

Productivity  
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INTERPRETING PRODUCTIVITY MEASUREMENTS AND  
THEIR APPLICATION TO ECONOMIC PROBLEMS...

by

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The term "productivity" found its way into economic literature about a century ago in the form of the marginal productivity theory of value. There is no need of analyzing that theory before an audience of professional economists. It is sufficient to remind you that this is a theory which relates the value of the marginal product to the value contributions of the factors of production (land, labor, capital). However, for purposes of this paper, I must emphasize three points: First, this equivalence of input and output occurs at the margin; second, the inputs and output are related in both value terms and physical quantities; and third, the theory attempts to account for the division of the value product among the factors. Thus, according to this theory, the wages paid to labor will equal the value productivity of labor at the margin.

From the very beginning this purely economic doctrine became entangled with ethical concepts. This confusion of ethics and economics was due in part (and perhaps largely due) to Karl Marx with his doctrine of surplus value. Marx argued that all value is created by labor, but that the returns

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to labor in the form of wages do not add up to the value produced. Consequently, there is a surplus value created by the worker but not accruing to him. According to Marx, this is the cause of business depressions and crises.

In defending marginal utility economics against these socialist arguments, some economists attempted to justify the marginal productivity theory of wages by arguing that these were the "right" wages, that the existing level of wages is just what wages "ought" to be, etc. However, later economists clarified this point. A marginal productivity theory does not attempt to justify wage levels; it merely tries to explain them.

So much for theory. On the practical side there were two significant developments which had an important bearing on the concept of productivity. One of these, which began about the turn of the century, was the industrial engineering approach of Taylor (and others) with their emphasis on time-and-motion study. Taylor's idea was that, at the bench or the machine, the output of the individual worker could be vastly increased without additional effort. Workers generally characterized this as a "speed up"; but in fairness to Taylor it must be said that he considered this a costless (to the worker) increase in output, and he certainly thought this increase would be reflected in the worker's earnings. However, the important point for us here is that Taylorism implied a physical concept of productivity--labor time was related to quantity of product. It also highlighted the contribution to production of the individual worker--his own productivity.

Some years earlier the government had taken a hand in this matter. Congress, by a joint resolution in 1894, directed the then Commissioner of Labor to investigate and report on:

"the effect of the use of machinery upon labor and the cost of production, the relative productive power of hand and machine labor, the cost of manual and machine power as they are used in the productive industries, and the effect upon wages of the use of machinery operated by women and children; and further, whether changes in the creative cost of products are due to a lack or to a surplus of labor or to the introduction of power machinery."

The survey covered over 60 manufacturing industries as well as representative operations in agriculture, mining, quarrying, and transportation. The analysis consisted of a comparison between (a) the labor time in hours and (b) the labor costs in dollars of the machine methods of the 1890's and the hand methods of a quarter to a half century earlier. The year 1894 was one of depression and unemployment. The intent of the Congress is quite clear--they were concerned about labor displacement by machinery and the substitution of women and children for men workers.

Note that this study measured output in physical terms, relating labor time (and labor costs) to physical output of goods. Furthermore, the comparisons that were made in the study were based upon average or representative performances of firms and industries rather than upon marginal performances.

In subsequent special studies over the next 30 years, the Bureau of Labor Statistics continued to use this type of productivity measurements, namely, relating the output of a given firm or commodity to the man-hours of labor expended on its production. In the middle 1920's a new idea was developed, namely, the making of annual indexes of output per man-hour for an industry or some particular operation. Although the Bureau by that time was using the term "labor productivity" quite freely, it was clearly understood that the term merely meant industrial output expressed as a ratio to labor input.

Furthermore, since current employment statistics in those days covered only production workers, it was the man-hours of these workers which were used for the calculation of annual indexes of output per man-hour. Since the purpose was to measure trends (not levels) of productivity, this limitation was not considered serious. However, since World War II, nonproduction workers, such as office workers and other white-collar workers, have been expanding in practically all manufacturing industries, while production workers have been declining in a good many industries. Therefore, production workers are no longer reasonably representative of trends in the total employment in manufacturing. So at the present time, the Bureau of Labor Statistics, wherever the data permits, is introducing measures of total employment, including both production workers and office workers, in calculating productivity trends.

