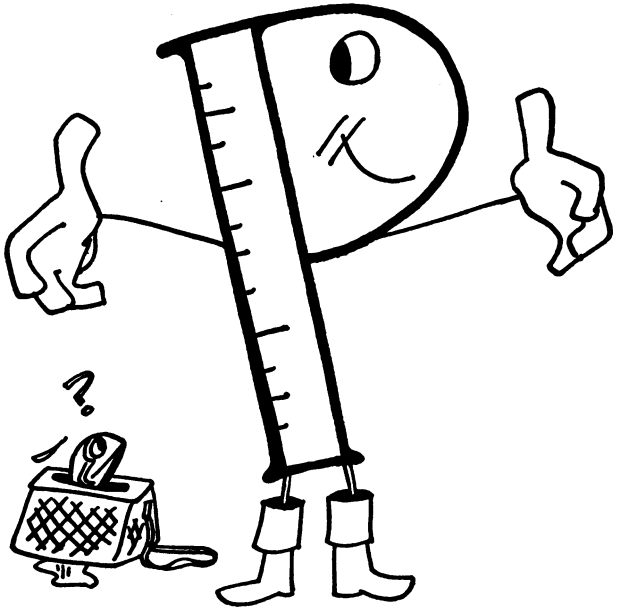
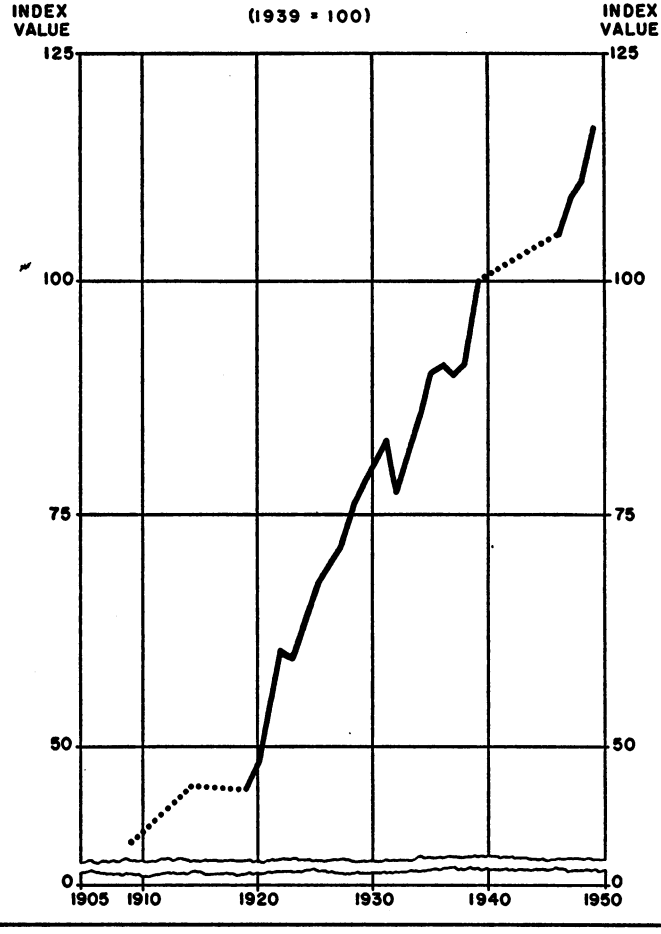


FIGURE 1

PRODUCTIVITY IN MANUFACTURING, 1909-1949



IV. Trends of Productivity

FROM THE PREVIOUS DISCUSSION, we know that there is no single measure of productivity. For one thing, productivity may be considered at many different levels. For another, there is no reason to believe that all measures would behave the same way over a period of time. But we may start by looking at output per man-hour for manufacturing and then see how other measures differ from it.

1. PRODUCTIVITY IN MANUFACTURING 1909–1949

The index of output per man-hour in manufacturing is detailed in Table 1 and plotted in Figure 1. From these data, two things are immediately apparent. First, a very real increase in output per man-hour has taken place over this period; productivity was about two and a half times as high in 1939 as in 1909. Second, behind this general upward movement were very uneven year-to-year changes. Some periods, 1919–1922 for example, exhibited very rapid increases; other periods, such as 1922–1923 and 1931–1932, showed actual declines. Although year-to-year changes are very uneven, when they are strung together, the underlying upward trend becomes clear.

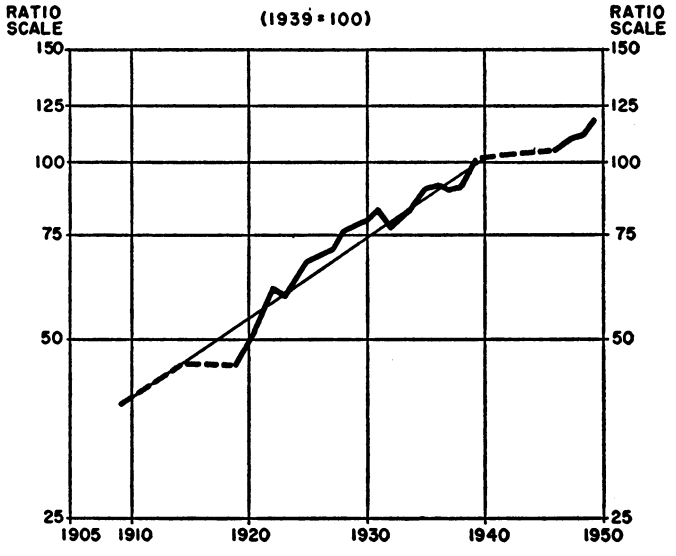
Table 1.—PRODUCTIVITY IN MANUFACTURING, 1909–1949 (1939 = 100)

