Productivity (1953)

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YARDSTICKS OF PRODUCTIVITY AND THE USE OF THE PRODUCTIVITY CONCEPT IN INDUSTRY

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U.S. Department of Labor

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One of the major problems we encounter in talking about productivity is the very loose meaning of the term itself. Productivity is not a single concept, but a whole complex of concepts which have some points in common, but also many points of difference. Expressed in the most abstract terms, productivity is a relationship between an input and an output. However, there are a variety of input factors which could be used as a base for measurement, if we wished to use them. Likewise, output can be measured in a variety of ways, each of which may have significance for certain purposes, though they may differ quite widely in quantitative terms.

The economists, who first coined the term, applied it to all inputs. They could talk about the marginal productivity of labor, of capital, of land, or of management functions. In our practical everyday attempts to measure productivity, we could do the same thing. However, the input factor which has generally been most significant for general economic purposes is the labor input. There are a number of reasons for this. The labor input is the largest of all the factors, since wages comprise, in the economy as a whole, about two-thirds of all money payments. Furthermore, labor has a high degree of variability in brains, skills and potentiality. Finally, labor, in the person of the worker, is not only a factor in production, but is also a final consumer; so productivity is of interest to society as a whole as well as to industry which produces the Nation's output.

Viewed in its broadest sense therefore, productivity is one of the great dynamic factors in any economic system. It measures, if satisfactory measures can be devised, the technological progress of the Nation's productive organization, and it gauges fairly accurately the rise in the standard of living of the whole people.

Productivity measurement takes on many different forms. At one extreme we can attempt to measure the output of a single worker at his bench, relating his input of time and skill to the product which he is shaping or making. This is the area of time-and-motion study, an area which has been studied for many years by engineers and other professions. Work in this field is going on all the time, but there is no way to produce any kind of summation of results which could be used for general economic purposes.

Moving to a broader level, studies can be made of the productivity of a given plant, treating the output of that plant as a unit and summing up all the labor time which has been used in achieving the plant's production. Sometimes, for purposes of simplicity, it is possible to select certain

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products of the plant and then to calculate by accounting methods the man-hours required on those particular products. If these are reasonably representative of the productivity performance throughout the plant, such a simplified input-output measurement might be used to gauge the plant's productivity changes from one period to the next.

We can then broaden the scope of productivity measurement still more and attempt to gauge the progress of a whole industry, including a large number of different plants and companies. Such industry-wide summations are more a matter of general economic significance and somewhat less a matter of concern to the individual company (except insofar as the company is concerned with the comparison of its own status with the industry as a whole).

We can go still further and attempt to summarize productivity for groups of industries, such as all manufacturing industries or various non-manufacturing groups yielding productivity measurements for broad segments of the economy.

Finally, of course, we can attempt to obtain a measurement of the productivity of the entire economy of the Nation. This, as I indicated above, is in a certain sense a measure of the technological progress of the economy and the gauge of the standard of living which that economy will yield to its people. Even this over-all measurement can be done in different ways. By one method, it can be built up by summing up in physical terms the entire output of the economy. By the other method, we can take the gross national product of the economy, as measured in dollar terms, and deflate this figure by the use of indexes of price changes.

While productivity measurement has such a widely varying scope, ranging from a work bench to the economy as a whole, the problem of measurement in all these cases has a common foundation, namely, data on output in all its forms and data on labor input. The statisticians who are attempting to devise the broader economic measures of productivity can only build on the detailed work which is done within the company or the plant.

Productivity Measurement from a Plant or Company Viewpoint

These measurements are being made all the time by cost accountants, engineers, and methods personnel in plants all over the country. A researcher in this subject, Mr. Irving Siegel, recently stated that "Productivity still plays its most vital role under assumed names in the countless calculations and decisions in the sprawling, decentralized, profit-motivated business community."

Over recent years there has been an extremely large increase in the amount of record-keeping and accounting done by industrial establishments. Most of this has been to record such data as will help the company increase output and reduce the input or costs of the productive processes. These operating records of work performance are, of course, basic parts of productivity measurement. This huge increase in record-keeping is implied in a report by the American Institute of Accountants which shows that the number of certified public accountants has more than doubled from 1940 to 1951, and in another report by the National Association of Cost Accountants it is stated

that their membership, who are by training and experience particularly adaptable to productivity measurement, has about doubled since the beginning of World War II. The expense of constructing and maintaining detailed records of performance and costs has been enormously reduced over the past ten years by the widespread use of office machines which increased the productivity of the accountants who measure it. In 1947 shipments of accounting and bookkeeping machines were three times as great as in 1939; shipments of adding machines two-and-a-half times as great over the same period.

Since virtually all labor cost records are derived from man-hour data, there should be no major difficulties in using the basic man-hour data as another form of cost analysis. Examining hours separately, and before translation into dollar terms, permits a plant to avoid changes in the dollar which has been vulnerable, even in short periods, to the workings of inflation or deflation. There has actually been a movement in the past few years among a number of plants to keep some records and make some analysis, using man-hours as a basic item. Many people are gaining a better understanding of the vital potential contained in an hour of work, and how the proper use of this potential can give a competitive advantage to the user.

Let us take a group of plants manufacturing the same product. Generally speaking, the prices they pay for raw materials, power and labor will not vary much from plant to plant. Consequently, there is very little chance for the individual plant to attain cost advantages via any of these basic items. When such advantages do exist because of particular location or other fortunate circumstance, usually they can be maintained only for the short run and eventually disappear. The individual plant's biggest opportunity for competitive advantages lies in the vital potential of an hour's work. What is actually accomplished in a man-hour varies widely from plant to plant within our hypothetical industry, as it does in all industries which comprise our economy.

Chart 1 shows the net changes over a 7-year period, 1939-1946, of the man-hours of work required per unit of product in the manufacture of leather. Expressed in these terms, low man-hours represent high productivity. Note that there were two plants whose unit man-hour index dropped to nearly 50, which means almost a doubling of productivity. There were two others with a man-hour requirement of 75. Yet note that in the same industry there was a plant with an index of nearly 150--a loss in productivity of nearly one-third.

