

## PRODUCTIVITY

14 January 1960

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## PRODUCTIVITY

14 January 1960

MR. MUNCY: Good morning, Gentlemen. It is appropriate that in our study of the problems of materiel management we have a clear understanding of the term "productivity" and its relation to our economic life. The concept is used, as you know, widely today by the press, labor, management, economists, and universities, usually with varying shades of meaning.

Our speaker this morning is a distinguished economist who has specialized in the study and clarification of productivity as an economic concept. He has served as consultant to many Government agencies. He has conducted special labor studies in this field, and he has written extensively on this important subject.

It is a pleasure for me to introduce Dr. John W. Kendrick, Associate Professor of Economics, George Washington University, who will speak on "Productivity."

Dr. Kendrick, we welcome you to this platform.

DR. KENDRICK: Mr. Chairman, General Houseman, Gentlemen: As your chairman has pointed out, "productivity" is a word which, although frequently used in recent years, is frequently misunderstood. I am going to try to clarify the term, explain the meaning of productivity movements in the economy, and say something about their significance in various areas of economic life.

Despite the fact that this term is frequently misused, nevertheless I think that people generally realize that it has something to do with productive efficiency, and therefore they realize that it is a factor of great importance in the economy. Already, back in the 1930's, people were quite concerned with the possible labor-displacing role of productivity advance, and there was a big national project, the National Research Project, designed to measure changes in output per man-hour in various industries of the economy and to try to gage the labor displacing effect.

Within a few short years the other side of the productivity coin was showing, and we were very much concerned with the output-creating side

of productivity advance. It was realized that this was an important element in broadening the material base of the war effort, and then, after the war, the contribution of increasing productivity to reconstruction and progress of war-torn nations, and the development of economically backward nations was stressed.

Productivity centers were created in many countries of the world, and productivity teams were sent to the United States, and are continuing to be sent here, ever since about 1949. Certainly this increasing productivity-consciousness on the part of peoples of most of the countries of the world has been a factor in the tremendous industrial progress which has been achieved in the rest of the world since the war.

It is rather interesting that this is one of the few countries that do not have any organized productivity organization which tries to promote the consciousness of the problems, to disseminate information, and so forth. But I suppose we feel that this takes place more or less automatically here, since we have led the world in the past in the rate of productivity advance. I would like to say some more about this matter later.

In addition to the contribution of productivity in increasing output, this factor has also been viewed as a means of mitigating inflationary pressure. That is, we know that inflation is a matter of too many dollars chasing too few goods, as it has been defined. So increasing our output of goods is one way of trying to dampen inflation.

Further, productivity has been held up as a yardstick or a guide to the wage increases that can be granted by industry, consistent with stable prices. Presumably wage increase significantly in excess of productivity advance leads to the phenomenon of increasing money demand faster than the increase in the physical volume of output.

Another aspect of productivity is that different rates of change in productivity in different industries do affect the economic structure. That is, the industries with faster productivity gains, the more progressive industries, tend to increase their output and their absorption of labor and capital faster than the less progressive industries.

But the final point I would like to make as to the significance of productivity advance is one which I think is the most important, one that would be of special interest to this group. I believe we can say

that relative rates of productivity advance are probably the most important factor determining the relative changes in the material strength and potential military power of nations, because productivity is the most important factor in our increasing output of goods and services. As such, over the long run relative rates of productivity gain may well determine the outcome of the power struggle between the Communist bloc and the free nations of the world. This is very clearly recognized by the Communist leaders ever since Lenin. Lenin stressed this fact, and he said in effect that only by increasing rapidly the productivity of labor would the Communist countries overcome the capitalist countries, and this has been a basic tenet in Communist doctrine ever since. It has been only in recent years, I would say, that we in the democratic countries have consciously come to realize the crucial importance of this factor.

Well, so much for the significance of productivity change. I'd like now to turn to some clarification of the concept of productivity. Just what is it? Is there a blackboard up here that I can write on? I'd like to put down a few symbols to try to indicate the relationship. As we all know from our elementary economics courses, production depends on the inputs of the basic factors, which are land, labor, and capital, in the economy, and on the effectiveness with which these resources are utilized. This is sometimes called the production function. Production is a function of the inputs into the productive mechanism and of the level of technology, that is, the efficiency, with which these factors are used.

Here I will indicate the output--"O," let's call it--is a function of labor (L), capital (C), the nonhuman inputs, including reproduceable capital and land, and also the level of technology (T) which we will use to indicate the effectiveness with which these resources are used in the production process. Efficiency is something you can't measure directly. It is something you can measure only indirectly through the relationship between the outputs and the volume of inputs necessary to produce that output.

So you can think of productivity, or "T," because productivity reflects the change in technology, as being a relationship which will show up in ratios between output and the human and nonhuman inputs into the productive system.

This formula relates to the economy as a whole, in which the factors of production boil down to labor and capital, but, for any individual industry or firm, you also have purchased materials. So that for industry

we would have to say that the productivity change is related to the changes in the ratio of output to labor and capital and materials or semifinished goods which are purchased from other industries. You see when you go to the economy level these materials wash out, because the sales of one industry are the purchases of other industries. These cancel out.

The national output is merely the output of the final goods and services, the goods and services that are not resold. So that the materials have all washed out, and the real national product or output of the economy is related to just the labor and the capital inputs.

This is the concept of productivity, which I have tried to implement in studies for the National Bureau of Economic Research, going back to the late 19th century, for the economy and for various industries of the economy. Notice that this differs from the more conventional concept of productivity as being output per man-hour. I am sure all of you have heard of that productivity concept. It is the one that is most usually used. The estimates of the Bureau of Labor Statistics are in terms of output per man-hour.

This is a deficient measure of productive efficiency generally, because changes in output per man-hour can occur not only because of increased productive efficiency generally, as a result of improved technology, but can occur as a result of the substitution of capital goods for labor. In other words, efficiency may not increase at all, but, if you use more machines and less labor, output relative to man-hours can rise. But you haven't necessarily increased efficiency, because the cost of that additional capital may offset the saving that you have achieved in the labor factor. The same thing goes at the industry level with respect to materials. Sometimes, by using more materials you can use less labor, because labor can be less careful in their processing. So you can substitute material for labor, in a sense. There is factor substitution among all of the major factors.

So that the relation of output to any one input, whether it be labor, capital, or materials reflects not only the changes in technology but also changes in the proportions of the factors that reflect substitution of one factor for another. Take for example what happens when the assembly line is automated, as has happened in most of the automobile engine plants. With these automated assembly lines, the production workers are cut down to practically zero. You have technicians and engineers. You probably have more than you had before. And, of course, you have a lot more expensive equipment. If you were measuring output per

production worker man-hour, there would be a tremendous rise in this ratio. This doesn't indicate your change in efficiency, because you have had to substitute skilled and professional labor for unskilled or less skilled labor as you have substituted capital for labor.

So, only if you relate output to all of the inputs, all of the cost items, can you measure the net saving of inputs, and to me that is the definition of the change in productive efficiency, the net saving in all cost items that is achieved over time.

What does such a ratio reflect? To distinguish this from some of the so-called partial productivity ratios, like output per man-hour, I'd like to call this measure total productivity. More and more economists are thinking in terms of this total productivity measure. Just what does it mean? I said it reflects changes in technology. We know that technological change is a result of invention and the development of the commercial application of invention in terms of better machinery, equipment, organization, and production processes. Such advances in technology depend basically on the amount of time and effort that people take to try to improve their processes of production. In recent years this has been done in a systematic way, and the amount of resources devoted to improving technology is roughly measured by our expenditure for research and development. These expenditures have increased tremendously since the end of World War I, when we were spending just a few hundred million dollars a year for research and development. Now we are spending around \$10 billion a year. It has not only risen tremendously absolutely but also in relationship to the national product.

Also, as a scale of production increases you get economies of scale. That is, you get greater specialization of plants and firms, with attendant economies. So that just the process of economic growth itself creates economies and technological improvements in the broad organization of production, looking at the economy as a whole as a productive mechanism. But this, too, you can call technological change.

Very broadly considered, productivity reflects changes in the social organization. For example, the creation of the Federal Reserve Board, which vastly improved our monetary and banking mechanism in this country, is a social invention which undoubtedly improved productivity because it eliminated for the most part the financial panics and crises which had plagued industry prior to 1914.