Year	Output per man-hour	Year	Output per man-hour
1909	39.4		
1910	....	1930	80.0
1911	....	1931	83.5
1912	....	1932	77.8
1913	....	1933	81.9
1914	45.5	1934	85.9
1915	....	1935	90.8
1916	....	1936	91.0
1917	....	1937	90.0
1918	....	1938	91.6
1919	45.3	1939	100.0
1920	48.0	1940	....
1921	55.2	1941	....
1922	60.5	1942	....
1923	59.5	1943	....
1924	63.4	1944	....
1925	67.6	1945	....
1926	69.5	1946	105.8
1927	71.3	1947	109.1
1928	75.1	1948	111.5
1929	78.1	1949	116.6

Sources: 1909–39, *Historical Statistics of the United States*, Series D-213, p. 72; 1946–49, Estimates.

FIGURE 2

PRODUCTIVITY IN MANUFACTURING, 1909-1949

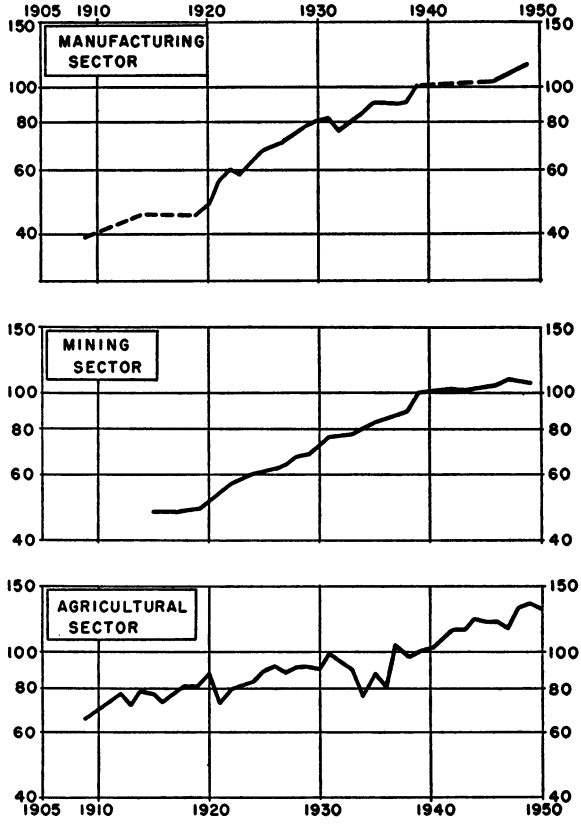


The increase in productivity can be seen more easily in Figure 2, which is on a logarithmic or ratio scale. This device emphasizes the percentage change in productivity. The steeper the line, the greater is the percentage change in the index. On this scale equal percentage changes are represented by equal vertical distances. The distance between 25 and 50 is equal to the distance between 50 and 100, 75 and 150, since each of them represents a doubling of the variable.

FIGURE 3

PRODUCTIVITY IN SELECTED SECTORS OF THE ECONOMY

(1939 = 100)



The straight light line in Figure 2 is the average rate of change of productivity over the period 1909–1939. It is apparent that the changes in individual years were sometimes great where the bold line is steep, sometimes low where the bold line is almost flat, and sometimes negative where the line slopes downward.

2. PRODUCTIVITY IN MINING AND AGRICULTURE

Figure 3 presents productivity data for mining and agriculture along with the curve of manufacturing. It shows that even though each of the three series behaved differently, the two basic points made with respect to productivity in manufacturing also apply in the other sectors. All three exhibit a rise over the period from the turn of the century to 1950. In mining the rise is very similar to manufacturing, but in agriculture it is less. Each shows an uneven year-to-year pattern.

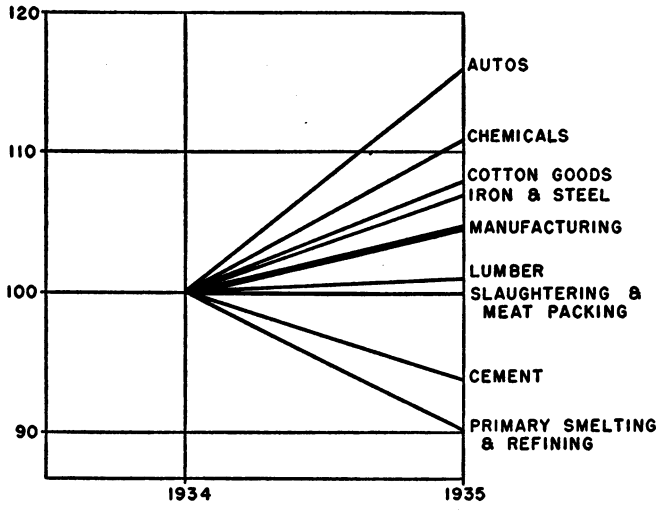
3. PRODUCTIVITY IN INDIVIDUAL INDUSTRY GROUPS

The index of output per man-hour for manufacturing summarizes the trend and year-to-year changes in productivity. However, it should be recalled that this index is an average of the indexes of many manufacturing industries. It therefore hides a great deal of diversity.

This can be seen in Figure 4, which shows the per-

FIGURE 4

CHANGES IN PRODUCTIVITY, 1934-1935
SELECTED INDUSTRIES



centage changes in the index of output per man-hour for eight manufacturing industries in the years 1934 to 1935. The heavy line is the average change for the manufacturing sector. Although it indicates the general drift, it does not illustrate the great variety in the changes in individual industries. The diversity that exists in the *plants* of each industry would contribute to a further spread of variation in Figure 4. It should be emphasized that Figure 4 focuses on *short-run* diversity.