Chart 2 shows the wide variation in productivity which can exist within an industry at the same period of time. This chart shows the plants classified into four groups, from the lowest to the highest man-hours per unit. Note that in men's work shirts (per dozen) the lowest group had an average of 3.5 man-hours, while the highest averaged 6.4 man-hours--nearly double the lowest. The range for individual plants would, of course, be even greater since some of the lowest were below 3.5 and some of the highest were above 6.4.

A still wider range is shown in gray iron foundries, where the highest group is nearly four times the lowest. In all of these industries and particularly in foundries, allowance should be made for the fact that products are not identical and perhaps some of the divergence is due to this factor.

With respect to men's dress shoes, the range from the lowest to the highest is definitely less than in the other industries shown. There is an interesting point for study here, namely, why the range of productivity is greater in some industries than in others. Another question might be, why do low productivity plants with large amounts of labor continue to survive in the industry? It may be that these wide divergences become possible during periods of inflation when practically all products of the economy are in heavy demand. In a more vigorous competitive situation, it is probable that the low productivity plants with the high labor costs would be forced out of business, if they did not take steps to improve their efficiency.

Some companies with advanced accounting systems have not only recognized the value of analysis in terms of man-hours, but have actually designed departmental budgets in man-hour terms alone. A departmental foreman is shown the number of budgeted hours allowed him for the coming months for a given amount of production, and in many cases finds this concept easier to work with than earlier budgets which were shown in dollar terms only.

In trying to show you why productivity measurement at the plant level is now at the threshold of acceptance by the business community, it is not sufficient to say that this has resulted alone from the increase in record-keeping, accountants, and office machinery. Contributing very largely to this development has been the phenomenal growth of the number of trained management personnel. For example, there were 72,000 degrees awarded in business and commerce subjects in 1950, five times as many as in 1920. In the case of engineers, the Washington Post stated recently that "Fifty years ago American industry employed one engineer to every 250 production workers." Contrast this with a recent announcement by the General Electric Company stating "Today, out of General Electric's 226,000 employees, one in 20 is an engineer." This new rising group of trained persons has brought to the industrial scene an enormous stimulus toward progressive management practices including the measurement of productivity at the plant level. They with their counterparts in the accounting and record-keeping offices realize full well the vital potential contained in an hour's work, and are emphasizing for us already the question of why measure productivity at the plant level.

Industry Uses of Productivity

One of the uses which industry makes of the productivity concept is in the various cost control systems in effect today. Time-and-motion study to establish standard performance rates in industry is, at the operational level, definitely a partial measure of productivity. This partial measure is generally translated into dollar terms and accumulated for the individual departments in a plant to serve as a control of operations for the departments. From this control record, plant management can observe the plus or

minus variances of a department from a predetermined standard of performance. Also they can determine these same variances in the manufacture of a single product or a group of products. In a large sense, this information is used primarily to construct costs for individual products.

Time study alone, however, does not in the full sense measure plant productivity, because it generally neglects the indirect labor functions. Chart 3 shows the extent to which indirect labor costs affected productivity in a number of industries during the war and postwar periods, 1939-48. In a general way, direct labor costs were being reduced, but indirect costs tended to rise. This is not a surprising development. In fact, it may represent the normal method of improving productivity.

There has been a growth in recent years of plans which are somewhat more comprehensive than simple time study. These are the types represented by the Scanlon Plan, which is designed to bring the workers in the plant (and their union organizations) into the project for increasing output by saving labor time. Other examples are the Eddy-Rucker Plan, the Lincoln Electric Plan, and others. There is no doubt about the fact that with the rapid growth of trade unionism in recent decades, Labor is becoming, like Industry, much more conscious of the productivity concept. Worker cooperation is absolutely essential if the maximum level of productivity is to be obtained.

Interest by business enterprises in productivity is by no means limited to the analysis of man-hour input alone. Indications have come to the Bureau of much sound work being carried on by industrial economists in an attempt to establish practical techniques which would include materials, supplies, power, and plant charges in the productivity equation. Such charges are generally included in the plant-wide plans noted earlier. A recent panel session of the National Conference on Productivity was devoted to "Experiments in Measuring Productivity at the Plant Level." Notable among the papers presented at this conference were statements by representatives of Johnson and Johnson, New Brunswick, New Jersey, and E. I. du Pont de Nemours and Company, Wilmington, Delaware. Of course, I might mention the authors of the papers which are being presented at this conference, who are also presenting illustrations of company use of productivity data.

A few years ago the Bureau of Labor Statistics made a study to determine how productivity data were being used in American plants. Forty manufacturing firms and 15 industry associations were interviewed and asked about their use of our Bureau data on productivity. All of the companies stated that the productivity data were used as a reference point for comparison with company performance. Ninety percent of the companies used the published reports for discussion or training purposes. Sixty-five percent of the respondents used the data in periodic reevaluation of job ratings, work standards, and production operations. Fifteen percent used the data to develop more accurate estimates of future production and potential production capacity.

Productivity from a National Point of View

For more than a half century there has been a general interest in productivity measurement from the point of view of the economy as a whole

or of major segments of it. Back in the 1890's, soon after the organization of the Bureau of Labor Statistics, the Congress authorized a major survey of productivity. The Bureau conducted surveys over a period of several years and published a 2-volume work entitled "Hand and Machine Labor," which is one of the great landmarks in the history of productivity measurement. Commissioner Wright and his staff prepared direct comparisons of the man-hours of labor required under the hand processes of 1850 and the machine production of 1890. This study showed the extent to which machine operations had come to dominate American industrial production.

Occasionally thereafter the Bureau of Labor Statistics made special studies in particular industries, such as the comprehensive study of productivity in longshoring made by Boris Stern in the middle 1920's and the historical survey of productivity in merchant blast furnaces covering the period 1911-1926. Then beginning in the middle 1920's the Bureau began preparing another type of measurement, namely, a year-to-year series of indexes of productivity for individual industries. These were later combined to make a general index for manufacturing industries as a whole, but this was as far as that type of measurement was carried at that time. The dislocations of World War II prevented continuation of the manufacturing index. Efforts in this field were renewed in the postwar period, and at present the Bureau is working on a restoration of the manufacturing index. The war years will necessarily have to be skipped, but we hope to build a bridge from 1939 to 1947, and continue with yearly indexes since that time.