In the short run, these measures, I might mention, also reflect changes in the rate of utilization of capacity. When we have a business recession and industry operates at less than the most efficient rates, this usually shows up as a decline or a slower rate of increase in the productivity ratios, because usually the overhead type of labor--management, engineering, and technical employees--is not dismissed, although production workers usually are, as output declines. So the labor force is not reduced as much as output. Also your capital equipment is still there, representing a continuing charge. So that in a recession productivity tends to decline somewhat or does not increase as fast.

But, except for the effect of cyclical changes in economic activities, productivity basically reflects changes in productive efficiency in the organization and the instruments of production.

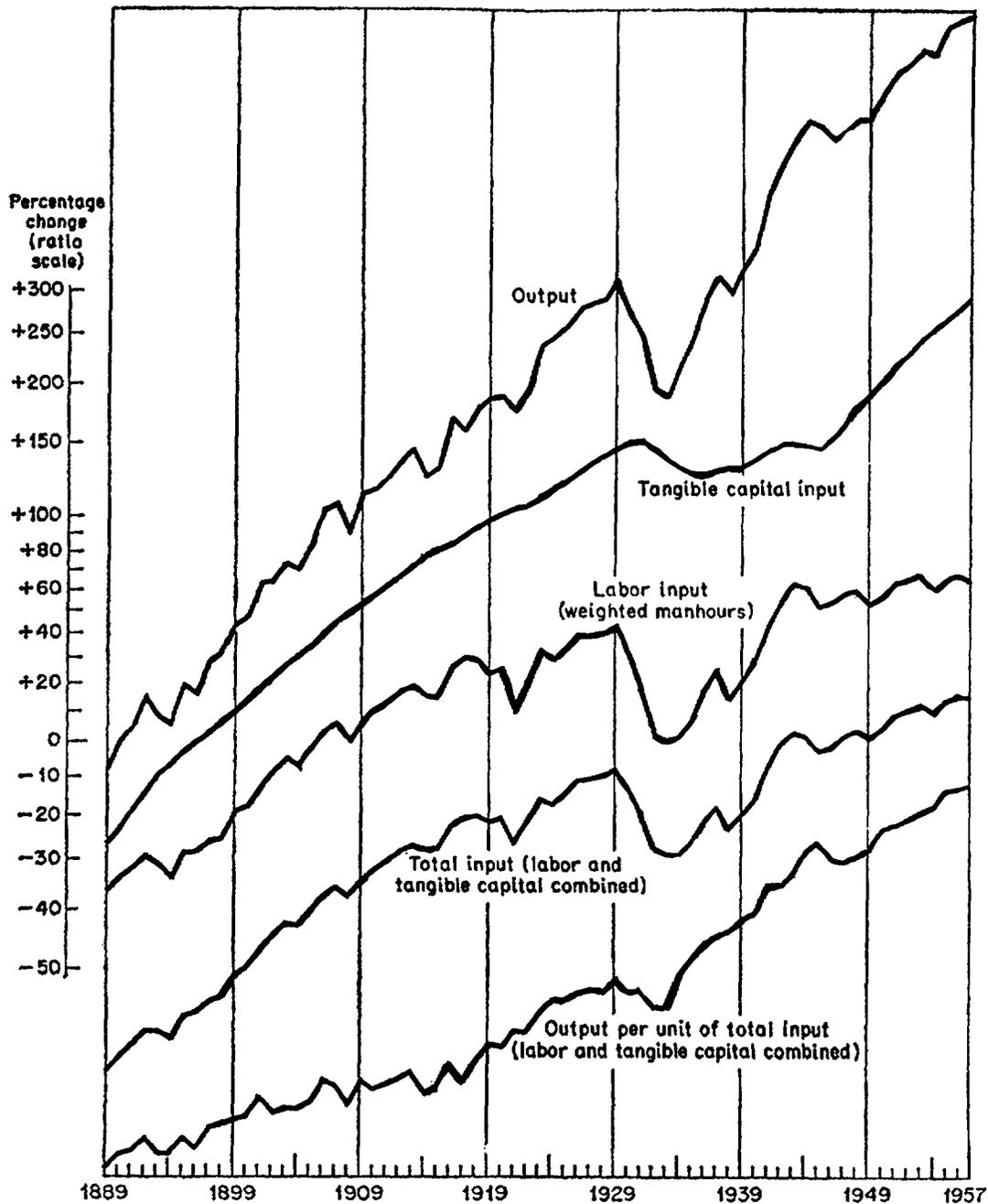
Now, with that much background, I would like to go on and show you graphically some charts illustrating the long-run changes in productivity that we have experienced in this country since the late 19th century, based on the estimates I prepared for the National Bureau of Economic Research, which should be published the end of this year, and, finally, I'd like to compare our rates of change with some of the changes occurring in other countries in the postwar period.

Chart 1, page 7.--In this chart that we will put up on the board, I have plotted the major inputs. This is the labor input (indicating). Here is the capital input of the economy from the year 1889 right through our latest cycle peak of 1957. And here is the total input, a combination of the labor and the capital inputs. Let me say just a word as to why man-hours are weighted here. I should indicate that usually labor input is measured in terms of man-hours. But you don't want to count every hour the same as every other hour that is worked. Certainly the hours of the hod carrier are not as valuable as the hours of an engineer, and so on. So we have weighted the man-hours in the various categories of work by the average hourly earnings of a base period in each. The base has been changed approximately every decade to reflect the changing relative value of labor, of output, and of capital.

The weighted man-hour series rises more than just straight man-hours. The reason why is that, as our labor force has become better educated and more skilled, gradually there has been a shift of workers from the less skilled to the more skilled occupations. A weighted series would reflect this shift into the higher paying categories. That is another defect of our official measures. They are just unweighted man-hours, output per man-hour. All man-hours are counted the same, which I don't think is appropriate.

Output, Input, and Productivity, 1889-1957  
 Estimates for the Private Domestic Economy

A. Totals



NOTE: This Exhibit and all others except Nos. 7 and 10 are taken from "Basic Facts on Productivity Change," by Solomon Fabricant (Occasional Paper No. 63, National Bureau of Economic Research, New York, 1959).

Under tangible capital input, we include the plant, equipment, land and inventories, the "real" capital of industry. It is a measure in constant dollars of the changes in the volume of such plant and equipment. Labor and capital inputs are weighted together by their relative contributions to the national income and product. Approximately, labor compensation has been around three-quarters of our national income. Capital compensation (interest, rents, and profits that accrue to the owners of capital) has been about one-quarter of the national income and product. Those are approximately the weights used to combine the capital and the labor inputs to give us this total input curve.

Then this is divided into the gross national product in constant dollars. Since we are interested in technical relations, we don't want the effects of price changes in here at all. So that for our national output we in effect weight the physical volume of goods and services by their prices in one base year. The base year is 1929 here. In that way we get a measure of the change in volume of output without allowance for price change. Of course the same thing is true when you use man-hours and deflated value of capital stock. These are physical relations, which they must be to show the changes in efficiency.

As you see, output has grown much more rapidly than the inputs. Output in this country, measured in terms of the deflated gross national product, has grown over this long period at an average rate of about 3.5 percent a year. Our total input, on the other hand, has grown at an average rate of about 1.75 percent a year, over the whole period. That means that the ratio of output to total input, that is, total productivity, has grown at an average rate also of 1.75 percent a year over this period.

In other words, productivity has accounted for one-half of the growth in total output. The other half has come from increase in our labor force and capital stock. You notice that, particularly since the early forties, our labor input really hasn't grown very much. Most of our input growth has come from the increase in capital; with a high level of saving and investment, our capital stock has grown. So total input has grown. Labor input has not grown too much, despite the increased population, because we have had a declining workweek. Average hours worked have gradually fallen over this entire period from around 60 hours a week at the beginning to less than 40 hours a week at the end. So that has exerted a downward pressure on our growth of labor input.

Chart 2, page 10. --On this chart I show the productivity ratios individually. Here is the same line as on the bottom of the other chart-- total productivity. I'd like now to point out that there are two periods of this productivity increase. Up until World War I the rate of increase was about 1.25 percent a year. Since 1919 or so the increase in productivity has accelerated to over 2 percent, about 2.1 percent a year on average. Even 2.1 percent doesn't sound like a very big figure, but, when you compound this, this alone would lead to a doubling of our national output every 30 years or so, by the compound-interest formula. So this little figure is extremely significant since it leads to a doubling of our output per unit of input within a generation.

