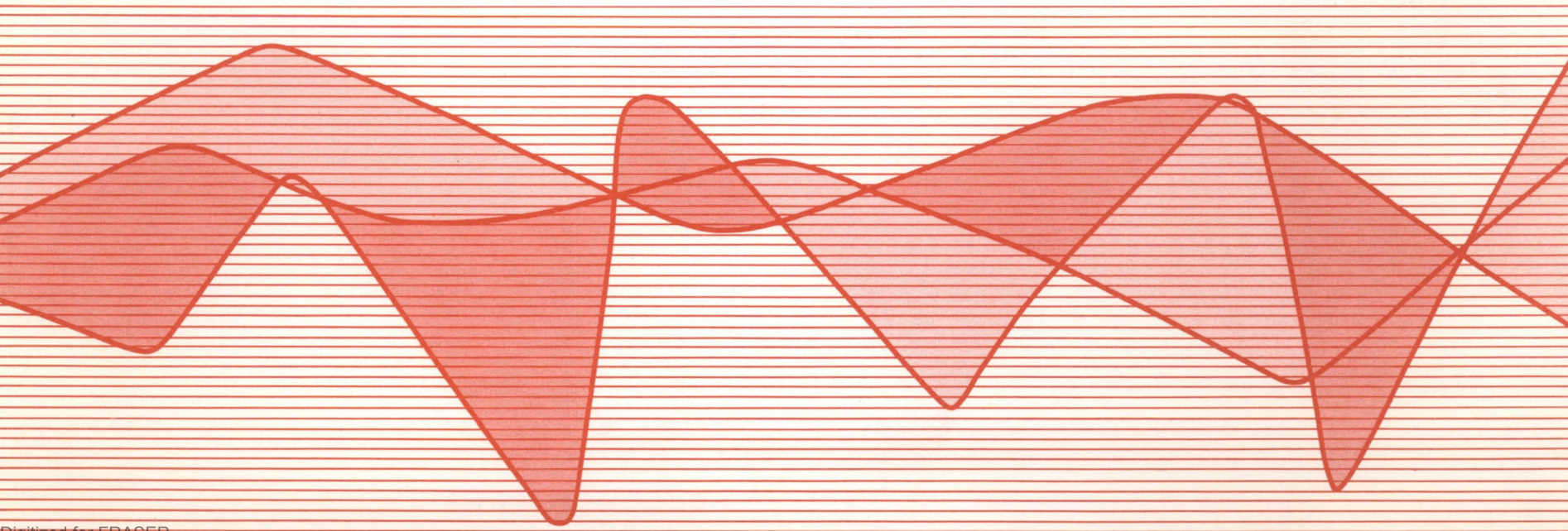
Productivity and the Economy

Revised 1973 Edition

Bulletin 1779

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics



Productivity and the Economy

Bulletin 1779

Prepared for the National Commission on Productivity by the Bureau of Labor Statistics

U.S. DEPARTMENT OF LABOR
Peter J. Brennan, Secretary
BUREAU OF LABOR STATISTICS
Ben Burdetsky, Deputy Commissioner
1973

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Preface

Productivity is involved in one way or another with most issues of economic policy. As a result, there is a continuous need for information about productivity, although the focus of attention varies with the economic climate. During periods of economic slowdowns, for example, interest turns to the relationship between productivity and unemployment, and concentrates on the role of changing technology. On the other hand, during periods of rising prices, attention centers on the relationship between productivity and wages.

This chartbook is designed to show what productivity is and how it operates. With this end in view, the book is divided into three parts. The first part shows how productivity has developed over time, the second presents changes in factors that are influenced by productivity, and the third traces trends in the various factors that influence productivity. Wherever possible, comparisons are made with foreign countries in order to add an international perspective to a subject that is often treated within a solely national framework.

In order to create a better understanding of productivity, this chartbook draws on the best available information, using a variety of sources in addition to material produced by the Bureau of Labor Statistics. This presentation in no way implies that the Bureau accepts all of the measures and concepts involved, but rather our hope of broadening the scope of discussion of that essential element in the Nation's economic well being – productivity.

This bulletin was prepared by the staff of the Office of Productivity and Technology under the general direction of Jerome A. Mark, Assistant Commissioner for Productivity and Technology.

Contents

Part I.

Trends in productivity

Productivity is a concept that expresses the relationship between the quantity of goods and services produced–output, and the quantity of labor, capital, land, energy, and other resources that produced it–inputs. Basically, productivity can be measured in two ways. One way relates the output of an enterprise, industry, or economic sector to a single input such as labor or capital. The other way relates output to a composite of inputs, combined to reflect their relative importance. The latter type of measure, which is usually called a total factor measure, is the most comprehensive as it takes all possible inputs into account. However, the practical problem of identifying and measuring all inputs is a long way from being solved, and no total factor measure has yet won general acceptance. The most commonly used measure of productivity using a single input relates output to the input of labor time–output per man-hour, or its reciprocal–unit labor requirements. Labor time includes the man-hours of all persons employed in the production process. Man-hours are treated as homogeneous: no distinction is made between hours of employees at different levels of skill or pay.