During the great depression of the 1930's, public attention was centered upon problems of unemployment. This was the time when many people attributed unemployment in large measure to the displacement of men by machines. World War II demonstrated the futility of this theory. It became evident that the unemployment of the 1930's was not due to mechanization as such, but to other causes. Furthermore, it was also clear that the introduction of new technology is a slow process, perhaps quite spectacular in specific productive operations and industries, and very important over a long time span, but small in relation to the total sweep of the American economy over a short period of time.

After World War II some new developments created some additional needs for productivity measurement. One event was the passage of the Employment Act of 1946, through which the Nation expressed its determination to maintain high levels of employment under practically all circumstances. The Act was passed at a time when there was great concern about a possible postwar depression with consequent unemployment of millions of workers. The primary emphasis of the Act was on stability, meaning the elimination, or at least the mitigation, of cycles of prosperity and depression.

As the fear of depression faded with the passage of years, attention shifted to the rate of growth of the economy. The elimination of cycles is in itself a factor making for faster growth, because there is some ground for thinking that alternative swings of prosperity and depression may slow down the growth of the economy to some extent. However, the remaining problem then was, is the economy growing as fast as it could? It was on this

point that there was renewed interest in productivity measurement for the economy as a whole, since productivity is a primary factor in determining the rate of growth. This type of productivity measurement is a global concept, relating the Nation's total output of goods and services to the total labor time expended in production.

Another postwar development was the application of the productivity idea to collective bargaining. In the General Motors agreement with the United Automobile Workers in 1948, the company agreed to pay each year a wage increase based upon technological progress. The wording of the section in the General Motors contract is as follows:

The annual improvement factor provided herein recognizes that a continuing improvement in the standard of living of employees depends upon technological progress, better tools, methods, processes and equipment, and a cooperative attitude on the part of all parties in such progress. It further recognizes the principle that to produce more with the same amount of human effort is a sound economic and social objective.

The word "productivity" is not used, nor is there specific reference to output per man-hour. Neither is there any mention of the rate of increase, the length of the trend, or the scope of the concept.

This brief, historical review does not by any means exhaust the list of the concepts and the measurements of productivity, but it should be sufficient to show how diverse these concepts and uses are. No wonder the term productivity is confusing to both economists and to laymen, and no wonder there are many proposed measures of this factor.

And there are indeed productivity measurements of many different dimensions. At one extreme is the simple measurement of the output of units of product by the individual worker or crew. This is a measure of physical output, but it is directly converted into value for the wage earner by the hourly wage, by the piece rate, or by incentive bonuses. Furthermore, since the machines and the processes are definitely fixed when the wage rates are set, the variations in output can be attributed to the efforts of the individual worker (or the crew). It is not surprising that many workers have firm ideas about the output of goods being directly due to the skill and effort of each individual worker.

The employer looks at this type of productivity measurement in a somewhat different way. He is less interested in such productivity expressed as output per man-hour than he is in the reverse form of expression--man-hours per unit of product. In this way he can measure the amount of labor time required for an operation, and thus can calculate his labor costs, as well as gauge the places where substitution of capital for labor will be profitable.

Management has a continuing interest in reducing costs of operation, including labor costs. Since wages can seldom be cut except in extreme depression, this interest takes the form of trying to reduce the number of men required for the operation, or to increase the output within the same labor time. This is the aspect of labor-management relations which takes the form of disputes over "working rules", "customary work practices", "restriction of output", etc. The complexity of this issue becomes evident

when we consider the many thousands of plants and industries in which local work practices differ. Management's interest is to make changes; labor's interest is to try to control or participate in these changes. But these local conditions can be different, not only among industries but even among plants within the same company.

At an intermediate level we have productivity statistics for an industry, combining or averaging the data for individual firms. However, the more common type of industry data are chronological indexes measuring changes in output per man-hour from year to year. Such indexes can be derived from production data for the industry as a whole, which can be matched with comparable employment data showing the man-hours of work. The result provides an annual index of output per man-hour which can then be computed year after year.

However, industry production indexes can't always be built from physical output figures, which are sometimes so diffuse and variable as to render it difficult to combine them all in an industry-wide figure. When an industry has a single basic product, such as cement, the physical output method is practicable. In many areas, however, where physical output data are not available or adequate, alternative methods such as price deflation of value of output may be used. Another approach to the development of output per man-hour measures involves the deflation of value added by appropriate price indexes. The result gives in constant dollars the net value added from year to year, which is an approximation of the real product. This method (or an

approximation of it) is used in the computation of productivity indexes for groups of industries, for major sectors of the economy, and for the economy as a whole.