During the period 1946-51 the Bureau also introduced the system of measurement known as "Direct Productivity Reports." This was for use in industries where it was extremely difficult to devise simple measures of production for the industry as a whole. Instead of trying to obtain an index of total production for the industry and relating that to the total man-hours of work, an effort was made to measure the output of one or more specific products, against which the required man-hours were measured by accounting and statistical processes. This method has the advantage of making it possible to get a more accurate measure of output from year to year, but it involves more effort in determining the approximate man-hours to be matched with the production. This type of study had a further advantage of yielding data for individual plants, so that it was possible to measure variations in productivity from one plant to another within the same industry and for substantially the same product. Some of the charts which we have used are based upon this type of study.

The Direct Productivity Reports have another disadvantage, namely, they are much more expensive to conduct because more field work and special data collection are required. Budget stringencies have compelled us to reduce this type of work during the past few years so that at present very little of it survives.

We are now centering our attention upon group indexes on the basis of secondary data. One of the most difficult problems in devising these general measures of productivity is the construction of satisfactory indexes of output. These have been built up by adding together all significant items of production on a physical basis by the use of a system of weights. There is another type of approach which takes the total dollar value of the

production of an industry and then attempts to cancel out the influence of price changes by means of price indexes used as deflators. Mr. Kendrick of the Department of Commerce, a year or so ago, published a productivity index for the economy as a whole based on this method of calculation. The Bureau of Labor Statistics in its present program is preparing indexes for the manufacturing sector of the economy, based on both physical volume and dollar volume of production.

From the point of view of industry, what is the shape and meaning of our increasing technology? I should like to review briefly some points that may be of interest to you. From 1946 to 1952 private purchases of durable producers goods, machinery and equipment exclusive of plant buildings, grew almost continuously as measured in constant dollars. Many of us often think of the prosperous year of 1929 as a high point in investment in technology. In constant dollar terms, the 1929 private purchases of producers goods amounted to $6.4 billion. Compare this with the year 1946, which showed purchases of $10 billion and our last available data, 1952, which shows private investment of this type amounting to $13.6 billion, all in comparable dollars.

Clearly, our national plant and equipment was and is being subjected to a refurnishing of major proportions. Plant level productivity measurement during such a time can identify the effects of new equipment, time lags in extracting and producing raw materials to keep pace with the new equipment, problems of training personnel, need for additional supervisors, and most important, perhaps, during this period, the need for carefully delineating the direct production workers from the growing number of indirect workers. Our efforts in this field have disclosed that as equipment and machinery are taken into an industry in large numbers, the group of indirect workers, i.e. technicians, set-up men, maintenance personnel foreman, and others also increase materially.

PRIVATE PURCHASES OF DURABLE PRODUCERS GOODS

(In billions of constant 1939 dollars)

1929	6.4	1948	12.5
1934	2.5	1949	11.5
1941	7.6	1950	13.3
1946	10.0	1951	13.4
1947	12.0	1952	13.6

Source: Bureau of the Census
U.S. Department of Commerce

Measurement of productivity over these postwar years, marked by expanding technology, can be interpreted in a large degree in the light of the new machines and equipment entering American plants. Our studies have

shown that over a period of years technology is the principal factor affecting productivity. (See Chart 4.)

A dramatic example of the effects of a technological change is shown in the Bureau's recent Factory Performance study in the men's shoe industry. Here a group of plants using the automatic toe-lasting machine are compared with another group of plants using an older model toe-lasting machine. The plants using the older model were toe-lasting from 180 to 316 pairs per man-day, while those with the automatic machine ranged from 427 to 702 pairs per man-day at this operation.

We have found that from year to year the most important factor affecting productivity, in general, is the change in volume of production--high volume is accompanied by maximum capacity utilization with consequent gains in productivity. Of course, at the same time radical changes may occur in individual plants as a result of technological advance or product redesign. Only now are we beginning to bring together a sufficient number of observations at the plant level in order to assess the effect of all of these factors upon the productivity level of industry. Chart 5 shows in a very dramatic fashion the way in which productivity in a group of plants in one industry changed from one period of time to the next. It is obvious that some one variable was quite controlling in this history. The variable in this case was volume of production.

I mentioned earlier the fact that Industry and Labor have been taking an increasing interest in recent years in productivity measurement. This arises partly out of the general recognition that productivity, real wages and the standard of living of the American people are basically derived from the growth of technical progress and the rise in productivity. Chart 6 shows the extent to which the real average hourly earnings of workers in manufacturing industries in the quarter century, 1914-1939, was correlated with the rise in output per man-hour in manufacturing. It is quite clear from the chart that the two curves may vary quite widely from one year to another or even at different phases of the business cycle, but the long-run trend is unmistakable. The long-run rise in real wages in the United States has been sustained by productivity increases; in the long run, real wages cannot increase faster than productivity, nor, on the other hand, can they fall too far behind.

These two curves also have another interrelationship. The pressure of rising wage rates on the employer undoubtedly contribute to the mechanization of industry and management efforts to save labor time.

Some International Comparisons

Other countries, besides our own, have in recent years become interested in the measurement of productivity. In Great Britain, in the late 1930's, Mr. L. Rostas, an economist in the British Government, made some rough measures of the comparative output per man-hour in British industry as compared to the comparable output in American industry. He arrived at the conclusion that in many American industries the rate of output was twice and even three times that in the comparable British industry. At the same time, there were a few British industries which had approximately equal productivity to the American.

In the postwar period, European countries were greatly concerned about first restoring their prewar levels of production and then moving forward in an industrial expansion. To achieve this under conditions of full employment was only possible through increased productivity. The United States also had a great stake in European industrial recovery, and we expressed this interest through the Economic Cooperation Administration, which later became the Mutual Security Agency, and is now the Foreign Operations Administration. Along side of the active cooperation of Government, management and labor in the United States and in European countries in achieving productivity increases in Europe, there developed a cooperation in the measurement of productivity. The Bureau of Labor Statistics has had an active part in this program of measurement.