The realization that the aggregate measure of productivity summarizes such a wide range of experience should not be misinterpreted. It does not mean that there is no long-run pattern of change among individual industries. Figure 5 shows the productivity index for each of six industries along with the index for manufacturing as a whole. In general, each of these industries exhibits a

distinctive pattern of productivity development and a related trend of gradual but irregular increase in output per man-hour over time. It is also true that the amount of increase varies substantially among these selected industries. Output per man-hour in rayon, for example, increased over the period substantially more rapidly than in manufacturing as a whole. Iron and steel increased less rapidly.

Further, not only do the industries exhibit differing rates of change, but the pattern of change varies, too. Some industries, motor vehicles, for example, show substantial rises in productivity during the twenties, but in the thirties the increases were below the general level. Other industries, such as cement, had trends closely com-

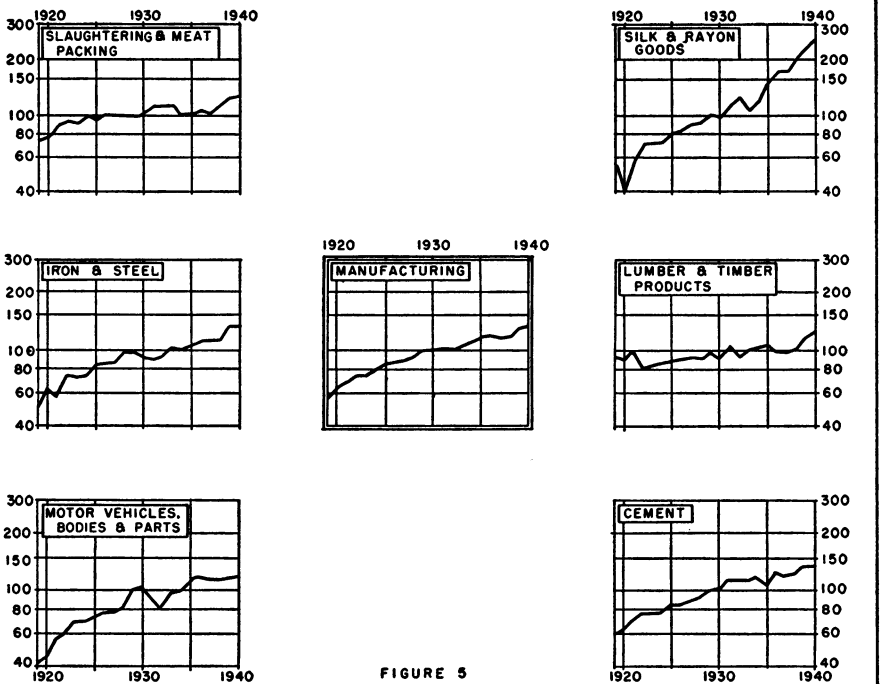


FIGURE 5

PRODUCTIVITY IN SELECTED INDUSTRIES OF THE MANUFACTURING SECTOR 1919-1940

parable to that of the manufacturing sector. Lumber and slaughtering and meat packing had patterns of increase that were much lower than average all through the period 1919–39. Some new industries, like rayon, exhibited substantial gains in productivity.

The conclusions suggested by Figures 4 and 5 are twofold:

1) The aggregate measure of productivity for all manufacturing summarizes the general trend of a variety of changes in individual industries. It is interesting and useful as such, but it does not give, by itself, a reliable guide to the nature of changes in individual industries.
2) Significant patterns of productivity for individual industries often exist. These trends may differ appreciably among industries and compared to the manufacturing sector as a whole. Here again, however, the over-all *industry* figures are not a reliable guide to the experience of *plants* within the industry.

V. The Significance of Changes in Productivity

THE CHARTS of Chapter IV illustrate the kinds of changes that have characterized the development of productivity in the United States. The clearly dominant feature is the rapid increase in productivity. How may these changes be interpreted?

1. THE OVER-ALL TREND

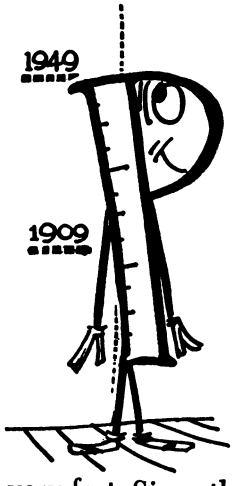
For the period 1909–1949 as a whole our productive efficiency has increased. We are getting more output per unit of labor time than ever before. At the same time, our labor force has also been growing. These two factors join in cumulatively increasing our ability to produce goods and services. In the war and postwar experience of the 1940's our great productive capacity, combined with high levels of employment, resulted in an unprecedented stream of goods and services and a standard of living unparalleled in the world.

Much of the rise in productivity is the result of greater mechanization of industry. The use of new and better machinery has enabled the labor force to produce more. Other factors have also contributed to the general gains. The higher level of education and skill of the labor force,

the lessening of fatigue resulting from the shorter workweek, improvements in working conditions, the scientific planning and control of production, and other policies have had important effects.

2. INDUSTRY GROWTH AND PRODUCTIVITY

While productivity has advanced over-all, there are differences in the rates of increase. In general, productivity seems to rise most quickly in the period of rapid growth of an industry. Rayon, a new product in the 1920's, exhibited an increase in productivity that was truly astounding in the decades of its major development. This increase was far greater than in the manufacturing sector as a whole. Similar evidence is provided by the motor vehicles industry. Manufacturers of automobiles achieved their most rapid growth before 1923 and in the years 1920–23 their productivity also rose very fast. Since then, productivity in motor vehicles has continued to go up, but much less quickly. Older industries like iron and steel and lumber exhibit a rise in productivity that is not only less than that of industries which are experiencing major growth but also less than the average of manufacturing as a whole.