The Bureau of Labor Statistics has published within the past year a series of indexes of output per man-hour over the period 1947-58 for the private economy as a whole, for agriculture and nonagriculture separately, and for manufacturing and nonmanufacturing within nonagriculture. These data show that output per man-hour for the total private economy increased at a rate of from 3 to 3½ percent per year on the average.

The range is due mostly to differences in the method of computing man-hours. The Bureau of the Census asks householders to report the hours they actually worked, excluding holidays, vacations, and sick leave; such a report represents the actual time spent at the plant. On the other hand, the Bureau of Labor Statistics asks employers to report the total hours paid for, including payments to employees on leave, vacation, etc. The actual difference between the two man-hour measurements may be due to statistical differences as well as conceptual differences.

Some economists have criticized the Bureau of Labor Statistics for using this "hours paid" concept instead of "hours actually worked"; but our judgment is that both figures are necessary and useful. One of the more important statistical series issued each month is the average hourly earnings of production workers in several hundred industries. If productivity and earnings trends are to be compared, both should be computed on the same

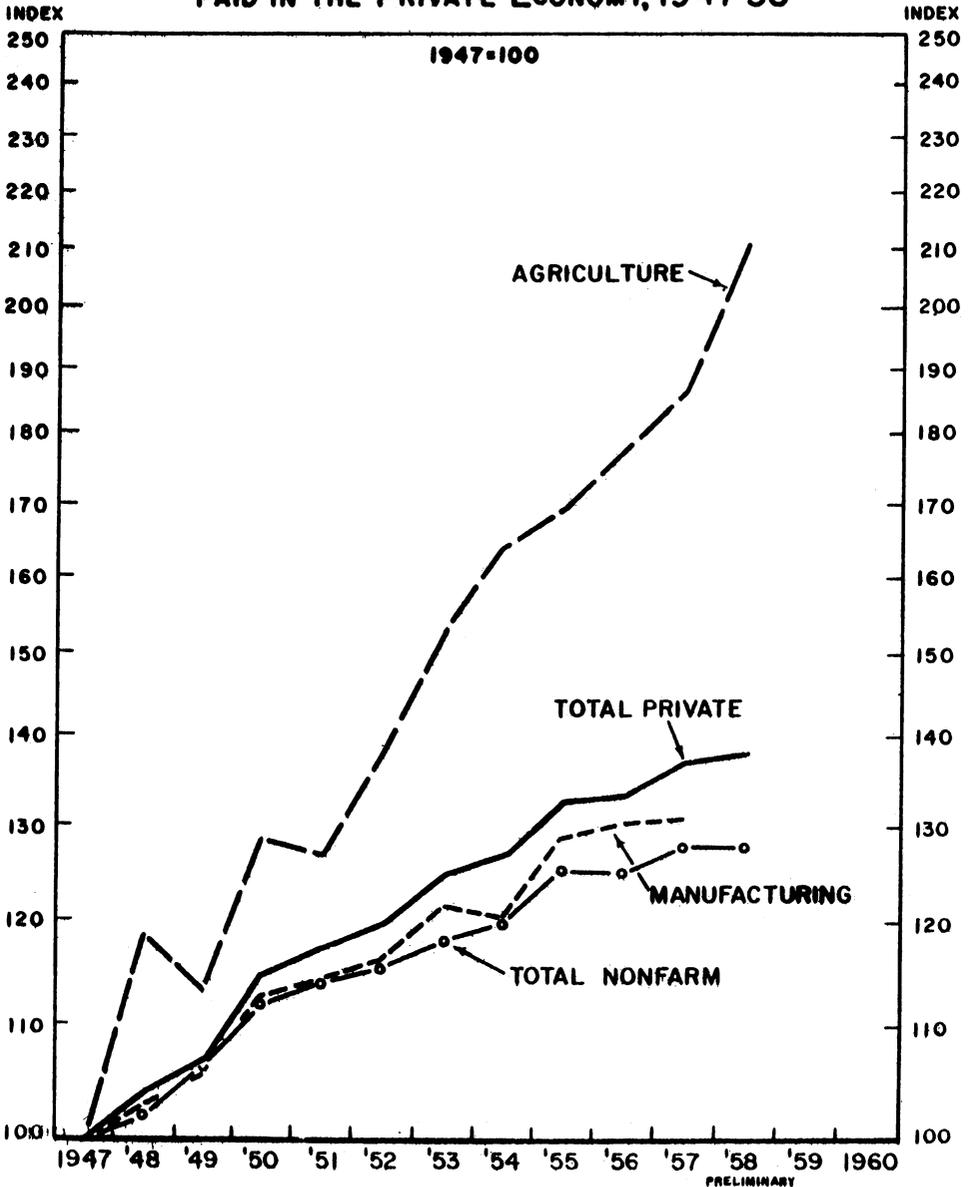
basis. That is to say, "hours paid" should be used in both series--or both should be on an "hours worked" basis.