One program, which the Bureau of Labor Statistics has conducted with the support of ECA-MSA-FOA is the Factory Performance Reports. These are detailed case studies of manufacturing operations in individual American plants, designed primarily for use in Europe. In this program we collect in full detail information which yields man-hours per unit required to make a given product, for a plant as a whole, for each department, and for each important operation. These data are supplemented by a description of each plant's equipment, layout, manpower, materials handling methods, and other similar plant characteristics. I need hardly add that in these case studies, as with all our Bureau reports, the identity of the individual plant is zealously safeguarded.

I might mention the fact that many American companies have been quite interested in these reports, even though they were not primarily designed for American use. The plants covered in the reports do not necessarily represent a cross-section of American industry, since the ones chosen were those which would most closely correspond in size with plants existing in European countries. As a matter of fact, they are probably somewhat more efficient than the average plant in the industry studied.

European plant managers can use these reports very effectively for identifying areas of low productivity and for providing guides for further action. Of course, at some point the services of trained managers or engineers must be brought in, since the reports do not go into the details of how to operate a plant.

Now we are just beginning to get from Europe similar types of studies to these Factory Performance Reports. These are studies made by European statisticians in their own countries and on a comparable basis. For example, the French Productivity Center has recently completed a study of output per man-hour in certain men's shoe plants in France, plants most nearly similar to the American plants shown in our Bureau study of factory performance in the United States. The lower level of French productivity is clearly portrayed by the fact that output per man-hour in the most efficient French plants was less than that in the least efficient American plants. French industry is using these studies as a guide to the methods of increasing productivity in France.

Just recently I received from England a reprint of a study of labor productivity in cotton spinning in the British Isles. This is a reprint from the Journal of the Royal Statistical Society. The study was conducted by L. H. C. Tippett and P. D. Vincent. Studies like this have been conducted by the cotton spinning industry in Great Britain for some years. Some of you who have statistical training may be interested in seeing the comprehensive statistical methods which were used in this most recent study.

I can hardly pass Great Britain without mentioning the work done by the Anglo-American Productivity Council which operated for about five years in this postwar period. A new book by Graham-Hutton (We Too Can Prosper) has just been published summarizing the British-American comparisons of productivity which grew out of the exchanges of British and American Industry Teams in recent years. I should also mention that the British Institute of Management has reprinted for distribution to British industry a number of our Bureau's Factory Performance Reports.

Last of all, we cannot discuss productivity on an international basis without mentioning Soviet Russia. Soviet statistics are characterized by their extreme scarcity and their general unreliability. Nevertheless, we statisticians have to do the best we can in endeavoring to discover what goes on in that vast world behind the Iron Curtain.

The Bureau of Labor Statistics, on a number of occasions recently, has made some rough estimates of the working time required by the Russian workers to buy food and some other consumer goods. We simply compare our estimates of money wages with such information as we can gather on consumer goods prices in the Soviet economy. The results, which are probably familiar to you, show that the Russian worker takes two, three and on up to even more than twenty times as long to earn the money required to buy a certain article as does the average worker in the United States. There is no doubt about the fact that the Soviet production of consumer goods is very low and that the Russian standard of living is below that of even the poorer countries of Western Europe.

These findings dramatize the results of the Soviet policy in the postwar period. There seems to be little doubt about the fact that the leaders have restricted the output of consumer goods to the lowest level acceptable to the Russian people. In fact, there is good reason to believe that some of the unrest behind the Iron Curtain is due to the fact that this low level has strained the Russian people to the breaking point. Certainly the Satellite peoples show plenty of evidence of this same strain. Whether the new economic policies announced after Stalin's death by Malenkov and other Communist leaders will actually improve the consumers' situation remains to be seen.

However, on the other side of the coin is the fact that the Soviets have been pushing the output of capital goods and the expansion of industry with a view to the longer future. Professor Galenson (formerly of Harvard University, now of the University of California) has shown that Russian statistics claim an average rate of productivity growth of over 13 percent per year for the period 1946 to 1950. Later Soviet reports indicate that the rate of productivity rise has declined appreciably since that period, to an annual

rate of 6 percent in 1952. Even so, the Russian figures seem spectacular, particularly considering the fact that the long-run average in the United States is only about 3 percent per year.

Of course, three points must be borne in mind. The first is that Soviet industry was almost totally destroyed in certain sections of the countr during the war, and so 1946 represented a very low level of productivity from which to start. The second, and perhaps more important point, is that large-scale industrialization was still in an early stage even before the war, and that the level of productivity at this time had nowhere near reached the Western level. This point is well developed by Irving Siegel in the Journal of the American Statistical Association for March 1953. The third fact is, as I said before, that Russian statistics (at least as published for the outside world) are quite unreliable and should be taken with more than one grain of salt.

Nevertheless, we cannot laugh off the fact that the tremendous drive of the Soviet leaders has been directed to the longer future. In the short run, they have starved the Russian people in consumer goods in order to expand their factories and capital equipment. The proportion of national income in Russia which is turned back into the creation of new capital goods is certainly tremendously higher than it is in the United States. This means that, even allowing for all the known and unknown inefficiencies of the Communist system of production, the industrial potential of Soviet Russia may be gaining on the United States.

It may be that the Russian threat will not take the form of World War III in the near or intermediate future, but rather the form of a race for production--a build-up of the industrial potential of their economy. If that is the case, the United States cannot ignore the importance of increasing productivity in this country. Can we maintain the tremendous productivity lead which we now have, or at least keep well ahead of any Russian expansion? The answer to this question may be vital to our survival. It is for this reason that it is important for the American people to keep productivity at the forefront of our thinking, and to devise measures which will keep us informed as to its progress.

CHART 1.