Since capital has grown faster than labor input, obviously output per unit of capital has not risen as much as output per man-hour. This is the straight man-hour (indicating) and this is the weighted man-hour, and output per unit of capital has grown less than either because of the fact that capital has been substituted for labor through mechanization, more capital per worker, and this measure doesn't rise as fast. It has been rising rather slowly, but during the depression and the war period, when capital formation was less than normal, we got a large increase, but it has been almost constant in the postwar period, meaning that our capital stock has been growing as fast as our output.

Output per unit of capital has grown about 1 percent a year and output per unweighted man-hour has grown about 2.5 percent a year since World War I. There has been a little acceleration since World War II. The rate of increase has been about 3 percent a year in output per man-hour. There has been no acceleration in output per unit of total output. Our total productivity has continued at about 2.1 percent a year in the postwar period. The reason why labor productivity, so-called, has accelerated a bit is that capital per worker has increased faster than it had in the previous decades.

So this isn't really an acceleration in the growth of total productivity. It's only an acceleration in output per man-hour because of the faster growth of capital per worker and per man-hour in the postwar period. However, some people have made a great deal out of this fact that we have gone from 2.5 percent to 3 percent in output per man-hour in the postwar period, thinking that means that we are on an accelerating curve of labor productivity in which you would get increasing rates of increase as you go out into the future. I think that it is very dangerous to extrapolate such a curvilinear trend into the future, because it means that eventually we would be getting enormous increases of 10 to 15 percent a year, which doesn't seem reasonable. So I wouldn't buy this idea that we've got an automatically accelerating growth in productivity.

## CHART 2

Indexes of Productivity in the United States, 1889-1957  
 Estimates for the Private Domestic Economy

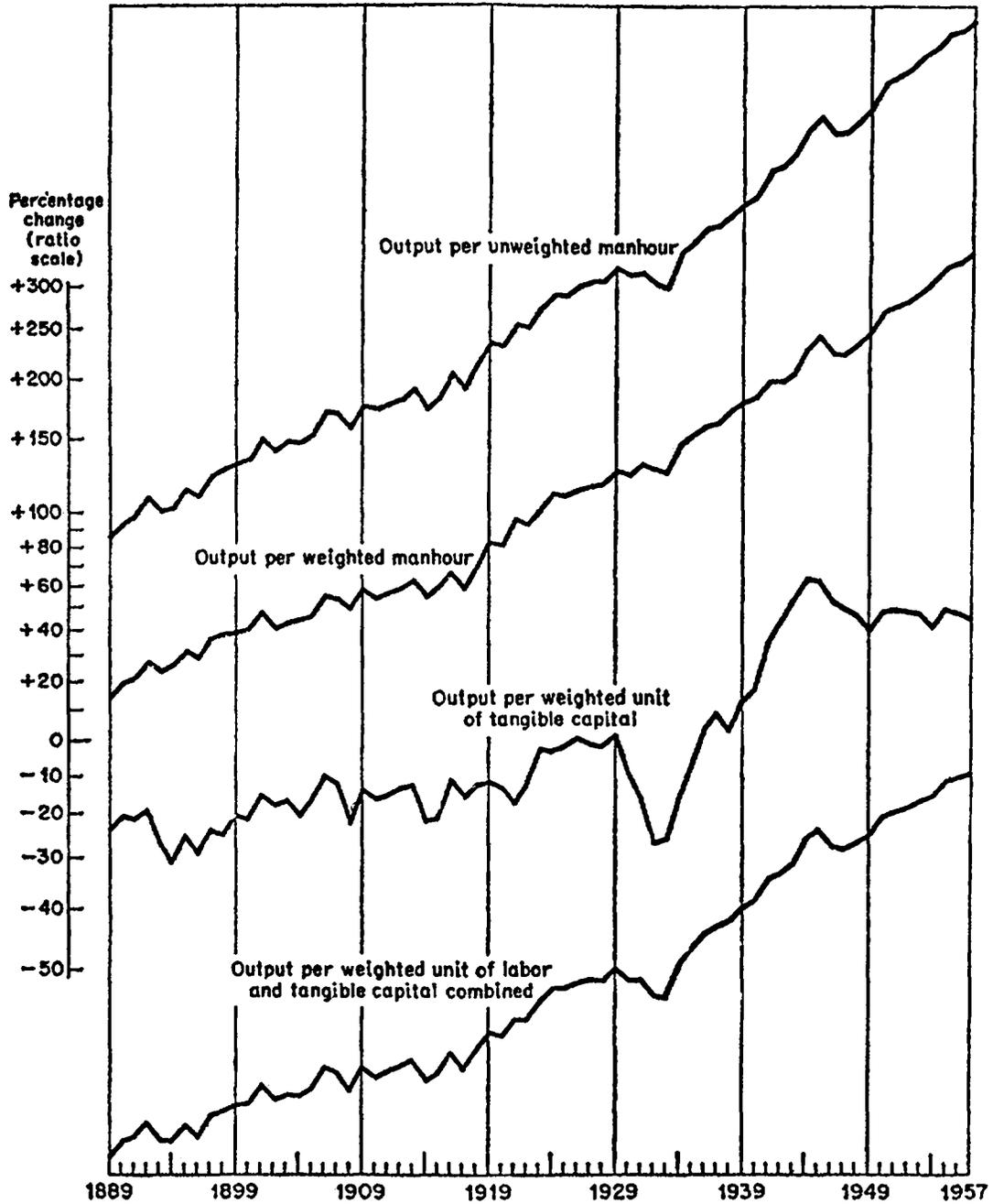


Chart 3, page 12.--This chart shows output related to population. After all, growth in the national product is significant insofar as it exceeds our growth in population, because that's the way in which our planes of living are raised, when we can get ahead of the population growth. Incidentally, as you know, that's one of the problems of the underdeveloped countries. As they get a little bit ahead in production population increases, and they have trouble raising output per capita.