In agriculture, while a substantial amount of mechanization has occurred, the increase in productivity has been smaller than in manufacturing. In part, there is less scope for new methods in agriculture. But the considerable rise in productivity in the last ten years suggests that much improvement is still possible.

3. PRODUCTIVITY CHANGES IN THE SHORT RUN

Analysis of productivity changes over long time spans is a highly useful kind of interpretation of the statistical measures. For long periods it is generally true that increases in productivity can be taken as indications of improvement in the economic situation of the industries involved. In the short run, however, the significance of productivity changes is much less clear.

Consider, for example, the increase in productivity in manufacturing occurring from 1929 to 1931. This was a period in which manufacturing output was being severely curtailed and unemployment was increasing at a rapid pace. The year 1931 was a time of economic crisis and not in any way a better year than 1929. What, then, did the rise in productivity signify? It signified an increase in efficiency only in that employment decreased faster than output and that the smaller output was produced with a lower per unit number of man-hours. It did not imply that less efficient plants were being replaced by more efficient ones, or that less efficient workers were becoming more skilled. It meant rather that the less effi-

cient plants and workers were the earliest casualties of the depression. Thus, it seems necessary to distinguish those changes in productivity that represent long-run trends from those that are a result of the fluctuations in business activity.

Another example of this is illustrated by World War II experience in many industries which achieved record-breaking outputs for the defense effort, but found that their productivity was either decreasing or increasing at a much slower rate than prewar. Such decreases in productivity were often perfectly understandable. In their efforts to produce as much as possible, untrained workers were brought in and trained, overtime and swing shifts were added, and every bit of machinery was pressed into service. Thus the decline in productivity was not a cause for alarm but rather a consequence of the high level of wartime output.

The greatest error that can be made in interpreting productivity measures is to assume that every increase in productivity is an indication that all is well, and every decrease an indication that something is wrong. While, in general, productivity increases do result in real benefits, this is not always the case, and it is necessary to go behind the figures to understand the basic economic conditions that have produced the changes.

While great caution must be used in analyzing short-period changes in productivity, whether at the level of the plant or for broad sectors of the economy, they are nevertheless of great use as a point of departure for examination of what has actually happened to the process of production.

VI. The Sources of Long-Run Productivity Increases

In an earlier chapter we emphasized that changes in productivity resulted from combinations of many influences and that it was not ordinarily possible to isolate the effect of individual causes. But if we look beyond the statistical measures and apply our knowledge of history and economics, it is possible to say something more about the factors which, in the long run, have had great influence.

1. INDUSTRIALIZATION AND TECHNICAL CHANGE

One source of the great increase in production and productivity that has occurred in this country is immediately apparent. During the last century, the whole method of production has changed. We have increasingly made greater use of machinery and of more industrialized processes. The development of large-scale industry with huge factories and mass production has made possible vast increases in the amount of output that can be turned out in a day. One need only think of the huge steel furnaces and continuous rolling mills of

today to realize the impact of such industrialization on productivity. In addition, there are also a variety of smaller changes that have had tremendous influence. For example, the development of automatic machines, machine tools, interchangeable parts, and the use of close tolerance, gigs, and fixtures have made mass production and assembly line techniques possible.

Although there have been many spectacular innovations, the greater part of our industrial advancement has been brought about by a large number of small changes which, added together, have effected a tremendous transformation. For improvements in techniques and in "know-how" are cumulative—a useless invention is discarded, but a helpful one adds to the store of useful techniques. Thus our industrial capacity is a monument dedicated to the cumulative contributions of countless men. The greatest single source of our continuously increasing level of productivity is to be found in the expansion of our store of technical knowledge—our "know-how."

Another source of the progress toward greater efficiency has resulted from the substantial shift in the kind of resources we use for energy. As late as 1900, the bulk of our power was supplied by men, horses, and oxen. Some additions to our energy usage were provided by waterwheels and coal. At the present time, the type of energy produced by animals and humans has been almost completely superseded by the inanimate sources of power such as coal, oil, and electricity. Statistics show that in 1950, animals and human workers provided less than 10

per cent of the energy used; in 1900, they had supplied over 60 per cent. Truly, muscles have been replaced by minerals.

This shift to inanimate sources of energy will continue as the commercial possibilities of atomic energy are developed. Atomic power may therefore have tremendous

influence on productivity in the foreseeable future. We now know that the energy in the atom can be released. We expect soon to be able to harness this energy to production and to develop hundreds of specific uses and applications of atomic power.

2. WEALTH AND SAVING; INVESTMENT AND "CAPITAL"

Technical improvements are vitally important in explaining increases in productivity, but alone they are not enough. To affect production a new invention must be utilized, and generally this requires investment in machinery or equipment. Our current stock of capital goods, the plants, machines, and equipment that provide

our productive capacity, is extremely large. However, these goods took time and materials and money to produce, without yielding any immediate flow of goods for consumption purposes.

To build such an industrial capacity has required production in excess of current consumption. It has required that the community as a whole not consume all it could produce. It has involved saving, and investment of these savings for the purpose of securing, at a later time, greater quantities of goods for consumption. Thus, in cataloging the sources of the increases in productivity, we must include savings.

For some countries the process of saving has proved relatively easy. Where vast natural resources or rich colonies have existed and the resulting levels of income exceeded the bare needs for consumption, saving and investment have occurred voluntarily in large quantities. Once high productivity has been achieved, it becomes possible to increase *both* the standard of living and the amount available for further investment.