PLANT DIVERGENCE OF TOTAL FACTORY MAN-HOURS PER UNIT FOR THE MANUFACTURE OF LEATHER

1939=100

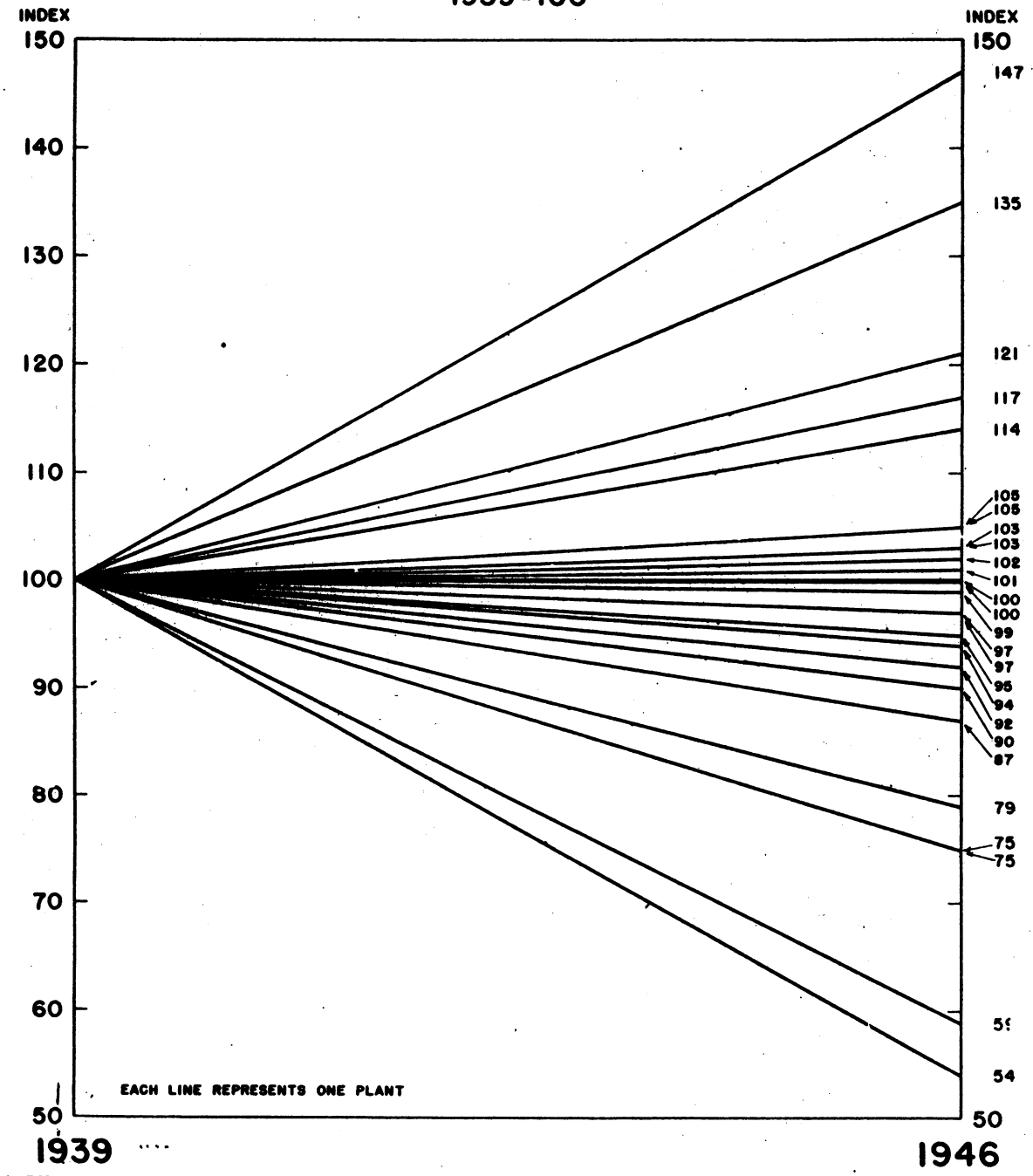

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CHART 2.