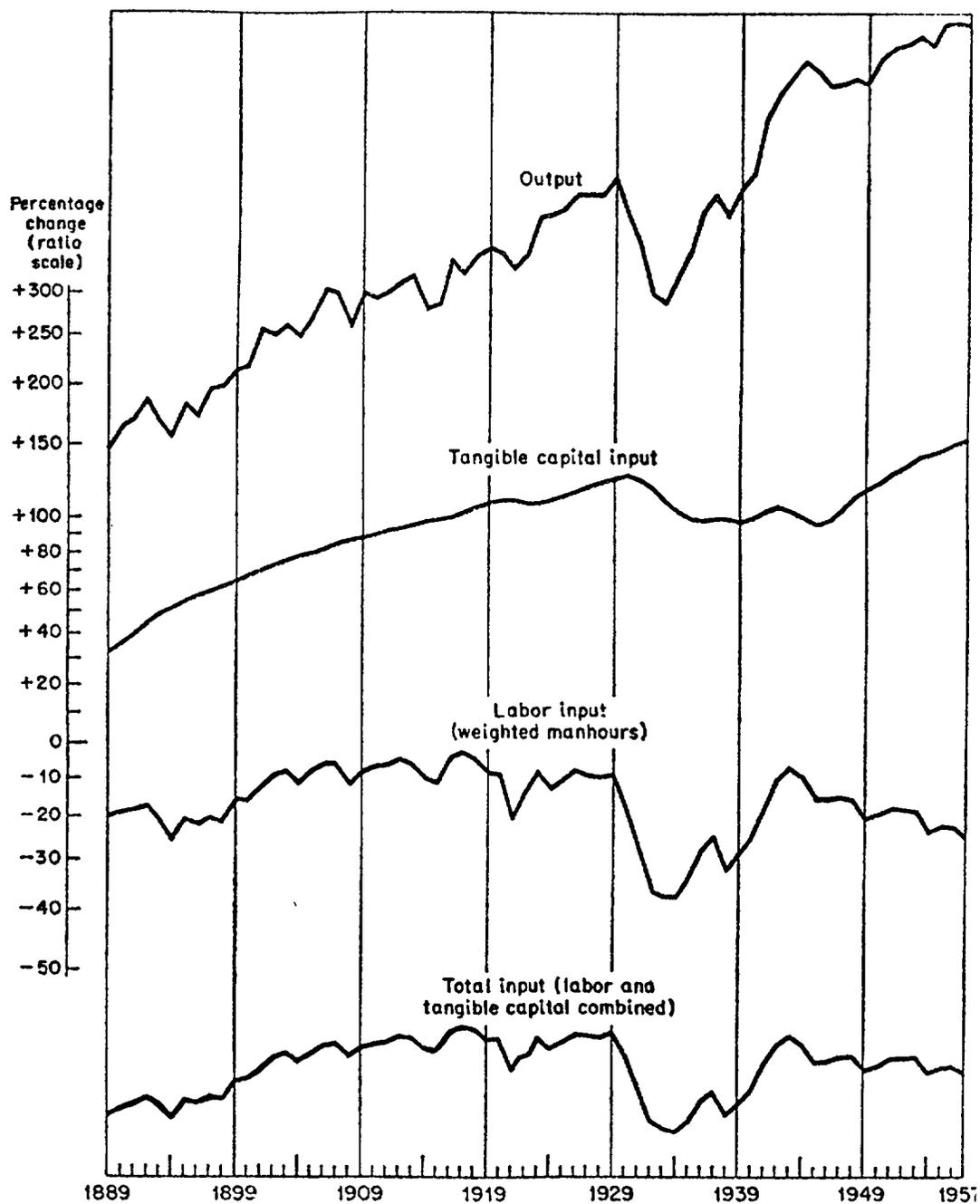
But in this country we've been more fortunate. Output per head has grown about 2 percent a year over this long period. One and three-quarters percent over the long period was productivity, of course. The other quarter of a percent was some increase in input per head. As we know, labor input per head has not increased. That has been about constant, due to the decline in the workweek, despite the fact that the labor force has grown relative to population as more women have come into the labor force. But the main factor increasing input per head was the increase in capital. But that primarily had occurred before 1919. Since that time input per head has been fairly level. So that the entire increase in output per capita has come from productivity. I wanted to show this chart to indicate the great importance of productivity when you look at planes of living. Our increase in efficiency has been the entire cause of our increasing production per capita in recent decades.

Chart 4, page 13.--Here we come to the relationship of productivity to the real average hourly earnings of workers. It is obvious that we can enjoy higher real wages, wages in terms of purchasing power, only as we increase our output. This shows the relationship. Here is total productivity (indicating). Here is real earnings of all workers in the economy, all employees. Here is a series showing manufacturing workers only, a separately derived series, which more or less has the same movement as the figure for the whole economy--not quite as big an increase.

But what I want to emphasize about this chart is that, if you can compare the difference between these curves, you can see that real average earnings of employees have risen faster than total productivity. In other words, it is possible for labor earnings to outstrip the increase in productivity, which is frequently not realized, because you hear economists say that the earnings of labor cannot exceed the increase in productivity without a rise in prices. But, since these are in constant dollars, you see that it would have been possible for earnings in current dollars to have increased somewhat more than productivity and still be consistent with stable prices.

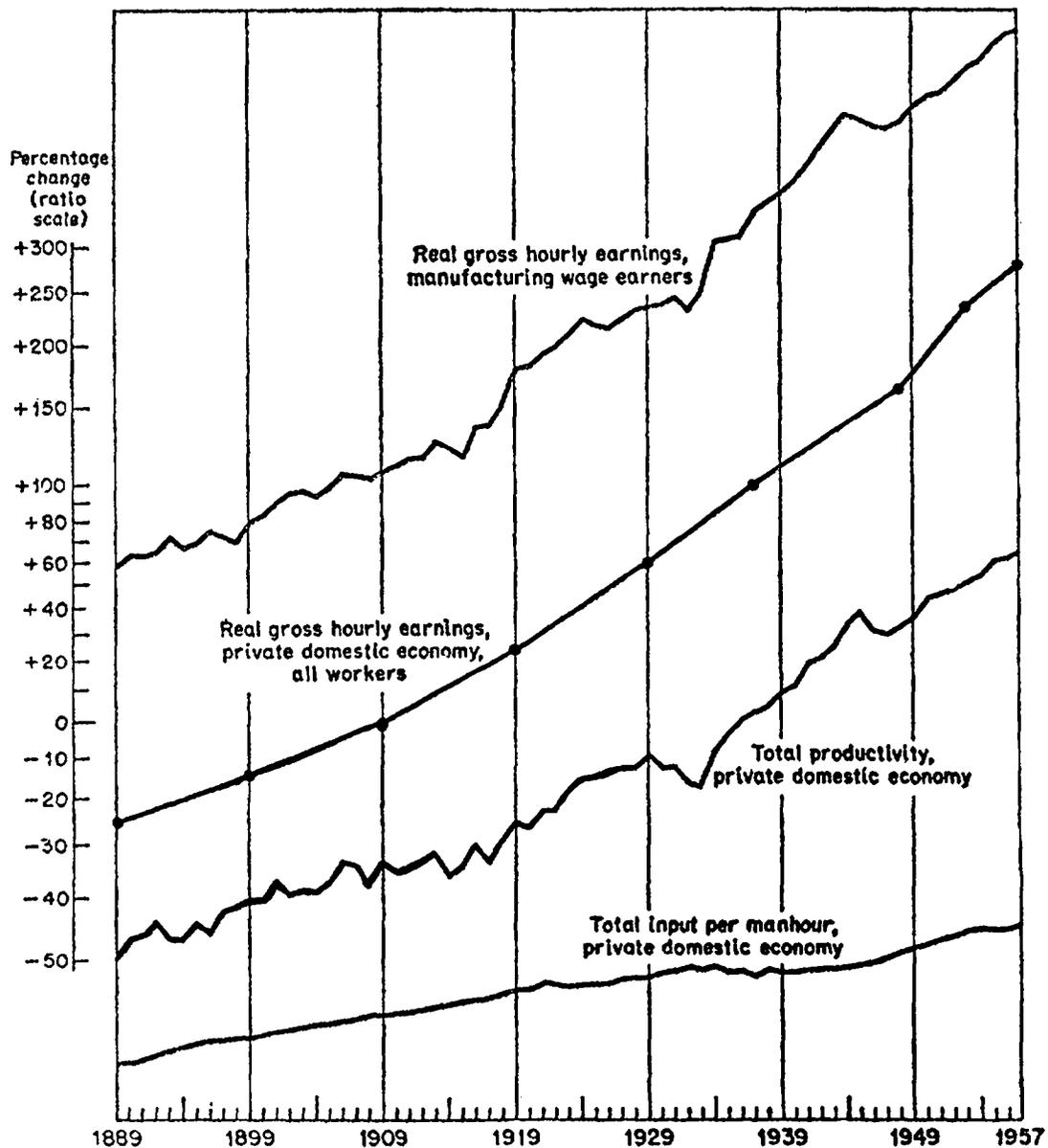
CHART 3

## Output per Head of the Population



## CHART 4

Real Hourly Earnings Compared with Productivity  
and Total Input per Manhour, 1889-1957  
Estimates for the Private Domestic Economy



Why is that true? Well, in the first place we know that output per man-hour has risen more than total productivity, but this average hourly earning series has risen even more than output per man-hour. How can that be, that the real earnings of labor can rise more than output per man-hour? The answer is that the real earnings of capital have not increased as much as output per unit of capital input. That is the key factor in explaining this. The rate of return on capital has been constant as to trend over the last 40 or more years. Back in the early twenties capital was earning 6 or 7 percent on average. In recent years capital has been earning 6 or 7 percent on average. Of course there have been fluctuations in between, but the trend has been fairly stable.

Now, with capital not sharing in the productivity advance, so to speak, it has been possible for labor to get more than the productivity increase. This is a point that has not been recognized in the discussions. I have an article in the "California Management Review" this spring discussing this relationship. I am sure the unions will be very happy to hear this, that it is possible for labor to get more, but their happiness can't be too great because labor cannot get much more than the productivity increase because the share of capital, as I said, is only one-quarter--in fact it is now a little less than a quarter--of the national product, and capital has to get at least a constant rate of return in order to induce new investment. So the amount of productivity increment which would go to capital normally is fairly small, and, when that is added to the labor share, the total surplus, or bonus, to labor is not very great. I would say that, with an increase in labor productivity of 3 percent a year on average, the total increase in average wage rates that is consistent with stable prices is about 3.5 percent. I won't go into the arithmetic of that, but that is a rough calculation I made, that 3.5 percent is consistent with stable prices. We know that in the post-war period, actually, labor has gotten about 5.5 percent increase in wage rates. This has been more than is consistent with stable prices.