One reason for the usefulness of a labor productivity measure is that labor input is readily measurable at several levels: the total private economy, its component sectors, industries, or plants. In addition, labor is quantitatively the most important factor in the economy. For these reasons, the productivity measures used in this book are expressed in terms of output per man-hour. Nevertheless, output per man-hour indexes do not imply that labor is solely or primarily responsible for productivity growth. In a technologically advanced society, labor effort is only one of many interrelated sources of improvement. Trends in output per man-hour also reflect technological innovation, changes in capital stock and capacity utilization, scale of production, materials flow, management skills, the state of labor relations, competitive pressure, and many other factors the contribution of which often cannot be measured.

The output side of the output per man-hour ratio refers to the finished product or the amount of product added in the various enterprises, industries, sectors, or the economy as a whole. Few plants or industries produce a single homogeneous commodity that can be measured by simply counting the number of units produced. Consequently, for the purpose of measurement the various units of a plant or industry's output are combined on some common basis, either their man-hour requirements in a base period or their dollar value. When information on the amount of units produced is not available, as is often the case, output must be expressed in terms of the dollar value of production, adjusted for price changes.

Productivity trends in the total private economy and the nonfarm and corporate sectors

Long-term movements in aggregates such as productivity in the private, nonfarm, and corporate sectors reflect changes within the various component industries as well as shifts in their relative importance. That is, changes in output per man-hour are influenced not only by increases or decreases in the component sectors but also by employment shifts between high and low productivity industries.

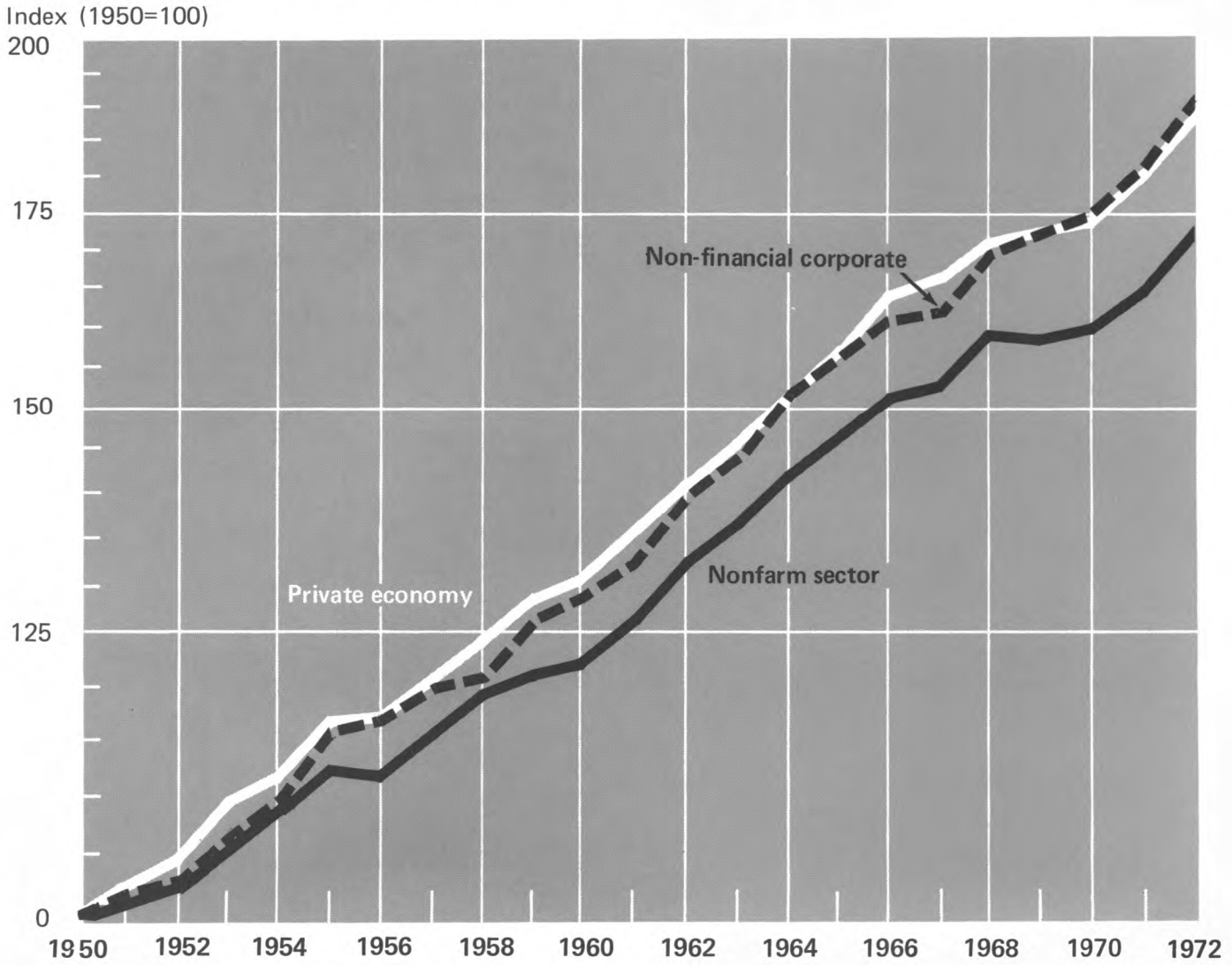
Between 1950 and 1972, productivity grew faster in the total private economy than in the nonfarm sector. To a large extent, this situation reflected both the greater increase in farm productivity and the shift of workers out of the farm sector, where the level of productivity is relatively low, into higher productivity jobs in the nonfarm sector. This shift contributed about 0.3 percent to the long-term average rate of growth in the private economy.