AVERAGES OF MAN-HOURS PER UNIT OF OUTPUT
FOUR SELECTED INDUSTRIES, 1949

Plants Classified into Four Groups from Lowest to Highest Man-Hours Per Unit

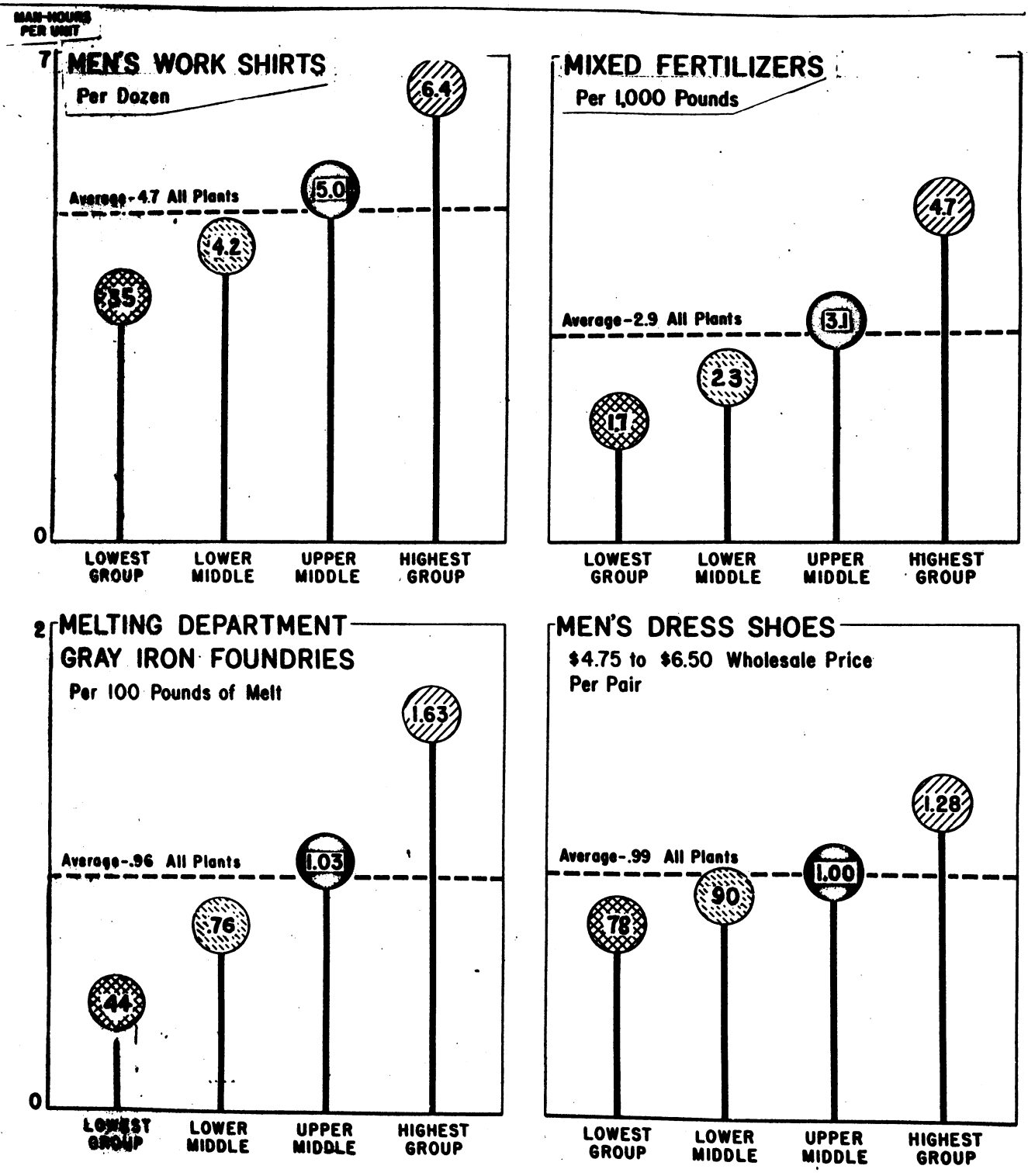

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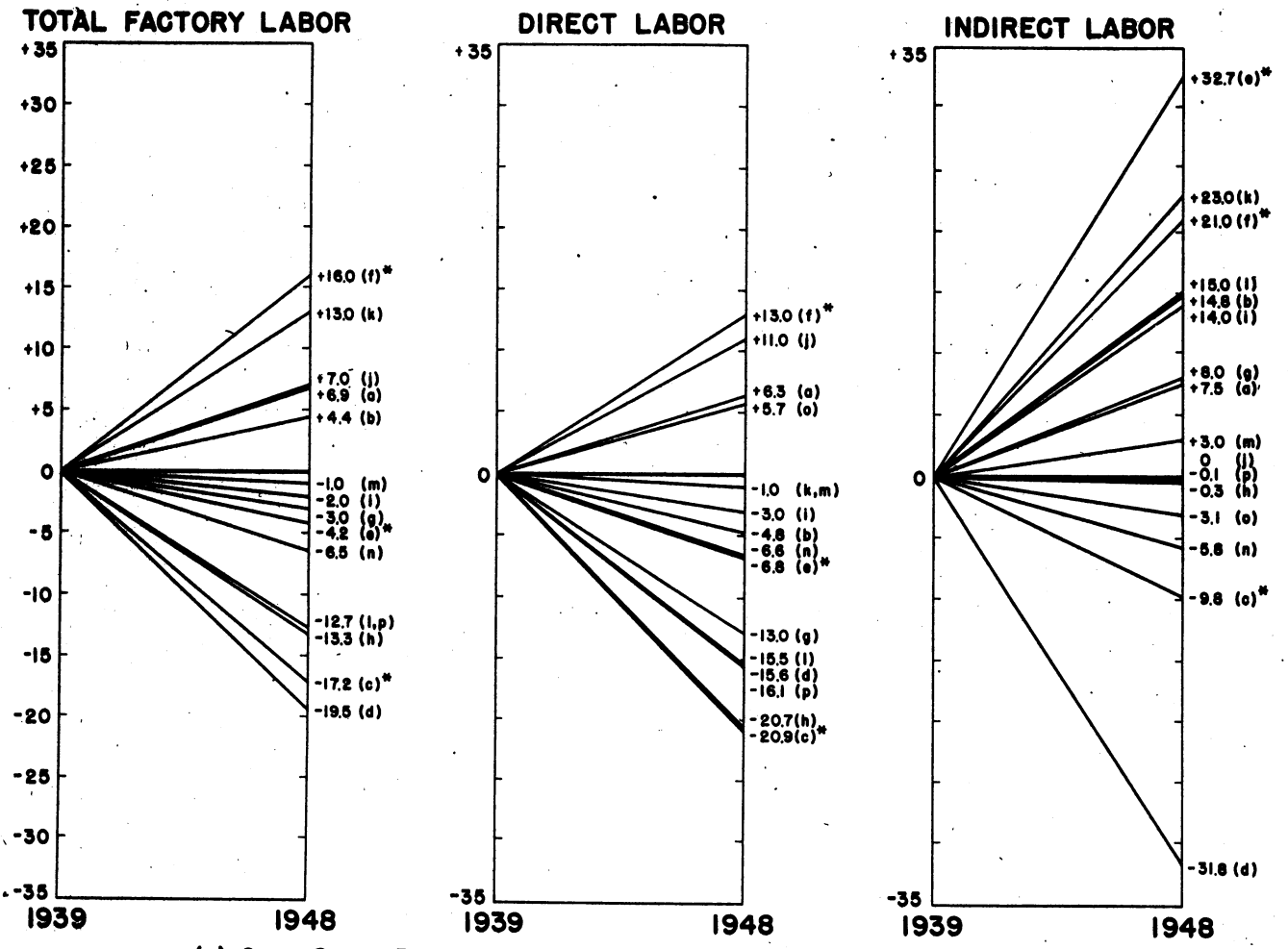
CHART 3.

PERCENT CHANGES IN MAN-HOURS EXPENDED PER UNIT

1939-48



(a) Cane Sugar Refining
(b) Construction Machinery
(c) Electrical Equipment and Supplies
(d) Fertilizer
(e) Footwear
(f) Home Radio Receivers
(g) Household Electrical Appliances
(h) Industrial Equipment
(i) Leather
(j) Luggage
(k) Machine Tools
(l) Men's Dress Shirts
(m) Metal-forming Equipment
(n) Mining Machinery
(o) Soap and Glycerin
(p) Railroad Freight Cars

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*INDEX FIGURE BASED ON 1947 DATA

CHART 4.