To return to the trends picture, the sector making the most spectacular progress since World War II is agriculture. (Chart 1) From 1947 to 1958 the output per man-hour in agriculture more than doubled--an annual average rate of increase of 6.2 percent. The high productivity rate for the economy as a whole, during this postwar period, has been due almost entirely to the performance of agriculture, with an average rate of gain more than twice as fast as the entire private nonfarm economy (2.4-2.9 percent per year). Manufacturing averages somewhat higher than the rest of the private nonfarm sector. Among the industries in this nonfarm sector are wholesale and retail trade.

A word of caution is necessary concerning productivity in agriculture. It is true that agriculture has forged far ahead since 1947, but this does not show that the level of productivity on farms is ahead of the level in nonfarm industry. On the contrary, the level of output per man-hour in agriculture has in the longer past been behind that of industry in general, and far behind that of many individual industries. What has happened recently is that agriculture is catching up with industry's productivity levels.

The close connection between productivity and real wages has long been recognized by economists. In the short run, wages can gain at the expense of profits, interest, rent, royalties, taxes or other shares in the total

# INDEXES OF REAL PRODUCT PER MAN-HOUR PAID IN THE PRIVATE ECONOMY, 1947-58



product. Or, in a particular industry or sector of the economy, the workers can obtain real differential advantages in wages over workers in less prosperous industries. But for the economy as a whole in the long run, the general level of real wages tends to rise only as fast as productivity increases. A rising standard of living for a nation is obtained largely from productivity gains.

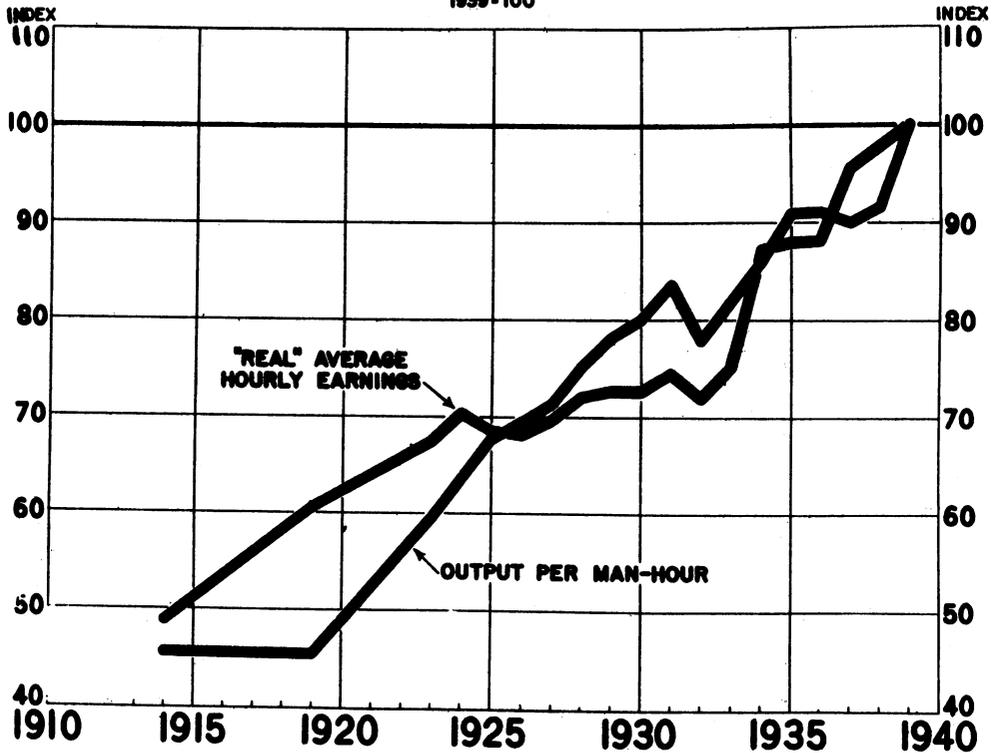
We have two charts which illustrate this point. One shows output per man-hour in manufacturing for the 25-year period, 1914-39, compared to the real earnings of factory workers. Despite all the inadequacies in the data, two points stand out: First, the general trends of the two series are quite similar; but, second, there are wide variations from year to year. Of course, this close correspondence for manufacturing was somewhat fortuitous. A principle which holds for the economy as a whole is not necessarily valid for major sectors. Factory workers might have achieved gains in real wages at the expense of other classes of workers; or conversely, they might have contributed their productivity gains to real wages elsewhere. The chart seems to indicate that they reaped their own productivity gains.