I don't mean to say by this that we have had a wage-push inflation necessarily. In parts of the postwar period demand was inflated; right after the war, with all the liquid assets people had, and the spending, demand pulled up prices, with wages following. This was also true right after Korea. But in more recent years I do think that the pressure from wages has tended to push prices up, because wage rates have risen 1 to 2 percent faster than is justified by the productivity advance, even though there is not a one-for-one relation between wage rates and output per man-hour. I would say that 3.5 is a better figure,

and it really is to the advantage of labor to keep wage increases within this limit, because, when wage increases go further than this and prices rise, that really cuts back the real gain anyway. If wage rates rise 5.5 percent and prices rise 2 percent, then the increase in real wage rate is only 3.5 percent anyway.

So I think it would benefit the economy if it were 3.5 percent to begin with. And, of course, that is nothing to sneeze at, because 3.5 percent compounds to a doubling within about 20-some years.

Chart 5, page 16.--In this chart I want to illustrate the fact that productivity has grown at different rates in different industries. Here I have only a few major industry groupings, broad groupings. You notice, for example, that in agriculture, up until 1937 or so, there was not very much increase in productivity. But in the last 20 years there has been a tremendous increase in agricultural productivity-- 5.5 percent or so in total productivity, and even more in output per man-hour. This also illustrates the fact that productivity change varies from one period to another. One industry may be going along at a slow rate of increase, and then, suddenly, there will be a spurt, which you see particularly when you break these figures down to smaller industrial components.

Manufacturing productivity increased 2 percent a year on average over the whole period, about the same as for the economy. But you had about a 5 percent increase in the twenties. Remember the spread of mass production and scientific management, and so forth, caused big increases then. Since the twenties it has been about 2 percent a year.

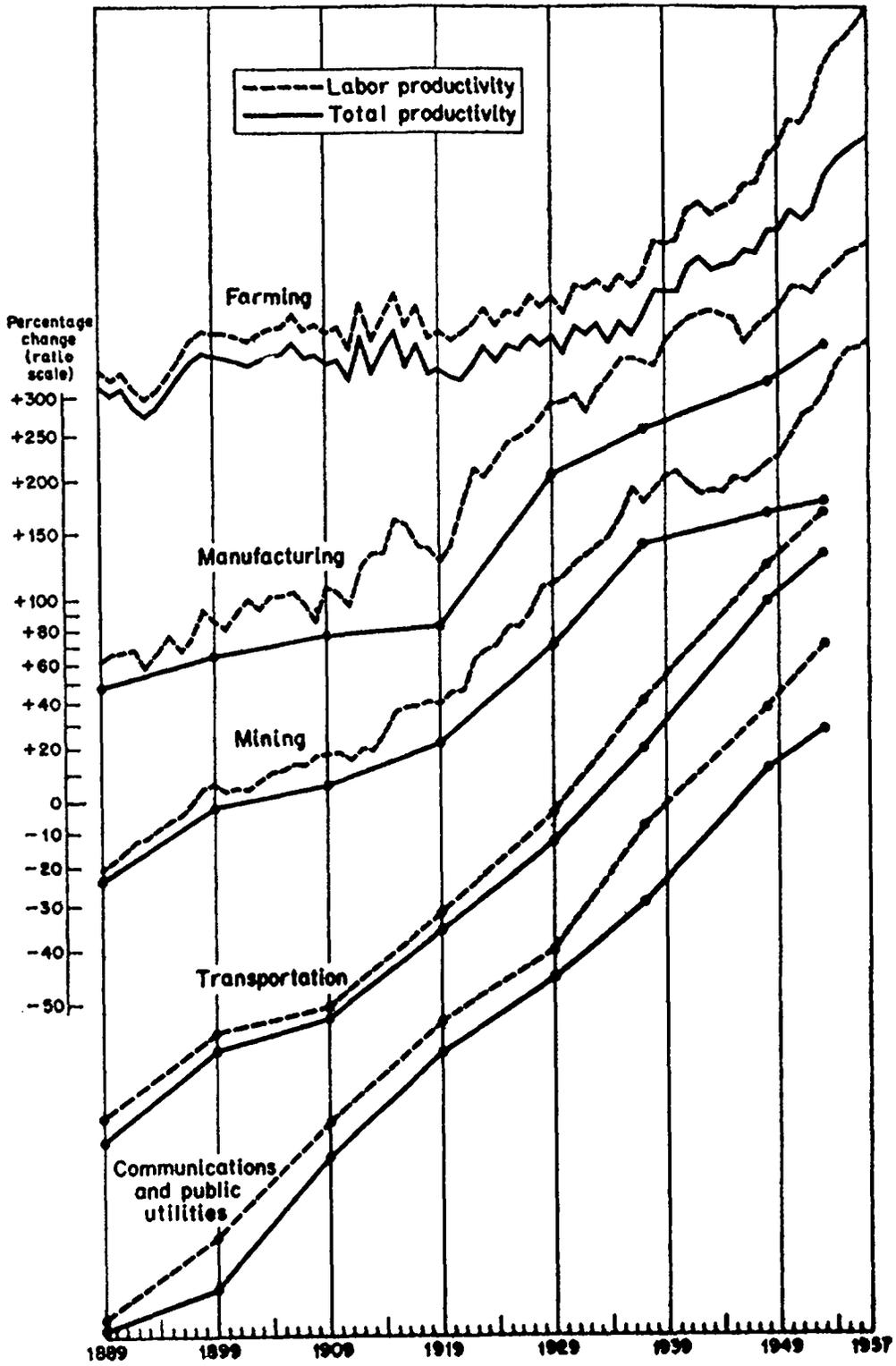
Mining also has averaged about 2 percent, with somewhat different rates throughout the decades.

In transportation we have had an increase of about 3.5 percent, as compared with the national average of 2.1 percent.

In communications and public utilities the increase has been even faster--over 5 percent a year in the electric and gas utilities, and telephone and telegraph communications.

CHART 5

Indexes of Productivity in Five Major Industrial Divisions  
Estimates for 1889-1957 or 1889-1953



So you have quite a dispersion in rates of productivity gain. If we had it broken down by smaller industry groups you would find even more. For example, in transportation, the railroads have increased their productivity about 3 percent a year. That's more than the national average, but it is much less than the increases in the newer forms of transportation. The airlines, pipelines, trucking, bus lines, and so on, have increased their productivity about 8 percent a year, as compared with 3 percent in the railroads. So, even though the poor old railroads have increased their productivity more than the Nation as a whole, they are relatively falling behind compared with the newer and more efficient transportation industries.

Within manufacturing, you get a big range. For example, tobacco products, the chemical industry, the electrical equipment industry, and petroleum refining have all done better than 4 percent a year, as compared with 2 percent for all manufacturing. Some have done better than 5 percent a year on average in increasing productivity.

Down at the low end of the scale you find leather and leather products and lumber products, which had only about 1 percent a year increase. So there again you get a dispersion in the rates of productivity change.

In the utilities, electric utilities have done almost 6 percent a year. Telegraph has been much less, around 2 percent a year.

So you have a fanning out of rates of productivity change in the various industries.

Chart 6, page 19.--What significance does this have for the structure of our economy? I don't know whether you are acquainted with so-called scatter diagrams. I am sure some of you are. This diagram relates productivity changes plotted against a vertical axis, to changes in average earnings, plotted on the horizontal axis. This mass of dots which show no particular direction of slope means there is no relationship between average earnings and productivity in the different industries.