But for some countries the level of wealth has not exceeded the level of need for mere existence, and there has been no excess available for saving. In part, this is the problem faced by China, India, and other so-called "underdeveloped areas" where the standard of living is barely above the subsistence level. The problem of helping these areas to help themselves involves more than merely providing them with trained specialists and "know-how," although that is needed. They must also be helped to build up a productive plant which will raise

incomes to the point where accumulation of savings is possible and investment is stimulated. Thus, one of the aims of the "Point-Four" program of the United States is to provide capital for backward areas. A similar concept underlies the "Economic Recovery Program" in helping Western Europe to regain the productive capacity so badly damaged in World War II.

3. THE ROLE OF LABOR AND MANAGEMENT

Clearly, our great advance in productivity could not have occurred without industrialization and saving. But perhaps most important of all, the opportunities for increasing efficiency have not been allowed to slip by. Labor and management have both played important parts in achieving higher levels of efficiency. Management has continued to exercise its function of risk-taking, basing the expansion of plants and improvement of processes on sound optimism. Labor, recognizing the benefits of higher productivity, has adapted to tech-

nological changes in the overwhelming majority of cases, and has developed the needed general and specific skills.

Labor and management have learned not only to use machinery, but to steadily improve it. It has been said we are a nation of mechanics, of tinkerers, of "gadgeteers." It is in large part because of these characteristics that we have built a productive machine that is the envy of the world.

PART 3

Productivity and Industrial Relations

VII. Collective Bargaining Provisions Affecting Production and Productivity

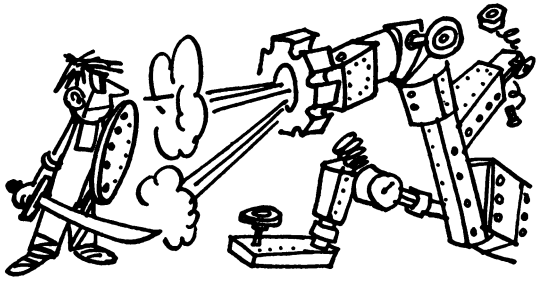
PRODUCTIVITY IS indirectly an element in virtually all collective bargaining, for the parties are establishing the conditions under which a principal input factor, labor, will work. We have already indicated that productivity is concerned with the relationship of output to input, and clearly the nature of the conditions of labor will influence the amount and rate of output.

1. TYPES OF BARGAINING PROVISIONS

Productivity *directly* enters the field of industrial relations in two different ways. First, there are the bargaining provisions that specifically deal with the conditions of production, including the rate of output, the introduction of new machinery or methods, and the required composition of labor crews. This type of provision directly *affects* production and productivity. Second, productivity sometimes provides a basis for compensation of labor. Included in this category are various wage incentive plans, "improvement factors," and in general the

whole area of wage policy, public or private. This second type of provision, considered in the next chapter, differs from the first in that the focus is on *adjusting to* productivity conditions rather than affecting or determining productivity.

Provisions affecting production and productivity may be divided into two quite different kinds. First, there



are provisos designed to protect the workers from hardships such as fatigue, injury, unemployment, and wage loss that sometimes accompany attempts to increase productivity. Second are those involving joint efforts by labor and management to improve efficiency.

2. LABOR'S FEAR OF TECHNOLOGICAL CHANGE

Employee resistance to technological change has been based upon the age-old fear that machines displace men, causing an oversupply of labor and low wages. This fear cannot be dismissed by the assertion that if

productivity rises all will be better off, for, as we have seen, productivity increases are not necessarily desirable if they are offset by declining employment. Particularly in periods of business depression or in declining industries, labor-saving changes may decrease employment and hence be undesirable. When and if all the displaced workers are reemployed, they may be better off, but the periods of transition may be both long and, for the men involved, expensive. Although unemployment insurance and high dismissal wages may soften the blow, they do not eliminate all the hardships nor prevent the destruction of old skills achieved by years of work experience.

A variety of policies have developed within the framework of collective bargaining to solve these problems. Some bargaining agreements frankly prevent the full achievement of gains in productivity by provisions for stand-by crews and similar devices. At the other extreme are agreements prohibiting any restrictions on the introduction of new machinery or new processes. In between these extremes are provisions requiring union-management negotiations prior to changes in process or in equipment used. The results of such negotiations find expression in contract provisions restricting dismissal of employees affected, maintaining the previous level of earnings, extending priority on transfers to new machines, giving preference to displaced employees, and granting dismissal pay. These controls encourage the introduction of innovations in periods of expanding production and minimize the transitional problems of change.

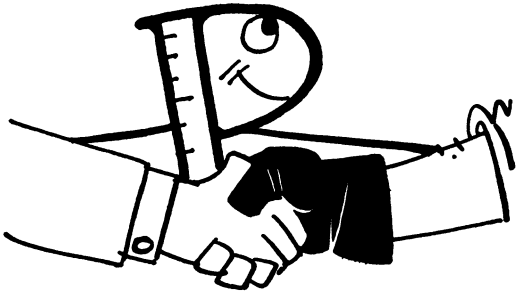
Adjustments to technological advances are largely determined by the severity of the problems, temporary or not, which are created. Where alternative employment is scarce, where skills are specialized, where ability to shift location is limited, and where the industry is not expanding rapidly, resistance to productivity-increasing innovations is likely to be strongest. Where the reverse conditions are true, opposition is likely to be mild if it exists at all.