The next chart shows a similar comparison for the period 1947-58. In this case we have used the real product per man-hour for the total private economy and two kinds of real compensation - for the total private economy and for the private nonfarm, that is, excluding farmers' incomes and farm wages. The general correspondence of the productivity and

# OUTPUT PER MAN-HOUR AND "REAL" HOURLY EARNINGS

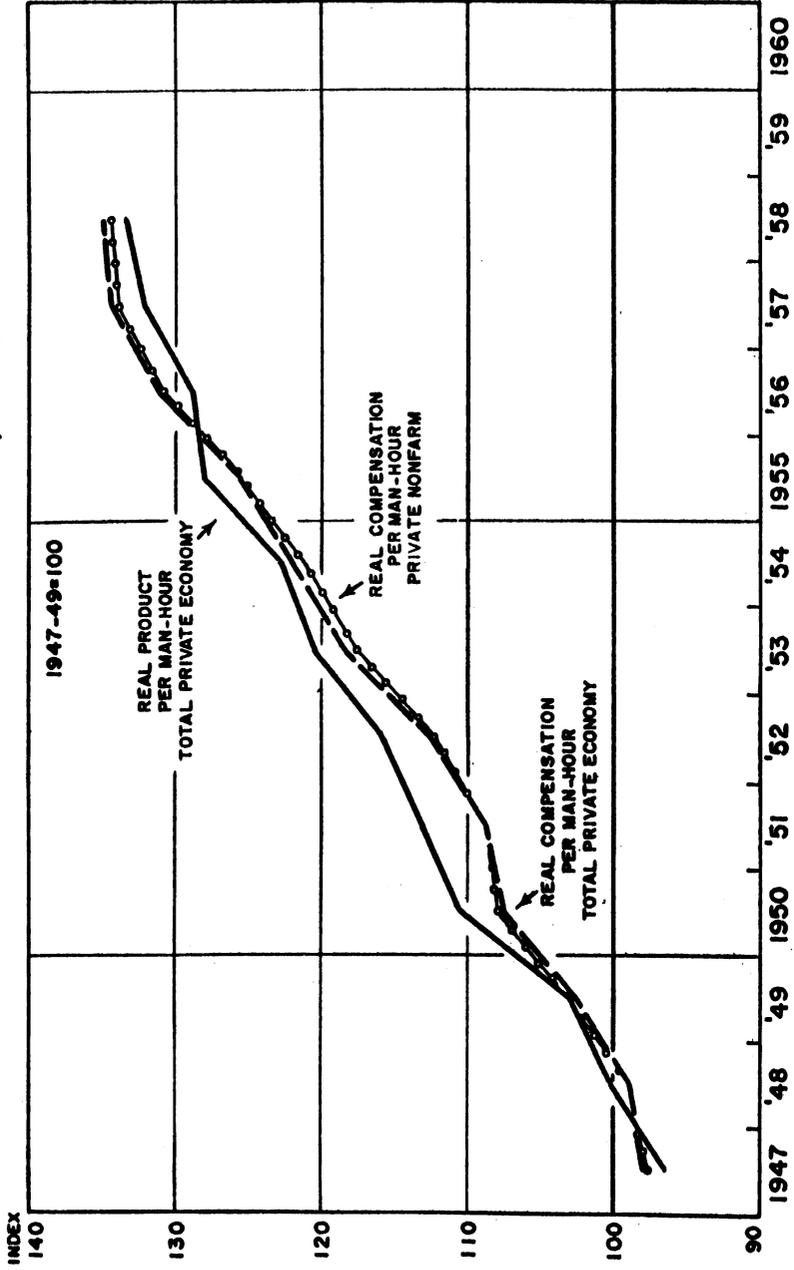
MANUFACTURING 1914-1939

1939 = 100



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**INDEXES OF  
REAL COMPENSATION AND REAL PRODUCT PER HOUR PAID  
THE PRIVATE ECONOMY - TOTAL AND NONFARM, 1947-58\***



\*1958 Preliminary  
Source: U. S. Department of Labor

compensation trends is quite evident. It is equally clear that in the middle years of the period nonlabor factors were getting some benefit from productivity gains, while in recent years real compensation has run ahead of productivity. Over the entire period the change in real compensation per man-hour has been about the same as the increase in overall output per man-hour.

However, this economic truism concerning productivity and real wages does not readily lend itself to statistical measurement, nor does it provide precise policy guidance. What is the long-run trend in productivity for the economy as a whole? Measurements of productivity trends can differ widely, depending on the length of the period of time covered, the specific statistical methods selected, and the uses to which the results are to be put.

Our analysis in this paper has surely demonstrated the multitude of concepts and measures which come under the general term "productivity". Consider how remote from each other are (a) measures of output of individual workers and crews, and (b) a comprehensive measure of trends in output per man-hour for the economy as a whole. It is difficult to connect two such remote ideas in any meaningful way.

This problem has been sharpened during the past decade because of the rapid growth of future or deferred wage increases negotiated through collective bargaining contracts. Mention was made earlier of the General Motors contract of 1948. It is interesting to trace the expansion of this idea since that first contract was negotiated.

This tie-up between productivity and future annual wage increases did not attract much attention at first. In fact, some labor and management groups tended to condemn the General Motors contract. However, when the outbreak in Korea occurred, with price and wage stabilization on the horizon, literally hundreds of contracts were negotiated on this pattern. These were negotiated in the hope and expectation that such contracts would be accepted by a wage stabilization agency (as in fact they later were). In the period of price stability following Korea, some labor groups tended to lose interest in quarterly escalation based on the Consumer Price Index. However, the concept of long-term collective agreements, with annual increases projected several years into the future, continued to grow. So while index escalation declined for several years, productivity escalation increased.