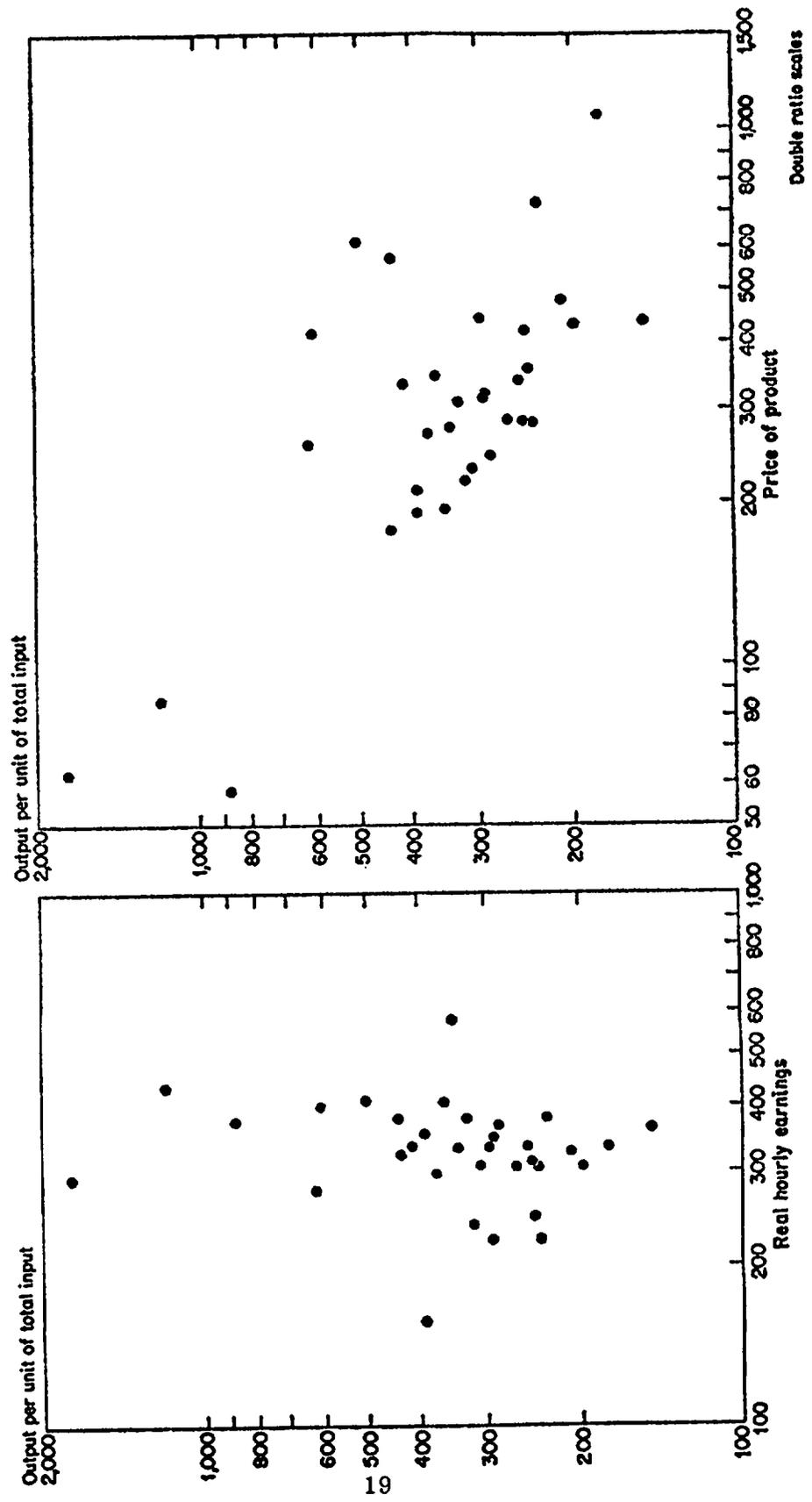
Here again we come back to the wage issue. The wages of the laborer in any particular industry cannot be related to the productivity of that industry. They must be related to productivity in the economy as a whole, because, if the wages in each industry were related to the productivity in that industry, you would soon have a completely distorted wage structure. The whole relationship of wages would soon be out of

whack. If a secretary in the airlines got an 8 percent a year increase in her wage because productivity increased at that rate in the airlines, whereas a secretary doing the same work in the shoe industry got only 1 percent because that is a less progressive industry, obviously that would be unfair and untenable. So that wage rates tend to show similar rates of increase in the various industries of the economy over the long-run.

That's what I wanted to indicate by the lack of relationship indicated in this cluster of dots on the left-hand chart. If productivity gains are not allocated to the factors of production in the industries, in accordance with the differential productivity change, then, how are the relative gains in productivity passed on? They are passed on to the community as a whole through relative price change. In the right-hand panel, where we relate productivity to prices of products, you see there is a distinct downward slope of these dots. There is a coefficient of correlation of about .75, which is a fairly good relationship. This indicates, since it slopes down, that the industries with high rates of productivity increase have shown price declines over this period--1889 to 1953--or the prices have not increased as much as in the industries which have low rates of productivity increase. In this group over here (indicating) with low rates of productivity increase, prices have risen relatively. So this inverse relationship between productivity change and price change is the way that productivity affects the changing industrial structure of the economy.

How does it affect it through price? Well, the answer is that both producers and consumers are price-conscious, and they tend to shift their spending from products which have risen more in price to items that have risen less in price. So that there has been a shift in buying, industrial buying and consumer buying, to the more progressive industries, those that have had greater productivity increase and therefore have had relative price decline. These industries have grown faster. The electric utilities, for example, have increased 2 thousandfold over this period because the price per kilowatt-hour has declined. There has been a tremendous increase in the consumption of electricity, of course, whereas some of the low productivity industries haven't grown at all; in fact, they have suffered declines relatively. This isn't always the case, but it tends to be the case.

CHART 6  
Relation Between Change in Productivity and Real Hourly Earnings, and  
Productivity and Price of Product, 33 Industry Groups  
Indexes for 1953 Relative to 1899



So we see that the progressive industries have grown. In fact, they have grown enough to increase their employment of labor, relatively speaking. This means, in other words, that what we need fear is not technological unemployment, not rapid rates of productivity advance in given industries, because these industries tend to increase their employment of labor and their absorption of capital. What we need fear is too little productivity advance, because, when an industry has too little advance, it tends to decline and has to either lay off labor or let attrition reduce its labor force.

Chart 7, page 21.--In this final chart I pull together some figures on rates of change, not of total productivity but real gross product per worker, which is a less desirable measure, but we don't have the total measure for other countries. But this gives some rough clue as to changes in productivity in different countries, between 1950 and 1957. This table indicates that, as you see, the United States is not at the top of the list in the postwar period. I like to show this table, because I think it indicates that we have no grounds for complacency as to our record, even though it has been among the best over the long period.

You might say that the big increases of Japan and Germany represent reconstruction from devastation of war, and that is certainly true, to some extent. I read a talk that Dr. Colin Clarke, now of the Econometric Institute, gave here some time ago, in which he showed rates of change over the long run for different countries. In his talk he said that these rates tend to persist, that, if a country falls behind because of war, it will show a rapid increase until it catches up with the trend, and then the increase will be slower. This is certainly partially true, but I don't think we should discount the possibility that there has been some structural change in the rates of productivity advance.

We saw in this country that there was a structural change around 1919. Our rate of productivity advance almost doubled as a result of research and development, scientific management, and so on. I think it is quite possible that some of the European countries, possibly including the U.S.S.R., although we don't have good productivity figures for Russia, are on a permanently higher productivity trend. We can't be sure yet, until we see whether these higher rates persist even after the catching up following war. But if they do, that means that in this country, we will have to be concerned about the possibility of further accelerating our own rate of productivity advance.

## CHART 7

**Real Gross Domestic Product Per Worker**

Index Numbers for 1957 Relative to 1950 as 100

Japan .....	146
Germany (F.R.) .....	141
Norway .....	126
Netherlands .....	123
Belgium .....	118
Canada .....	116
United States .....	116
United Kingdom .....	114

*Source:* International Labour Review, March 1959

I see the time has come for a break. Possibly in the later discussion period I can indicate a few ways in which the rate of productivity advance might be accelerated.

Thank you.

CAPTAIN FIKE: Dr. Kendrick is ready for your questions.

QUESTION: Doctor, you stated that you had concluded that increased technology would be beneficial to all of us, but your last statement indicated that you had drawn some more conclusions from these studies. I wonder if you could elaborate on those, please.