Corporate productivity also grew faster than nonfarm productivity. This disparity came about because the greater part of industries where productivity tends to be low – industries such as services, construction, finance, and real estate – are not incorporated and are thus not part of the corporate sector.

Year and period	Average annual percent change in output per man-hour		
	Total private economy	Nonfarm sector	Corporate sector
1950-72	3.0	2.6	3.0
1950-60	2.8	2.2	2.7
1960-65	3.9	3.5	4.1
1965-72	2.3	2.0	2.7
1968-69	0.4	-0.1	2.1
1969-70	1.0	0.6	1.0
1970-71	3.6	3.6	4.7
1971-72	4.2	4.7	4.7

Chart 1.

Output Per Man-hour in the Private Economy and the Nonfarm and Corporate Sectors, 1950-72



Recent trends in productivity

Productivity analysis varies with the length of the period studied: short-term movements show cyclical effects, while long-term movements reveal a secular trend. Typically, productivity movements follow a certain pattern in the course of a business cycle. When business activity starts to decline, output per man-hour generally drops sharply as capacity utilization falls below optimum rates. Once cost-cutting efforts get underway, adjustments are made and the decline in productivity is arrested or reversed. When activity picks up again, output per man-hour increases at a faster rate because of higher capacity utilization. Then, after a sustained period of production increase, bottlenecks emerge, less efficient resources are brought into use, and the rate of productivity advance declines.

Recent movements in productivity show how the business cycle causes shortrun changes that diverge from the long-term trend rate. Chart 2 shows that actual productivity fell behind trend productivity in late 1968 and reached its most distant point in the first quarter of 1970. The economic upswing started to close the gap in 1971, and virtually eliminated it by the end of 1972.

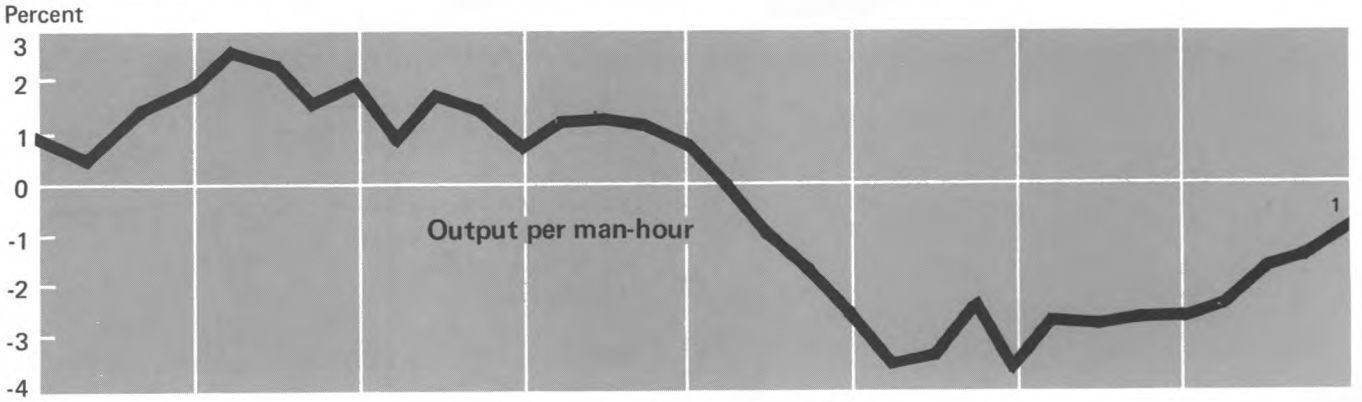
Total private economy
Average annual percent change

Year and quarter		Output per man-hour	Output
1969	I	-0.5	3.6
	II	-0.9	1.8
	III	-0.1	1.7
	IV	-0.8	-2.5
1970	I	-1.3	-2.6
	II	4.3	1.7
	III	6.9	2.3
	IV	-1.9	-5.1
1971	I	7.5	8.7
	II	2.2	3.7
	III	3.2	2.5
	IV	3.7	7.2
1972	I	3.9	7.0
	II	6.2	10.2
	III	4.1	6.5
	IV	4.7	8.4

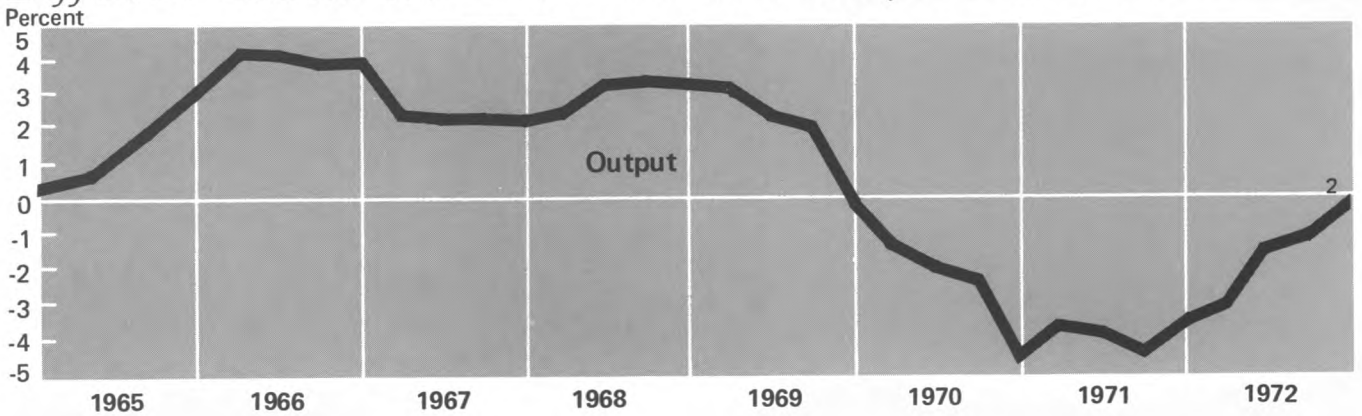
Chart 2.