These future or deferred wage increases were not always tied to productivity gains. In the General Motors contract, there was clear recognition of the responsibility of the union to cooperate in bringing about the increases in productivity which would warrant the increases in wages. In many of the new agreements for deferred wage increases there was no such contractual provision; in fact, there was often no indication at all of any connection between the wage increases and productivity.

With the new upward surge of the Consumer Price Index, 1956-1958, there was a renewal of interest in price index escalation, and the number of workers under such escalation increased to new peak levels--about 4.5 million.

At this time, a new factor entered the picture, namely, nationwide concern about the problem of inflation. The doctrine was advanced that wage increases should not exceed productivity increases, for otherwise prices would rise and inflation would continue. Critics of these long-term escalation agreements assigned these contracts a major responsibility for creeping price inflation. However, some studies by the Bureau of Labor Statistics have shown that workers under these contracts have not fared any better over the years than other workers who negotiated annual wage increases without escalation. Then the argument shifted toward a slightly different direction, namely, that wage increases negotiated by strong unions in prosperous industries, perhaps those with high productivity gains, have spread to other industries and occupations less prosperous and perhaps with little or no productivity increases. According to this theory, it is the rapid spread of wage increases throughout the economy which force up labor costs and cause higher prices.

One difficulty with this theory is that we do not have enough information on wages (and salaries) to test the idea. We don't know how fast wage increases spread from industry leaders to the less prosperous industries, to nonunion workers, to salaried office workers and to the different sections of the country. It was for this reason that Congress this year provided funds to the Bureau of Labor Statistics to develop a comprehensive program of wage statistics which would provide answers to some of these questions.

In this discussion there has been no mention of monetary policies or fiscal policies, and their influence on price and wage levels. This omission is deliberate, but it is not because monetary and fiscal factors are considered unimportant. No analysis of inflationary trends would be complete without them. However, this paper is concerned with institutional factors, such as labor-management relations, through which monetary and fiscal policies are injected into the stream of economic life.