UNIT MAN-HOUR TRENDS

PLANTS IMPROVING EQUIPMENT, LAYOUT, AND METHODS
PLANTS MAKING NO IMPROVEMENTS

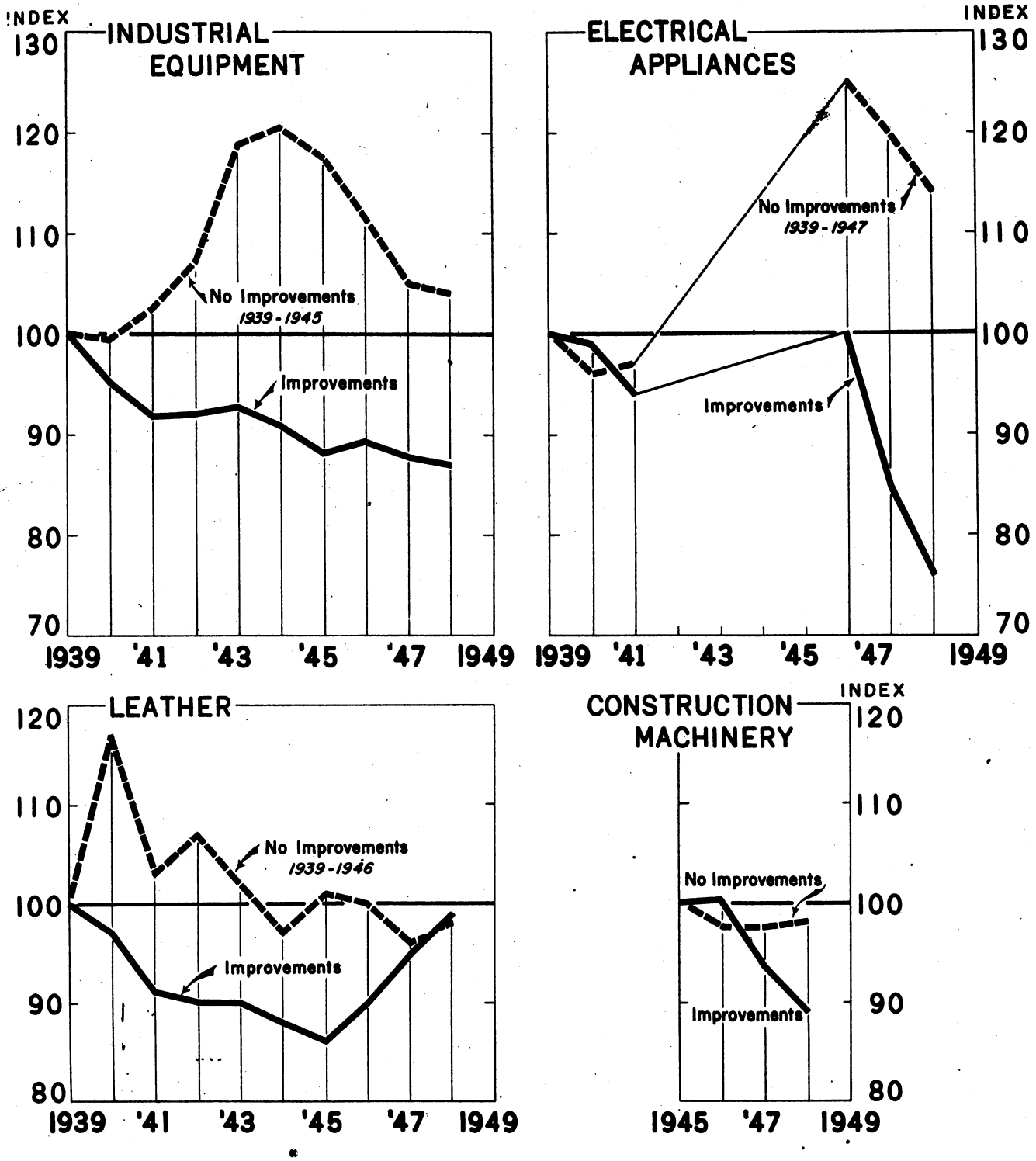

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CHART 8.