3. PROGRAMS OF UNION-MANAGEMENT COOPERATION

Another outgrowth of collective bargaining which affects productivity is the formal program of union-management cooperation. These kinds of programs have never had wide application throughout the economy. However, their successes in some sectors of industry have provided examples which merit some comment.

Union-management cooperation in improving productive efficiency is predicated on acceptance by the employer of the principle that the workers' jobs, earnings, and standards of working conditions will be safeguarded. Through such cooperation unions and employers provide an opportunity for the workers to share in any resulting economies. Where these agreements have been incorporated in the union contracts, they are aimed at the elimination of plant inefficiency. The union may agree to prevent (or not to condone) restrictions on out-

put, to correct inefficiencies of its members, and to combat absenteeism. Sometimes the union's responsibility is phrased in more general terms such as, for example, the achievement of low-cost and efficient operations, or the maintenance of profitable and productive efficiency.



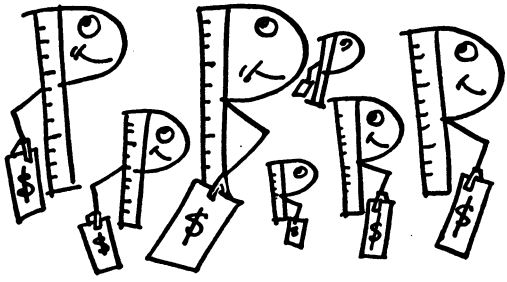
Labor-management production committees constitute another approach to increasing productivity at the plant level. Such arrangements, established through collective bargaining, have existed in some companies for many years. During the twenties, many of the railroads established committees of this type, and although many of the roads have terminated the arrangements, others, notably the Baltimore and Ohio, have continued them to the present day.

In the steel industry, the United Steelworkers of America—CIO succeeded in establishing production planning committees, whose functions were pointed toward greater union participation in output problems. These committees were organized in about one-third of the plants having bargaining relationships with the Steelworkers in 1939.

As a final example of union-management cooperation, the situations in the clothing and printing industries may be mentioned. In both of these industries, which are characterized by strong unions and numerous competitive employers, the union provides technical experts to help the employer work out production problems, and establish production standards, and even to aid in financial matters. The basic theory behind such assistance is that inefficient employers mean low wages, long hours, and irregular employment. In order to maintain higher standards for the union membership, the union constructively assists the employer in the solution of his management problems.

VIII. Productivity Measures as a Guide for Wages

THE LOGIC of "efficiency wages" has long appealed to employers who hope thereby to regularize their unit labor costs despite differences in skill or effort of individual workers. The piece rate is directly an efficiency wage rate geared to the differing productivity of workers. Various kinds of incentive plans and improvement factors also involve gearing wages to changes in productivity.



1. INCENTIVE WAGE PLANS

Incentive wage plans are designed to encourage the fullest possible use of individual ability and thereby to increase the worker's productivity. They recognize individual capacity and make provision for its

measurement and remuneration. Basically, incentive plans enable workers to increase their earnings by exceeding specified standards of output. They establish a norm of output or productivity per man-hour and provide for bonus payments on output in excess of this norm.

An employee's earnings under an incentive wage plan may be geared directly to his own productivity, to the performance of a small group or team of which he is a part, or to the performance of the entire mill, plant, or shop.

Unlike individual incentive plans, under which a worker's earnings fluctuate with his own output, group incentive plans tie his earnings to the output of the group as a whole. Groups may vary in size from two to several hundred.

Consideration of productivity at the plant level is a more recent development in collective bargaining. Although group incentive plans have existed in the past, it was during World War II that plant-wide incentive bonus systems were introduced in substantial numbers. This type of plan was usually easier to install and simpler to administer than most of the individual and group plans. In general, under such a scheme, all employees in the plant receive a percentage bonus for the plant output above standard. The standard is usually expressed in physical terms, e.g., pounds of aircraft per month, number of cars per year.

Although many unions have traditionally opposed incentive wage plans in principle, there is a wide divergence in union attitudes toward them. Much of the

opposition of workers and unions to incentive plans is caused by past experience with rate cutting and the speedup. Some union leaders, however, recognize that the reduction of unit labor costs of production which may be achieved through incentive plans provides them with the opportunity to press for higher wages and higher labor income.

Employers generally favor incentive wage plans because they are assured of a relatively stable unit labor cost and greater employee efficiency and productivity. It is unfair to pay the same wage to a slow worker as to a more efficient one, employers contend, and a system which rewards the individual worker according to his skill and industry is therefore both more equitable and more desirable.

2. WAGE POLICY BASED ON PRODUCTIVITY MEASURES

As we have seen, it is impossible to separate the contributions of each factor in achieving increases in productivity. It is equally difficult to reward each factor according to its exact contribution.

Wage policies based upon productivity measures have been suggested which roughly share the benefits of increased productivity among all producing groups. These policies involve the use of "improvement factors" which provide for automatic annual wage adjustments based upon long-term rates of increase in productivity for the whole economy. They are designed as a means by which

labor can share in over-all productivity increases. Recently several economists have urged that productivity-based wages be used on a far larger scale. Similar proposals also were made in 1949 by the Council of Economic Advisers to the President. Before considering the implications of such policies, let us see how they provide for sharing by all groups.

3. SHARING GAINS IN PRODUCTIVITY

Consider the case where an increase in productivity comes about as a result of increased output for the same amount of input. There is clearly a net gain to the community. The question arises, "How shall this gain be distributed?" If we assume no change in taxes there are the following possibilities:

1) Wages can be increased so that employees are enabled to buy the additional amounts of output. In this case, productivity gains would go to the employees.
2) Higher prices can be paid for raw materials, thus giving the raw material suppliers the benefits.
3) Prices of finished goods can be reduced, allowing consumers to buy the additional product with the same total amount of money. In this case, purchasers of goods would benefit.
4) Profits can be increased by leaving things alone. If wages, raw materials, and prices remain the same, the additional product resulting from a gain in productivity will create added revenue for the producer. Since his costs remain about the same, his profits would increase.