Output Per Man-Hour and Output in the Private Economy

Difference Between Quarterly Productivity Movements and Long[1] Term Trend, 1965-72



Difference Between Actual and Potential Output Levels, 1965-72



[1] Long term trend = 3.0 percent, 1950 - 1972

[2] Trend of 4.0 percent from 1965 (1st Qtr.) to 1969 (4th Qtr.). Trend of 4.3 percent from 1969 (4th Qtr.) to 1972 (4th Qtr.).

Productivity trends in major sectors

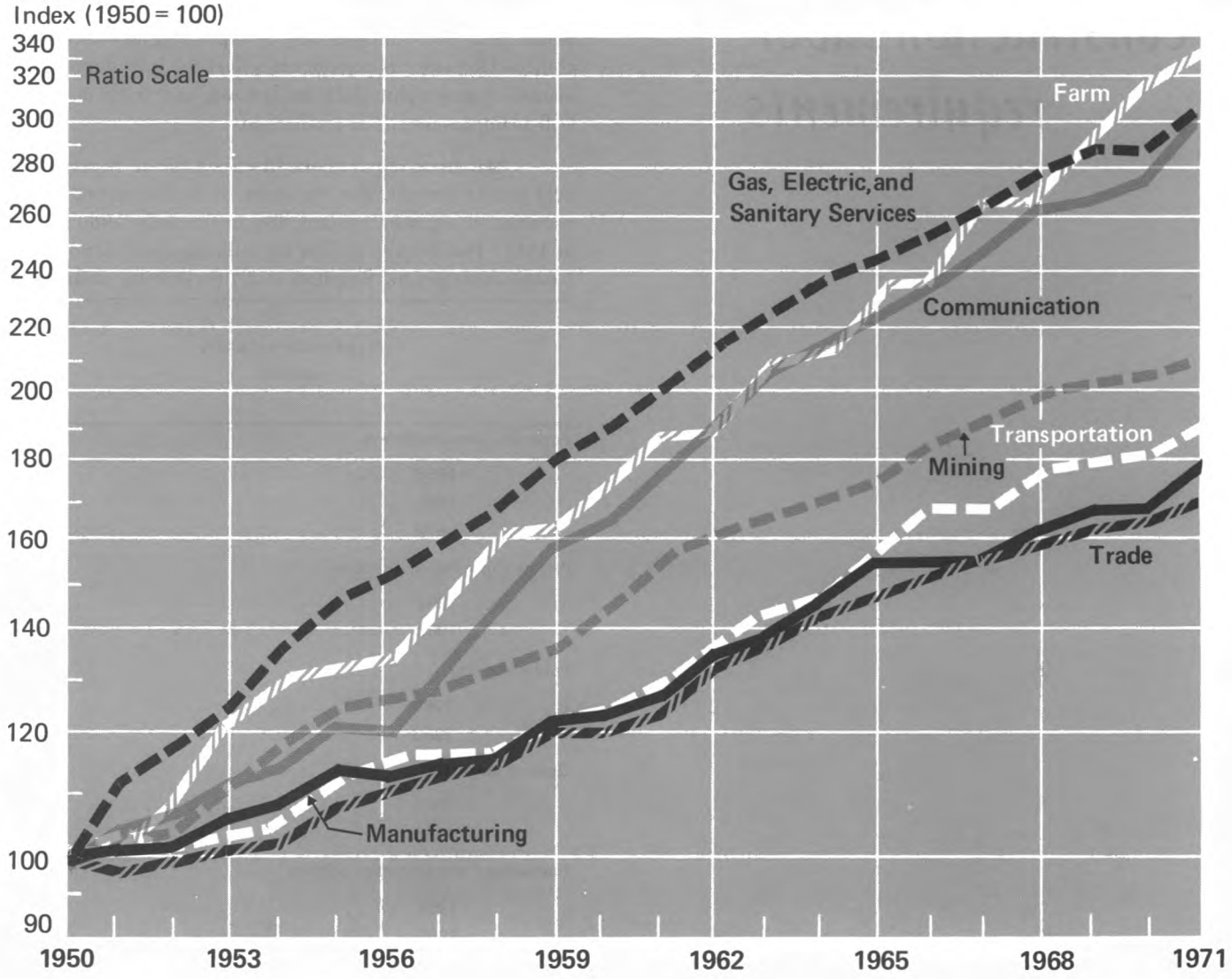
Productivity growth varies from sector to sector over both the short and the long term. Between 1950 and 1971, the average improvement in output per man-hour ranged from 5.8 percent a year in the farm sector to 2.9 percent a year in trade and manufacturing. Sectors for which adequate productivity information is not yet available – services, construction, and finance, insurance, and real estate – are estimated to have even lower long-term rates of productivity growth.