At the collective bargaining table, or in the unilateral wage determinations by nonunion employers, these overall national policies seem very remote, and seldom have much to do with the specific decisions of workers or employers. This paper is directed toward this latter aspect of the problem.

The interaction of the debate on inflation from the viewpoint of national economic policies with the labor-management negotiations at company or industry levels has further confused the relationships between productivity, prices and wages. What are the actual productivity gains to which reference is made? Do they refer to productivity of the nation as a whole, or the industry, or the firm for which the contract is being negotiated? From the point of view of the worker, the productivity which he sees is that in his own plant or in his own work. But it is quite clear that wages throughout the nation cannot be determined on the basis of the productivity of the plant or industry. Over the last 11 years (1947-1958), the productivity in agriculture has more than doubled. At

the same time, there are other industries in which there has been scarcely any gain at all. Should agricultural wages therefore be doubled, while in these other industries they should not be increased at all? This next chart shows the extreme variation which occurred in the man-hour outputs of 34 manufacturing industries in the seven-year period, 1919-26. The wage changes in these industries during that period showed no such variation.

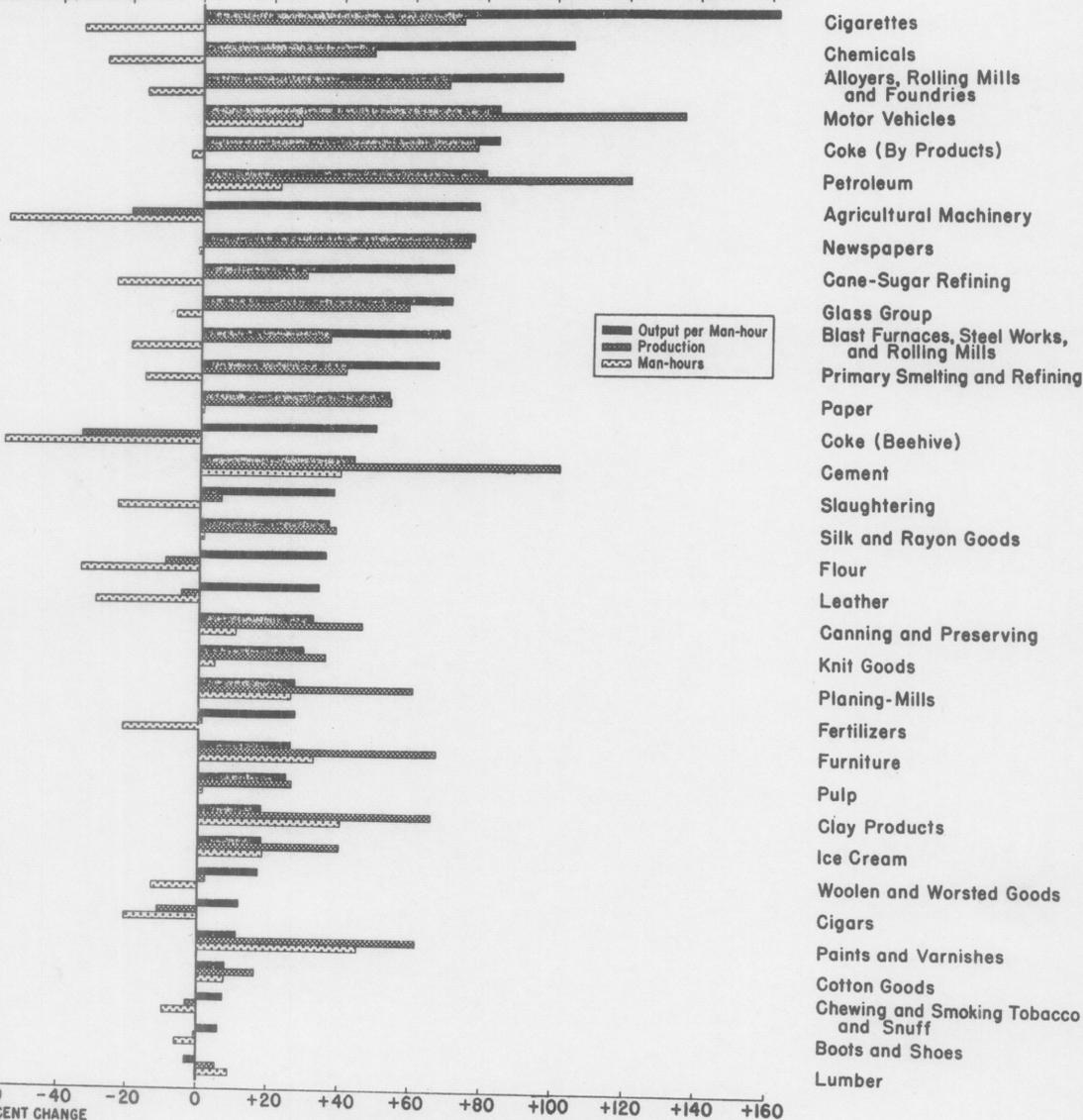
It is quite obvious that plant or industry productivity does not govern wages. A much more potent factor is the competitive relationship of jobs and occupations in the labor market. Workers with the same skill or occupation try hard to get the same wage, whether they are working in a prosperous industry or a declining one. Agricultural wages and farmers' incomes have shown some gains as a result of the high productivity during the last decade, but the biggest factor in that productivity has been the decline in the number of farmers and farm workers. These have shifted from agriculture to other industries where wages were higher. In other words, productivity has been accompanied by the elimination of jobs.