5) The benefits of gains in productivity might be shared by several groups. If wage increases equal to the percentage rise in productivity are granted, then all of the other factors of production can also receive the same percentage increase in payment for their service. They would share proportionally the advance in well-being brought about by the higher productivity.

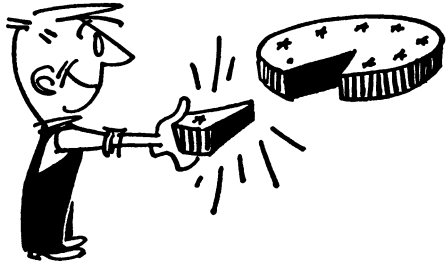
Let us examine the following simplified example.

Table 2.—EXAMPLE SHOWING EFFECT OF WAGE CHANGES PROPORTIONAL TO CHANGES IN PRODUCTIVITY

Item	*Year 1*	*Year 2*	*Percentage Change*
Productivity Data:			
1. Output	1,000 units	1,100 units	
2. Man-hours	500	500	
3. Output per man-hour (1 ÷ 2)	2.0	2.2	+10
4. Index of product (Year 1 = 100)	100	110	+10
Sales Data:			
5. Price of product	$2 per unit	$2 per unit	
6. Value of output (1 × 5)	$2,000	$2,200	
Cost Data:			
7. Wage rate	$1.50 hr.	$1.65 hr.	+10
8. Labor cost (2 × 7)	$750	$825	+10
9. All other costs, including profits (6 – 8)	$1,250	$1,375	+10

Table 2 gives certain hypothetical information about years "1" and "2", in which output has increased 10 per cent and man-hours have remained unchanged. The ex-

ample also assumes that there are only two kinds of costs, "labor costs" and "all other costs." All other costs include not only payments for raw materials and power but also the profits of the firm. In this example productivity has risen 10 per cent. Let us trace the effect of a wage increase of 10 per cent equal to the increase in productivity. The wage rate is raised from $1.50 to $1.65 and the wage bill from $750 to $825. But notice that this does



not exhaust the increase in value of product produced. The amount available for payments to all other contributors to the industrial process has also gone up 10 per cent.

Wage increases may come about in three ways. First, they may occur in accordance with real gains in productivity, in which all groups share. Second, labor may increase its proportion of income at the expense of some other group. However, limits to this are imposed by the ability of other groups to maintain their share, and also by the fact that labor costs are a relatively large part of total costs. Third, wages as well as other costs may rise if the price of the product rises. But general gains in wages that are accompanied by corresponding price rises

may constitute only an illusion of benefit, for wages are used to buy goods, and purchasing power is determined not only by money income but also by the prices of goods and services.

Thus, except for an increase at the expense of other groups, the amount that wages can rise *without* forcing up prices is fixed by the increases in productivity that occur. In a time when inflation is a major fear it is not surprising that a wage policy limiting increases to those consistent with advances in productivity should be frequently suggested.

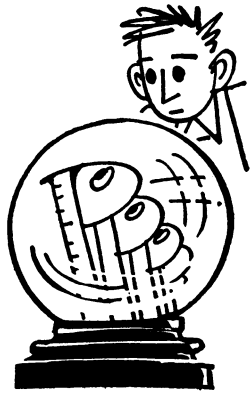
It should be further emphasized that a policy providing for increases in wages, profits, and other costs that matches productivity gains is an alternative to cutting prices and keeping wages and profits unchanged. The question of which is preferable, increasing wages and the income of other factors of production or decreasing prices, is a matter of debate and cannot be treated here. However, where the major fear is inflation, it can be understood that the focus is often upon *maintaining* prices rather than decreasing them.

4. PROBLEMS INVOLVED IN A PRODUCTIVITY-WAGE POLICY

The apparent logic and widespread public appeal of a general policy of linking wage changes to changes in productivity make it necessary to consider several problems that are involved.

First of all, productivity can increase even though

both output and employment are declining. If output declines 10 per cent from 1000 units to 900 units, but employment declines by 20 per cent from 500 to 400 man-hours, output per man-hour will increase from $\frac{1000}{500} = 2.00$ to $\frac{900}{400} = 2.25$, or by 12.5 per cent. This increase in productivity may merely show that some of the less efficient plants, machines, and men are unemployed. Wage increases might lead to more unemployment by forcing plants to shut down. Thus, there is an important difference between productivity gains that are accompanied by full employment and result in increased output, and those that occur in periods of decreasing employment. Adjusting wages to short-term changes in productivity under these conditions constitutes a dubious wage policy.



As a second qualification, use of an "improvement factor" in wage contracts, calling for, say, 2 or 3 per cent yearly wage increases to absorb gains in efficiency rests upon a long-range view of productivity. This kind of wage contract assumes that, on the average, similar annual increases can be expected in the future. However, there is nothing automatic about advances in productivity. They require continued effort and ingenuity on the part of all concerned with the productive process. Future changes may be much more or much less than past changes, depending upon the efforts involved. In

addition, year-to-year changes are often very different from the long-term average change in productivity, and thus in short-run comparisons an "improvement factor" wage policy may give much less or much more than is warranted by actual production results.