Productivity growth in sectors varies in the short run according to the effect of changes in the business cycle. For instance the farm sector, which is relatively unaffected by cyclical movements, was the only one in which productivity grew faster during the latter half of the 1960's than during the early half.

Sector	Percent change in output per man-hour		
	1950-71	1960-71	1965-71
Farm	5.8	6.1	6.5
Communications	5.6	5.2	4.7
Electricity, gas, and sanitary services	5.3	4.3	3.8
Mining	3.7	3.3	2.8
Transportation	3.3	4.1	2.9
Manufacturing	2.9	3.2	2.5
Trade	2.9	3.2	2.2

Chart 3.

Output Per Man-Hour by Major Sector, 1950-71



Trends in construction labor requirements

Since technical problems still impede development of an adequate productivity measure for the construction sector, the best available insight into changes in construction productivity is provided by studies of labor and materials requirements for various types of construction over time. Though declines in man-hour requirements would seem to be another way of expressing increases in output per man-hour, changes in construction labor requirements reflect the introduction of new methods, equipment, and materials; geographic shifts in demand; and shifts in the type of building constructed; as well as improvements in productivity.

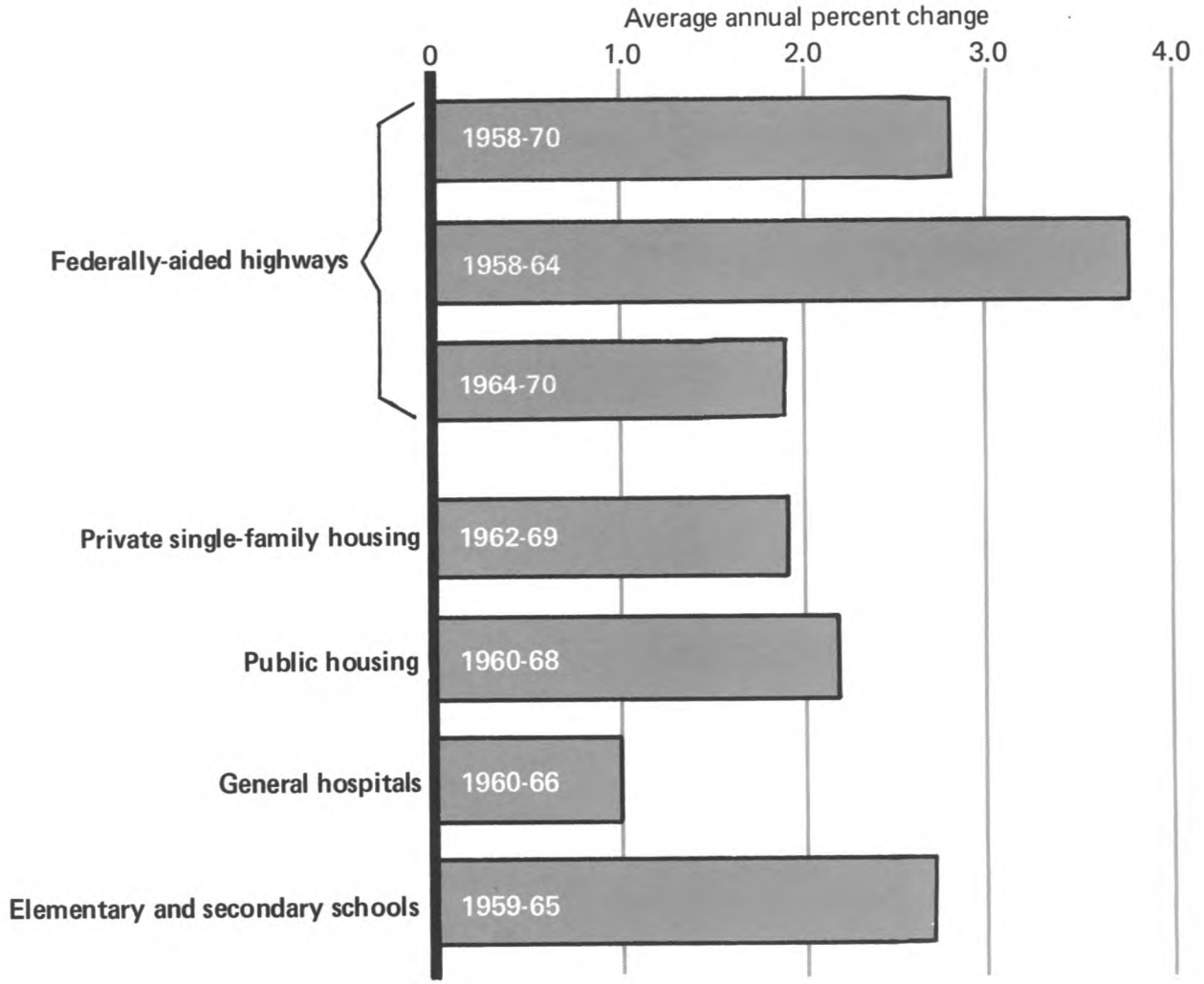
Man-hour requirements declined for all types of construction studied by the BLS over recent periods, but the rates of decline varied considerably. The sharpest decline occurred in highway construction in the early 1960's: a significant slackening was noted in 1964. The average decline for building construction was about 2 percent, ranging from 1 percent for general hospitals to 2.7 percent for elementary schools.