DR. KENDRICK: It is not really a conclusion from the study. These are some of my own thoughts as to how we might further improve our productivity record. This is not easy to do, because a 2.1 percent increase in productivity and a 3 percent increase in output per man-hour are quite high rates over the long run. But still, I think there are ways in which we could further increase our productivity advance, although the increases would be slow and altogether wouldn't seem large. But even one-half of 1 percent is a large amount when cumulated.

I mentioned that research and development is basic to developing innovation. I think we have to continue to increase substantially our outlays for research and development. However, it won't help just to spend money unless we have the trained personnel, the scientists, engineers, and technicians, who can make the inventions and develop their commercial, military, or other applications. So we must accelerate our education and training of people particularly in these lines.

However, the whole economy has to continue to operate and improve. We shouldn't try to train scientists and engineers and technicians to the exclusion of other professions and specialties. The whole level has to rise. For example, in the business world the training of management is important, and this should go ahead and continue, although already over half of the executives of corporations have gone through schools of business administration, with continued refresher courses, either within their companies or sponsored by universities, and so on. There should be a continued rapid advance in our educational level, not necessarily just through the public schools but through the training courses in industry, in Government, and in the military. That's a good plug for the Industrial College. This sort of thing I think is very important.

Also, our tax system should be improved, in that some of our taxes do not give as much incentive to investment in new capital as would be

desirable. For example, we have kept on this additional 5 percent corporate tax for many years. It was put on as an emergency measure. If the corporate tax were decreased somewhat, this would increase the rate of return after taxes, which is what the investor looks at.

I saw an interesting chart recently, put together by the Joint Economic Committee, which showed that in the United States we have the highest marginal personal income tax on the upper brackets. This certainly does not encourage the investment of capital in risk enterprises. I think that some reduction in the tax rates in the upper brackets would help as far as incentive to risk investment in new ideas, new processes, and so forth, is concerned.

Maybe my particular suggestions are not as good as others would be, but I think we have to overhaul and look very carefully at the tax structure from the viewpoint of incentives.

Well, I think these are some of the major avenues to try to improve the productivity record. One other is that we shouldn't neglect the possibility of learning from other countries. They have been learning from us; we have not had any organized productivity center. I was talking with someone in the shipbuilding industry in Norfolk not long ago, who said that last year they had sent several people to Europe and they had come back with some excellent ideas from the British and Norwegian shipyards. As we know, that is one industry in which Europe is absolutely ahead of us.

In that connection, the Russians have an excellent service for their scientists and engineers, translating articles from American and other foreign journals into the Russian language. They have almost all of the articles put out in other countries at their fingertips. That is not true here. I would say that particularly articles appearing in Russian journals may not be accessible. In other words, we may not be getting the latest ideas from abroad. I think something can be done along those lines.

There are thousands of ideas which would improve our productivity and help to increase the rate of advance. The important thing is that we are conscious of the problem and the need to increase efficiency faster.

QUESTION: Dr. Kendrick, would you apply your theories to the steel industry? And, specifically, do you think the wage settlement was economically justified?

DR. KENDRICK: Well, the steel industry has been in an increasingly unfavorable position in the postwar period, for two or three reasons. One is that their productivity has not increased as much as that in the country as a whole. Before the war it had been going up faster. It was a progressive industry. But since the war it has not increased productivity as fast as the economy. The Bureau of Labor Statistics has some figures showing a little more than 2 percent a year increase in output per man-hour, compared with 3 percent for the economy.

Secondly, the wage rates in the steel industry have risen faster than those in the economy. In steel, the increase in the postwar period has been between 7 and 8 percent, as I recall, compared with around 5.5 percent in the economy.

Those two factors in conjunction mean that unit labor costs, that is, labor costs per unit of output, have increased faster than those in the economy. As a result, the prices of steel mill products have gone up considerably faster than the wholesale price index generally. Obviously, this isn't good for the sale of steel products. It is not good domestically, because there has been a tendency over the long run for customers to substitute other metals--aluminum as a metal, and plastic materials where possible, and so on. Also, it means that our relative position in foreign trade has been deteriorating, as you know. Last year, for the first time, we became a net importer of steel products, which are supposedly an American specialty.

As I was explaining to someone during the break, it is changes in relative prices that affect our foreign trade position. It is the fact that the relative price of steel, compared with the overall wholesale price index, has risen in this country, compared with the relative price of steel in other countries, which has disadvantaged our producers and caused a shift in the trade pattern. This will happen to any industry whose costs have risen relative to the costs in the economy as a whole.

Now, with respect to the recent settlement, let me say that this is a much more reasonable settlement than the average in the postwar period. Instead of 7 or 8 percent, the increase in wage rates per annum, computed on a per-year basis, is about 3.5 to 4 percent. It hasn't all been worked out yet. It is hard to translate some of these fringes into dollar terms and put them on an annual basis. But, if it is near 3.5 percent, this is not much more than is consistent with stable prices. This is certainly a move in the right direction. It means that at least the steel

industry is not going to be falling behind its foreign competitors to the extent it has in the past, and I think it is much more economically sound.

I am in favor of all of us increasing our real planes of living. Most of us are employees, after all. But the thing is, it doesn't help to get a bigger than average increase if prices go up and eat it away so that we end up with no more than we would have gotten had the money increase been more moderate.

The present rate of increase in steel probably will mean a small increase in steel mill product prices, but that itself will depend somewhat on what happens to productivity. If the industry can increase its efficiency more in the next year or two than it has in the last 10 years, maybe it can absorb this.

One other factor in the picture is the rate of profit. Of course the union stressed the large profits of the steel companies. Let me say that the absolute level of profits is not relevant unless you take into account the absolute amount of investment, because it is the rate of return on the invested capital which is important. When you look at the rate of return on capital, it is true that this has held up better in the steel industry in the last 10 years than it has in other manufacturing industries. There has been some sagging in the profit rate in manufacturing generally. The steel companies have been able to hold up their rate of profit at about the same rate over the last decade.

If the steel companies were willing to accept some reduction in their rate of profit, there again, I think, they could absorb this, together with their productivity advance, and not have to raise prices. However, there is some minimum rate of return on capital which is necessary to encourage people to save and invest. You can't infringe on that. Probably the steel rate could be reduced a bit. However, that is a decision for the management of the industry.

QUESTION: Doctor, going back to your productivity figure for the national level, that equation you have over there, I am curious what happens if for "O" you substitute gross national product in current dollars, for "L" you use prices paid for labor in current dollars, and for "C" you use capital input in current dollars. How does that compare with the adjustments you go through to get it just on the man-hour basis, and then go back to some base year?

DR. KENDRICK: If you have these in current dollars, then they are equal, because, the national product at factor cost--exclusive of depreciation and indirect taxes, which have to be covered in price and don't represent a payment to the factor--is equal in current dollars to the national income. In other words, in current dollars, if the two sides are equal, that merely means that the receipts from production are paid out to somebody, or accrue to the owners of the equity capital in the form of undistributed profit, so they are equal. This means that the market mechanism is distributing the productivity gains to the factors of production. Somebody has to get the increased output, or the increased income to buy the increased output, and it automatically occurs through the pricing of the factors relative to the prices of the products.

In order to get the changing technical relation, you have to eliminate those price changes and put them both into constant prices, into physical volume terms, and then you find that the output has been rising faster than the input.

I'm glad you brought that up, because it is important to realize that the market mechanism distributes the productivity gain. The way it has worked, it has distributed it to labor. I might say one word or two more about that. This isn't a result of unions or anything else, in my opinion. It is a result of the pricing function of the market, and, as I indicated before, capital has increased in supply faster than labor; as we know, the item that increases more in supply is apt to increase less in relative price. Since capital has risen more in supply, its relative price has fallen, compared with labor. They have both gone up, but the price of capital has gone up less than the price of labor. The price of capital has gone up only as much as the price level, which means the rate of return has stayed constant. The price of labor, the wage rate, has gone up faster than price, which means that real average earnings have risen, and, as I say, labor has gotten almost all of the productivity gain, according to my computations, as a result of this pricing mechanism.

I think we are very fortunate in having an enterprise economy to make all of these decisions for us. As I read the reports of some of the Russian bureaus, they have a terrible time allocating resources. In trying to have a centralized allocation of resources, this segment gets too little, that segment gets too much, production is slowed down here for lack of components or raw materials. I think our type of market-directed economy is much more efficient. It not only takes care of

the allocation of resources but takes care of the allocation of income, although we alter it somewhat through taxation.