If productivity in the individual plant or industry is not the right measure, then perhaps it is the average productivity of the economy as a whole which counts. This means that the average wage (and salary) gains in a given year would not be higher than the average productivity gain for that year.

# PERCENT CHANGE IN OUTPUT PER MAN-HOUR, PRODUCTION, AND MAN-HOURS, 1919-1926

## 34 MANUFACTURING INDUSTRIES

PERCENT CHANGE  
-60 -40 -20 0 +20 +40 +60 +80 +100 +120 +140 +160



One difficulty here is that productivity gains do not rise in a smooth trend. In some years, the figures are quite spectacular, but in succeeding years they may be rather small. In 1950, as compared with 1949, the gain was about 6 percent; likewise in 1955. But in 1956-58, the gains were less than 2 percent per year. It is quite clear that the close relationship between productivity and real wages grows out of general trends and does not reflect annual fluctuations.

The other statistical problem is the measurement of the wage and salary increases which are to be matched with productivity. The actual statistics which are most widely available are average hourly earnings in several hundred industries, but these constitute only the most general approximation of wage changes. The average earnings can be influenced by changes in the composition of the labor force. For example, the elimination of some unskilled occupations and an increase in the skilled could cause the average hourly earnings for a firm or industry to rise, even though there had been no change in the wage rates for either of these groups. (Of course, under some circumstances the reverse actually happens, namely, average hourly earnings decrease because of a decline in the highly-paid skilled workers.)

But even if average hourly earnings were acceptable as a crude measure of wage rates, they are not a true indicator of total labor payments by the employer. In addition to cash wages, many workers in recent years have received extensive fringe benefits, such as pensions, holidays with pay, sick

leave, etc. These fringes constitute actual costs to the employer. However, no adequate statistics on the extent of these fringe benefits, industry by industry, are available. It was for this reason that the Bureau of Labor Statistics was authorized this past year to undertake detailed studies of the extent and volume of these benefits. In some industries the employer costs of these benefits are quite substantial. In relating productivity to wages, therefore, these must be added to the average hourly earnings or to the cash wage rates.

Then there is still another factor which must be taken into account in comparing productivity and wages. That is the effect of shifts of manpower from one industry or occupation to another. When a low-wage worker, such as a farm sharecropper, leaves the farm and finds a job in industry, he produces gains in both productivity and wages by the shift. Since he is moving from a low-productivity industry to a high-productivity industry, the productivity figures for the nation as a whole will show an increase. However, at the same time, he moves from lower wages to higher wages, thereby raising the average income of the community. It is the shift itself which produces both gains.

Now to conclude. Surely this review of productivity statistics amply demonstrates the problems faced by labor and management, by economic analysts, by government policy makers and by the general public in trying to make use of this vital, dynamic factor in our economy, namely, productivity. It is to be hoped that the statisticians will be able to develop more and better

information on the various forms of productivity, and that the economists will multiply their efforts to analyze and clarify the relationship of productivity to prices, wages, the standard of living, and the Nation's economic growth.