CHANGES IN MAN-HOURS PER TON IN INDIVIDUAL CANE SUGAR REFINERIES

SELECTED PERIODS

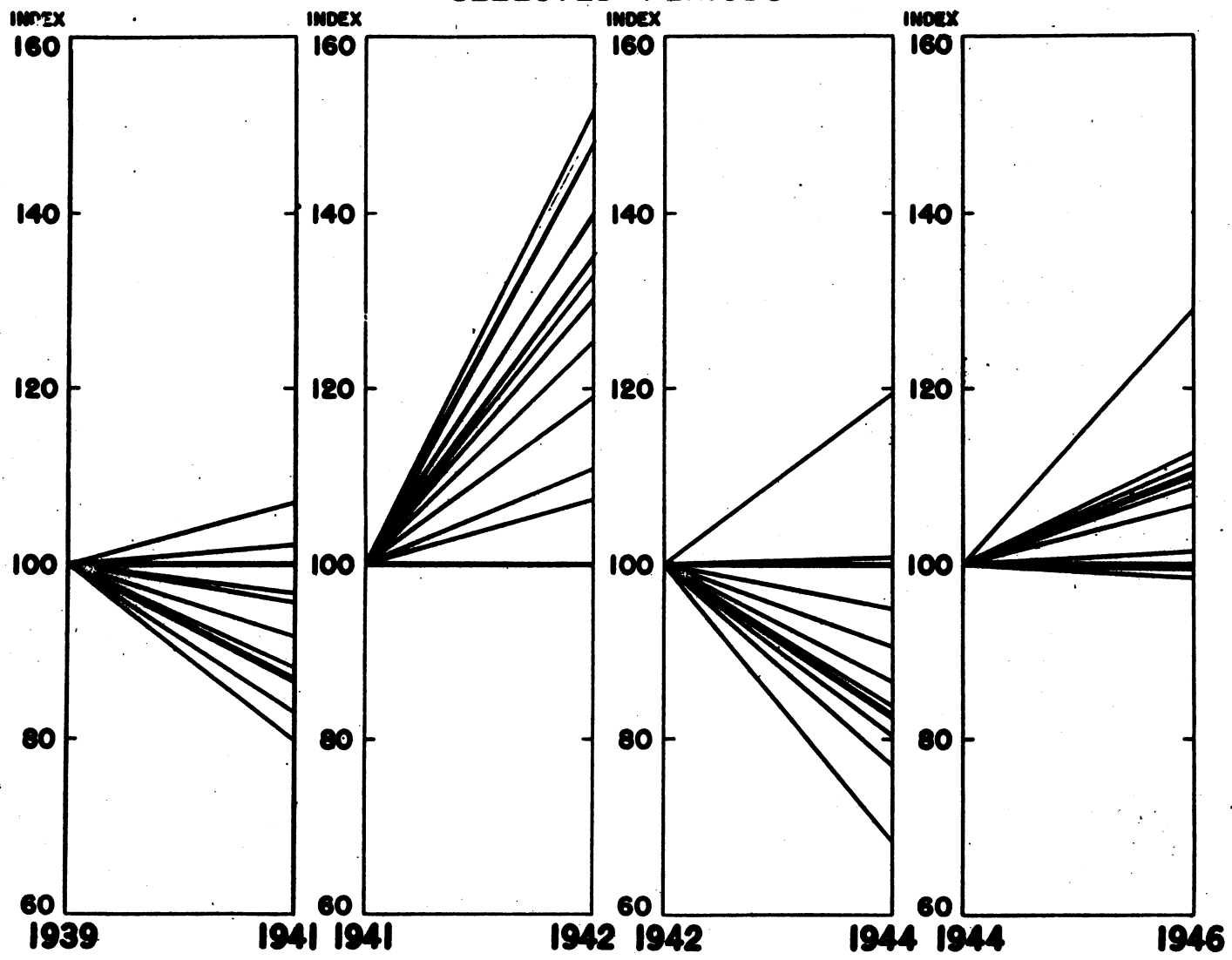

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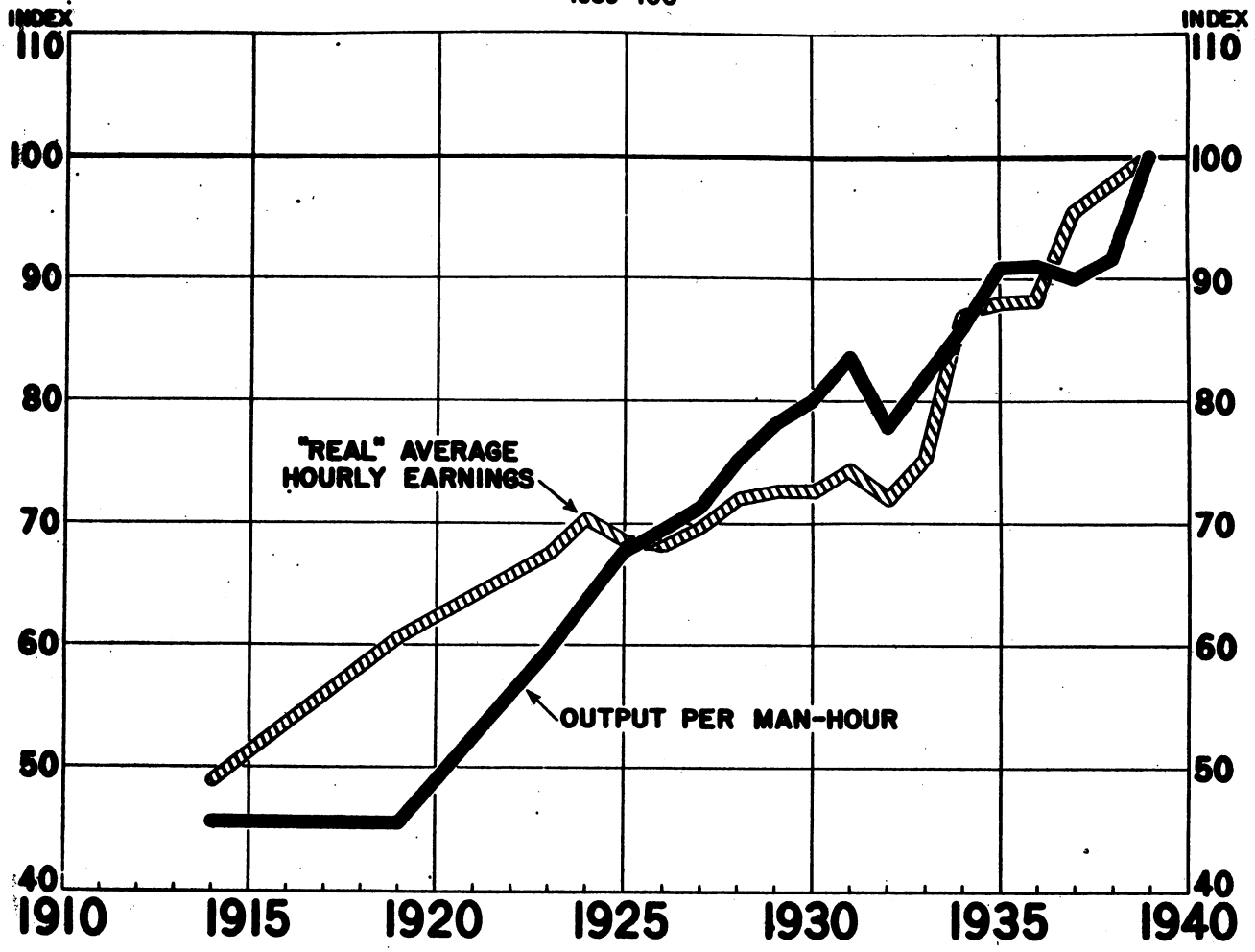
CHART 6.

OUTPUT PER MAN-HOUR AND "REAL" HOURLY EARNINGS

MANUFACTURING 1914-1939

1939-100



VISUAL INFORMATION
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