QUESTION: My question probably stems from my lack of understanding of the units you used in the construction of your charts. You mentioned that it was necessary to weight the labor because of the fact that the man-hour in a lesser skill was not equivalent to a man-hour in one of the higher skills. It would seem to me that before it could be applied to your formula the labor would have to be converted into dollars anyway, and that the differential in wage rates between the skills would automatically take care of this. Could you straighten me out on that point?

DR. KENDRICK: If you just have a straight output per man-hour measure you do not have to convert it to dollars. You can just divide output by man-hours and get output per man-hour. To combine labor input with capital input you do have to use the common denominator of the dollar in terms of the income which goes to each factor, which we assume represents the relative contribution to output of each factor. So we have to go through the weighting procedure of the man-hours to get it into dollars, the constant dollar labor input, weighting man-hours of each type by average earnings in a base period in order to combine it with capital, which is the constant dollar capital stock weighted by the base period rate of return. In other words, if our constant dollar capital stock were 100 billion and the base period rate of return was 6 percent, then our capital input in effect would be 6 percent of 100 billion, or 6 billion, which is an absolute dollar amount we would combine with the weighted labor input. And so on year by year, but with this movement being determined by the change in man-hours by type and the change in capital stock in constant dollars, with the prices not influencing this input measure.

The technique does become a bit complicated but it is in accordance with accepted statistical procedures in this sort of thing. One trouble is that in any kind of statistical aggregate the movement of the aggregate is influenced somewhat by the base period you take for weighting. In other words, relative wage rates change and the relative return of capital and labor changes. If I use 1929 as my base instead of 1949 I get a different movement of the aggregate. This is also true of output because relative prices change. We weight our units of output by price. It makes a difference whether you choose 1959 or 1939 as your base.

A statistical oddity is that the earlier the base you use the greater the increase you get in your output and your input measures because the relative price falls of items that have increased most rapidly in production. You look at the radios and the TV's, and so forth. They fall in relative price as their production increases rapidly. So that, when you use early weights, you are weighting fast-growing items heavier than when you use late weights. In using late weights you get less increase. That's one of the reasons why the Russians use the 1920's for their weight base. It gives them a much bigger increase in production. If they used later bases their increase in production wouldn't look to be so big. You have to consider that in comparing country production rates, to use the same weight base in the comparison.

However, I didn't mean to get into technical aspects. But you asked for it.

CAPTAIN FIKE: I don't know whether this will be a question or a statement, but this student has something to say.

DR. KENDRICK: Fine. I welcome statements, too.

QUESTION: I didn't intend to ask this, but you generated it by your comments. How good is this self-generating thing that we have compared to the Russian problem? It is what that "O" stands for that concerns me. Do you think that the "O" we are making now is really a proper one for the condition of the world? You put the moral issue up, so this is a more political than an economic question.

DR. KENDRICK: Let me say that, if we had an international order without the possibility of conflict among nations, I think the market would be the best method for allocating resources according to people's wants. If people want one item more then the price rises and resources flow into that type of production, and so on. The market allocates according to people's preferences. However, when you have the need for large national security outlays, then you immediately get into a political decision as to how much should be devoted to this area. Also, you have the same decision to a lesser extent on the usual civilian functions of government as to how much should be devoted to education, and highway construction, and the things that are accepted government functions.

How much of our national product should be devoted to public purposes is a big problem. Here we are no better off than the Russians are. Here we have to make the decision through value judgments in

our Government bodies. Congress makes a decision. Whether or not their decisions are perfectly correct I am not wise enough to say. I know that some people feel that we should be spending considerably more for public education, for roads, for school buildings, for research and development, and for defense. The thing is that this means that we have less for other things, and people hate to pay more taxes or to deprive themselves.

So it has to be a decision the community as a whole makes. I think that, if the community as a whole feels that it is a problem and that we should be devoting more to these common purposes, then this will be felt in the legislative decisions.

But you are aware of the problem as much as I am. I can't say that our allocation between the public and private sectors is correct. My own feeling is that probably we should be spending more for some public services.

QUESTION: Sir, we know that many of our technological achievements of recent years have been due to developments of the military, or brought about by military requirements. Have you got any figures that show how our increased productivity is related to our military budget?

DR. KENDRICK: No, I do not, except that I know that the major portion of our research and development is being financed by the Federal Government in one branch or another, although most of it is contracted out to industry or to universities. Therefore, I would say that indirectly, at least, the military research and development program has been an important factor. Of course there are a lot of indirect civilian applications of many of the discoveries that are made in that program. I think it is important. I have no measure of just how important it is, though.

QUESTION: In your formula for productivity, how do you treat what I would call management overhead--the salaried departments of research and development, the comptroller, the personnel offices, staff officers, the president of the company? Is that labor or capital?

DR. KENDRICK: That is labor. I have all work in as labor. You can't really distinguish. I mean, all people who perform productive work are contributing to the output. I even included the man-hours of proprietors of their own enterprises here. It's all work. Production

is a cooperative process in which the various skills and the providers of labor and of capital cooperate.

You did bring up one difficult problem when you mentioned the people who are engaged in research work. This is a problem because their output is not reflected in the current year. Usually it is longer range and is reflected in output of later years, and yet we count their man-hours in the present year. So there is a little distortion insofar as some workers are engaged in investment-like activities which bear their fruits in later years, but their work is counted in the current year. This, as I say, is a little distortion, but it can't be too big, because the total proportion of workers in research and development work is less than 2 percent.

It is a problem. It is also true of force-account construction workers in industry. This doesn't show up in our output index but it does show up in the input. There is a little lack of balance sometimes between input and output. But this is not serious, because relatively small amounts are involved.

QUESTION: Regarding your studies on the productivity of labor, of course, we have heard a lot about featherbedding, make-work rules, and all the other things that many people claim are holding down to a considerable extent the productivity of the labor force. It is a little complicated, because you've got management included in there as labor, and what not. What do you think is a fair increase in the productivity of labor if we could get rid of this alleged featherbedding practice, et cetera? Or is it a very serious thing in the aggregate?

DR. KENDRICK: I would like to see some studies made of the amount of man-hours that are wasted by this type of practice. It certainly is not as bad here as it is in Europe. Our unions in this country generally have accepted the desirability of technological change, of new machinery, new methods, although often they set up procedures whereby they will be consulted on the introduction. I think this is the most important thing, that labor be willing to accept new methods and equipment, and in general this is true in this country. Labor has not obstructed improving technology.

However, at times there have been these rules which require more people than are necessary for certain jobs, and so on. It is particularly flagrant, presumably, in the railroad industry, and since the war there has been a little of that in the steel industry, which was at issue in the recent wage negotiations.

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It would be desirable, of course, to try to gradually eliminate that. In order to do it I think you have to give the workers a feeling of security on their jobs. In other words, there is a reason why these rules have grown up. Everybody is interested in security. If methods could be set up whereby workers would be retrained within the same companies for new jobs when their jobs were eliminated by technological change, or if the work force was reduced in a company, if procedures were set up for the retraining of workers for jobs in other industries, and so on, I think this would help to cut down on that type of rule.

In other words, if you look at the source of these rules and try to attack that source, the insecurity resulting from technological change, then possibly constructive action could be taken on it. But it is very complicated. In general I don't think it is a big source of waste, and, as long as it stays in the same proportion, it won't affect the productivity change. It is only if this practice spreads that it would be particularly bad. Of course you get a little boost in productivity if this could be reduced. I would hope that we can work in that direction.

Incidentally, in conclusion, let me say that these output-per-man-hour measures obviously do not reflect changes in the efficiency of labor as such. I hope I have indicated that. They reflect merely the saving in labor achieved as a result not only of labor efficiency but of management efficiency, of technological change generally, and of the substitution of capital for labor.

CAPTAIN FIKE: Dr. Kendrick, on behalf of the Commandant, the faculty, and the students, I would like to thank you very much for increasing our knowledge and understanding of productivity. Perhaps you have given us a new focus for our lens to go out in the field next week and look at some of these managements that we will visit and evaluate them with this new thought.

DR. KENDRICK: I have enjoyed talking with you.

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