Type of Construction and year	Onsite man-hour requirements per $1000 constant dollars of construction
Federally-aided highways	
1958	91
1964	72
1970	65
Private single-family housing	
1962	72
1969	64
Public housing	
1960	114
1968	96
General hospitals	
1960	230[1]
1966	217[1]
Elementary and secondary schools	
1959	119[1]
1965	102[1]

[1] Per 100 square feet.

Chart 4.

Decline in Onsite Man-Hour Requirements for Various Types of Construction, Selected Periods, 1958-70



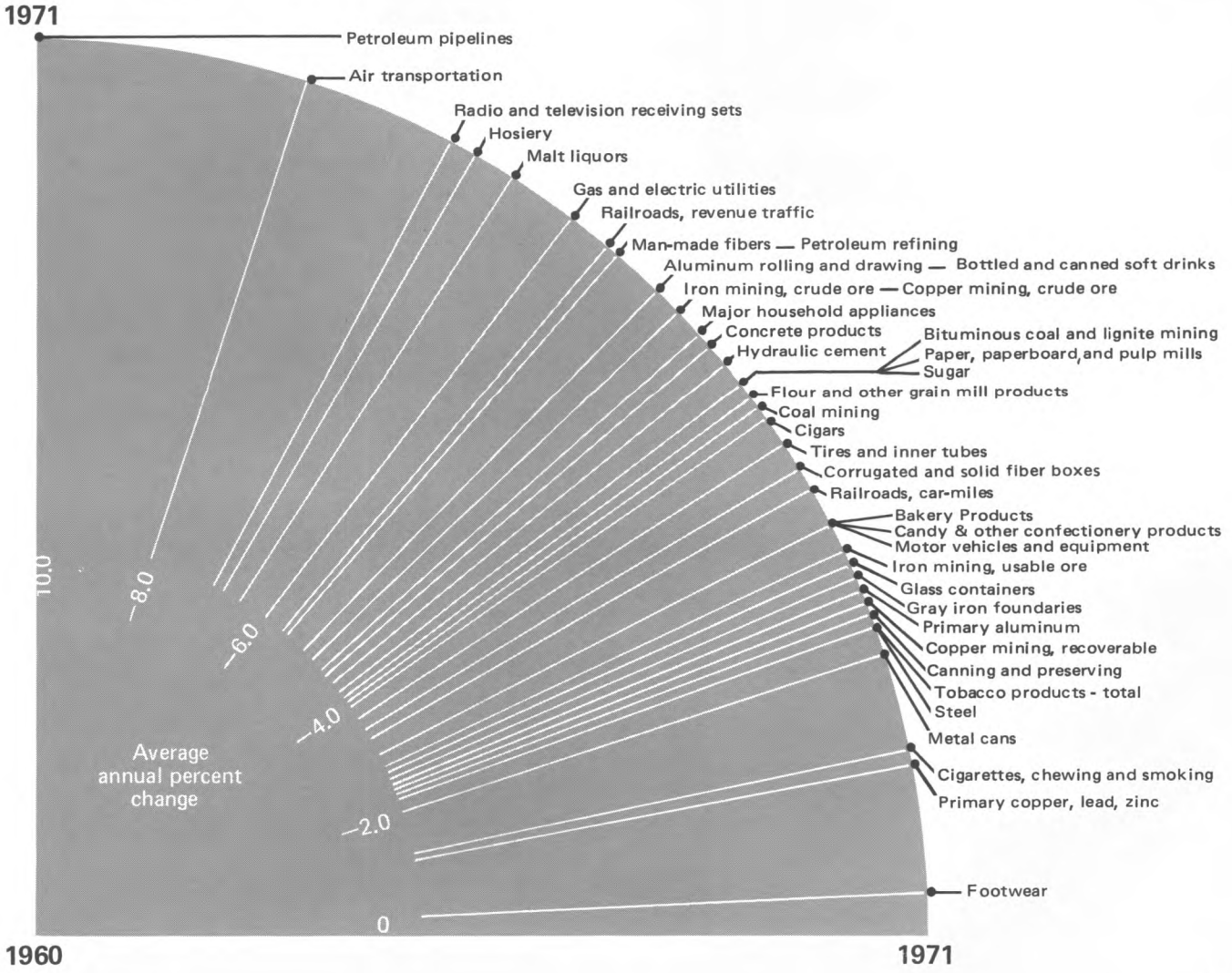
Productivity trends in industries

Variations in output per man-hour growth among industries stem from many sources. For example, the large productivity advances of the 1960's in air transportation were produced by the introduction of jets and the great expansion in traffic. The lack of productivity growth in the footwear industry resulted from the fact that footwear producers deal with a variety of sizes and styles that make adoption of mass-production methods difficult. Low productivity gains in copper mining reflected a situation in which operators were faced with less and less recoverable ore as the richest veins became exhausted.

Although productivity trends for individual plants are not shown in the chart, they vary in both the level and the rate of productivity growth. Some plants may exceed the trend for the industry significantly, while others may lag well behind the average.

Chart 5.

Growth in Output Per Man-Hour in Selected Industries, 1960-71



International comparisons: Productivity trends in manufacturing

Growth in manufacturing productivity since 1960 has varied substantially in the countries for which the BLS makes productivity comparisons. Between 1960 and 1972, average annual gains in output per man-hour ranged from 3.1 percent in the United States to 10.4 percent in Japan. Although the U.S. growth rate was the lowest, the evidence available indicates that the United States continues to have the highest level of manufacturing productivity, though this may not be true for all industries.