A third major consideration is that changes in productivity vary greatly in different jobs, plants, industries, and sectors. Which changes are the appropriate ones to use in wage policies? Logically, wage changes based upon productivity would require use of the productivity measures at the specific jobs or in specific plants. But such measures would distort the *structure* of wages; the wage relationships which have developed between different jobs, different plants, and different industries would be substantially altered. Jobs having increased productivity because of new processes, improved tools and machinery, would have larger wage increases than jobs where no change in job content is taking place. These jobs might be in the same plant, under the jurisdiction of the same union, with personnel that are interchangeable filling the positions.

Similarly, different plants bargaining with the same union might be faced with different wage increases owing to the modernization of some plants, a situation that the union would find unacceptable. Again, among industries in a common labor market serious structural distortions of wages would result from a literal productivity-wage policy.

An alternative to the use of many specific measures of productivity is the use of some over-all *average* produc-

tivity measure. Such an alternative avoids the distortions mentioned above but may create maladjustment of another sort. In plants, jobs, or industries having greater than average increases in productivity, labor will be getting less than its share of the benefits; whereas in others, where productivity has not increased, a squeeze on management (or on prices) is imposed, and may result in various distortions of the economy. As one example of this, consider what has happened in recent years in those situations where productivity has not increased, but where wages have risen in accordance with the general level of wages. In some service industries, like domestic service, there has been a tremendous curtailment of employment. Domestic servants have been "priced out of the market" to a large degree. In other service industries, like dry cleaning, laundry, and barbering, prices have risen very sharply, as is well known to every consumer.

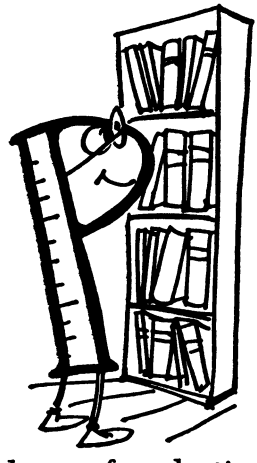
These problems illustrate the difficulties in translating the obvious connection between wages and productivity into a satisfactory wage formula. Although increased productivity is a basic factor that should always be considered in wage negotiations, many other factors may have to be given great weight in particular instances.

IX. Suggestions for Further Reading

An excellent and modern treatment of the problems involved in formulating the concept of productivity is the International Labor Office publication, *Methods of Labour Productivity Statistics* (Geneva, 1951, 136 pp.). The interest of British industry in this phase of the productivity problem is given expression in Smith and Beeching's pamphlet, *Measurement of the Effectiveness of the Productive Unit* (London, British Institute of Management, 1949, 35 pp. and appendixes). The U. S. Bureau of Labor Statistics has issued Irving Siegel's *Concepts and Measurement of Production and Productivity* (Washington: 1952) which is a detailed technical study of productivity measurement. *Production, Employment and Productivity in 59 Manufacturing Industries* (Washington: 1939), the three-volume WPA National Research Project study, has a treatment of concept formulation and statistical measurement in productivity. It also is the most comprehensive collection of empirical data on the productivity problem available at the time of its publication in 1939.

Other sources of basic statistical information that are organized to give answers to productivity questions have

since been published. The National Bureau of Economic Research has turned its research resources to work on the problem and published the monumental *Employment in Manufacturing, 1899–1939: An Analysis of Its Relation to the Volume of Production,* by Solomon Fabricant (New York, 1942, 360 pp.). The U. S. Bureau of Labor Statistics has also carried forward the data of the National Research Project (with some changes) in a series of industry studies. In addition, BLS has made notable progress in measuring the man-hours expended on individual products at different points of time and in different kinds of plants. The BLS studies are individually published and are summarized frequently in the *Monthly Labor Review.* Almost all of the BLS data has been collected together in BLS Bulletin 1086, *Productivity Trends in Selected Industries—Indexes through 1950.*



The recent comprehensive revisions of national income data made by the U. S. Department of Commerce provide basic material that can be used for economy-wide calculations of productivity. The sections that are particularly useful are those deflating the Gross National Product to constant dollar values. In addition, detailed industry breakdowns of productivity may be roughly calculated. Data for the period 1929–1950 are detailed in *National Income: 1951 Edition.* Cur-

rent data are summarized in the monthly issues of the *Survey of Current Business.*

Important articles covering the role of productivity in industrial relations are found in several of the academic journals covering primarily economic problems. Among these are Mordecai Ezekial's, "Productivity, Wage Rates, and Employment," in the September 1940 *American Economic Review.* The November 1949 issue of the *Review of Economics and Statistics* is devoted exclusively to the problems of productivity in the area of industrial relations, and it includes several articles of major import. John T. Dunlop has written a significant chapter, "Productivity and the Wage Structure," in the volume *Income, Employment, and Public Policy; Essays in Honor of Alvin E. Hansen* (New York: 1948). Qualifications on the use of productivity in the collective bargaining process are summarized by Solomon Fabricant in his paper, "Productivity Measurement," which appears in the *Proceedings of the New York University Third Annual Conference on Labor* (New York: 1950), pp. 75–92.

A trade union viewpoint is presented by Lazare Teper in his short article, "This Thing Called Productivity," in the *American Federationist,* November 1948. Another interesting labor viewpoint is presented in the study by the British Trades Union Congress, *Trade Unions and Productivity* (London: 1951).

The Institute of Industrial Relations, University of California, Berkeley, has published two productivity articles of its staff members as Reprint 18, "The Short Run Behavior of Physical Productivity and Average

Hourly Earnings" by Clark Kerr, and Reprint 28, "The Productivity Ratio: Some Analytical Limitations on Its Use" by Peter O. Steiner. These reprints are available upon request.

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