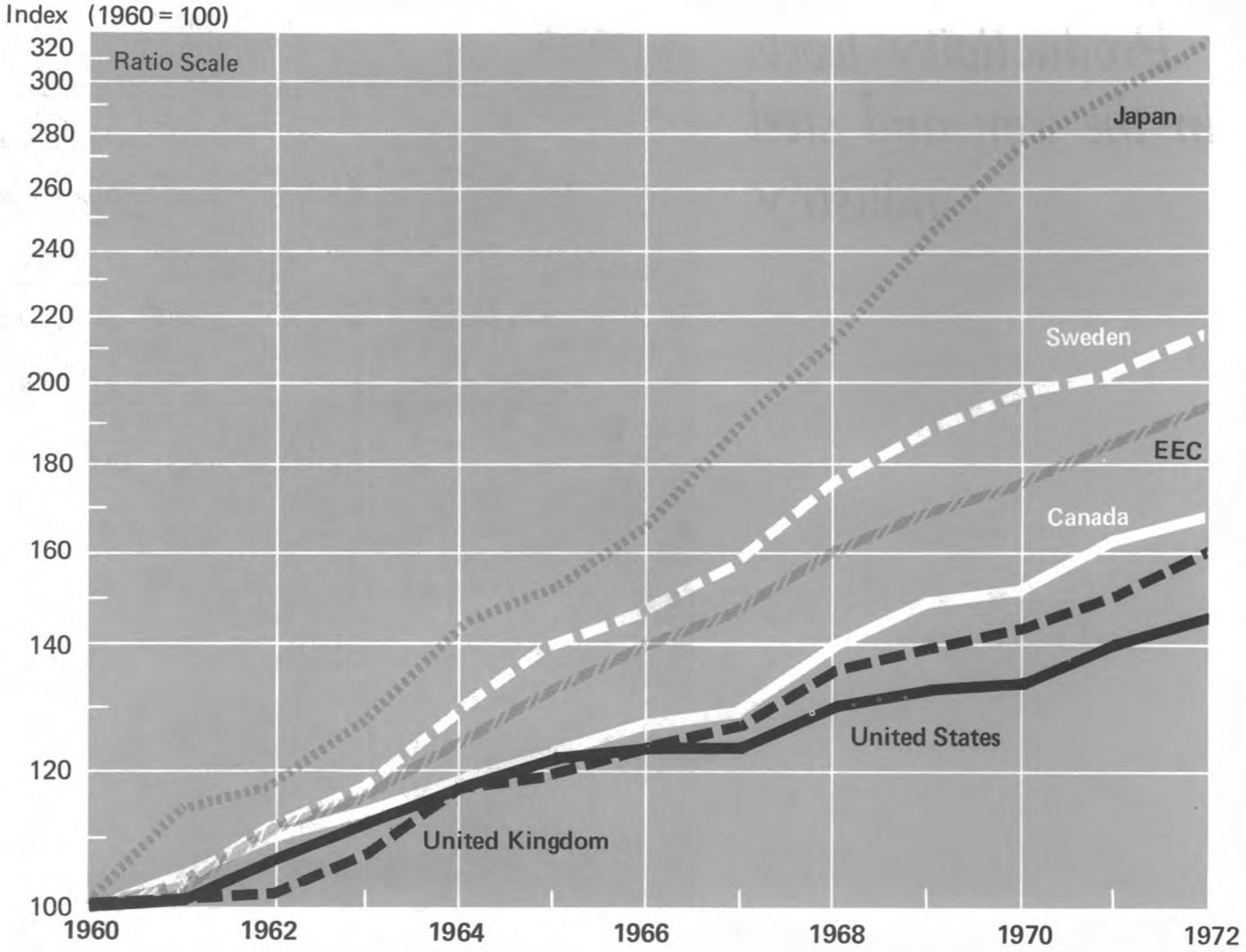
The largest gap between productivity growth rates existed during the 1965-70 period, when manufacturing productivity grew 2.0 percent a year in the United States and 13.2 percent a year in Japan. The economic recovery that began in 1970 brought about a substantial improvement in U.S. productivity growth. Though productivity still grew at a faster rate in most of the other countries between 1970 and 1972, the margins by which these rates exceeded the U.S. rate were reduced significantly.

Country	Average annual percent change, 1960-72[1]			
	1960-72	1960-65	1965-70	1970-72
United States	3.1	4.3	2.0	4.9
Canada	4.4	4.3	4.7	5.1
European economic community	6.0	5.9	6.0	5.7
Belgium	6.6	5.3	7.9	6.5
France	5.8	4.9	6.0	6.9
Germany	5.8	6.3	5.7	5.1
Italy	6.0	6.8	5.3	3.5
Netherlands	7.2	5.5	8.9	6.6
Japan	10.4	8.5	13.2	7.7
Sweden	7.1	7.2	7.7	4.5
United Kingdom	4.2	4.0	3.9	6.6

[1] For many of the foreign countries, 1972 estimates are based on data for less than the full year.

Chart 6.

Output Per Man-Hour in Manufacturing, United States and Other Industrial Nations, 1960-72



International comparisons: Productivity levels in the iron and steel industry

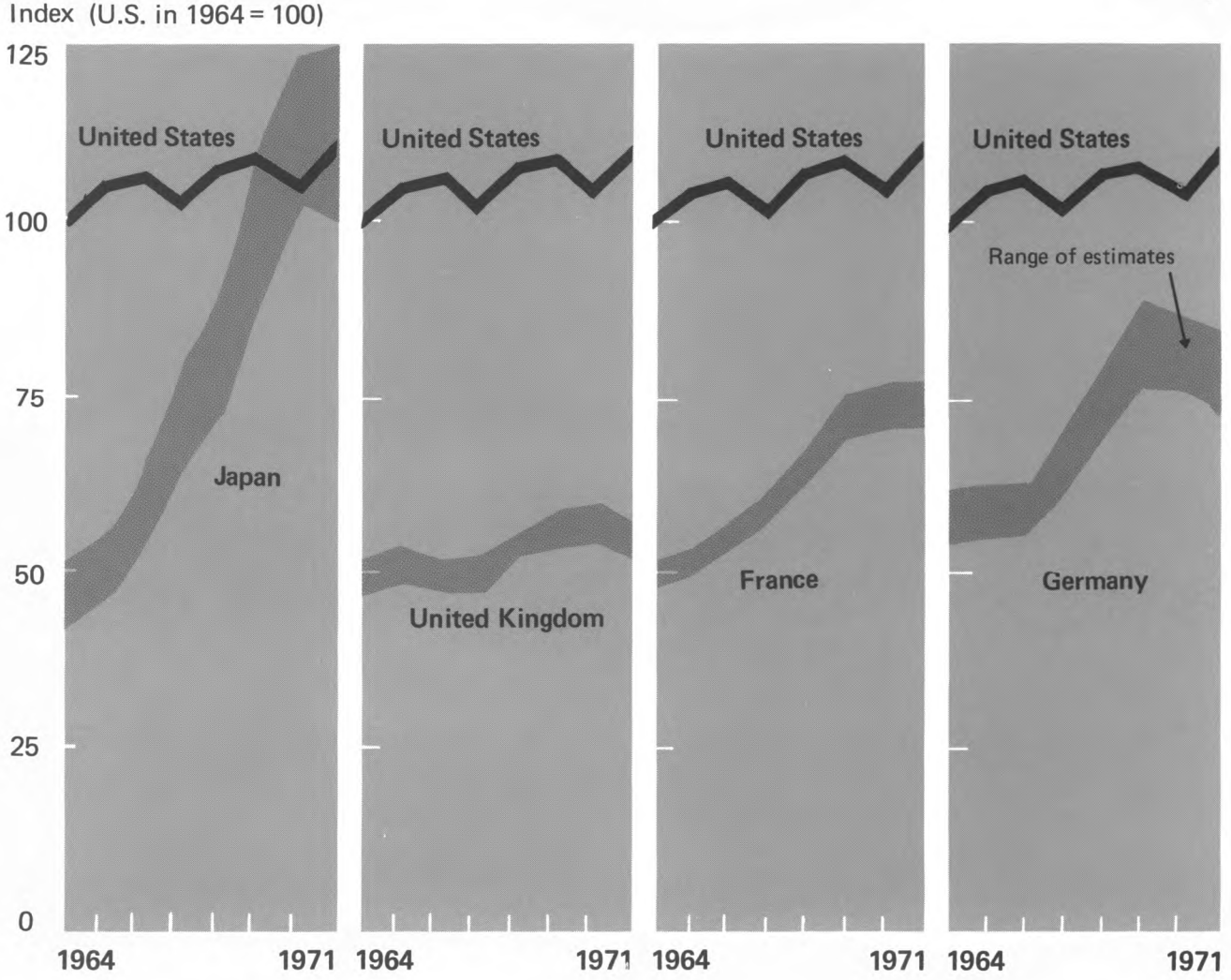
In 1964, productivity in the U.S. iron and steel industry greatly exceeded the levels reached in other major steel-producing countries. Output per man-hour was about 60 percent of the U.S. level in Germany and around 50 percent in France, Japan, and the United Kingdom. In 1971, however, though labor productivity in the British steel industry was still only about half the U.S. level, the French industry was up to two-thirds the U.S. level, the German to about three-fourths, and the Japanese may have exceeded it.

Country	Index of output per man-hour: 1964 = 100			Relative output per man-hour: U.S. = 100[1]		
	1964	1970	1971	1964	1970	1971
United States	100.0	104.8	108.6	100	100	100
Japan	100.0	232.6	234.2	43-54	96-119	93-116
United Kingdom	100.0	115.3	110.6	46-50	51-55	47-51
France	100.0	148.2	147.6	48-51	68-73	65-70
Germany	100.0	139.6	137.0	54.63	73-84	68-80

[1] The data for Japan and the Western European countries are presented in terms of ranges, with high and low estimates, because of data gaps and limitations.

Chart 7.

Relative Levels of Output Per Man-Hour in the Iron and Steel Industries of Five Countries, 1964-71



Part II-a.

Implications of productivity growth for price and cost stability

Productivity movements are an important factor in determining price and cost stability. This aspect of productivity change stems from the role of output per man-hour – an especially relevant concept when dealing with unit labor costs – as a critical link between the cost of labor and the price of goods.

In most industries, labor costs, including hourly rates of pay, overtime, and all types of fringe benefits, are the largest single cost element. Consequently, the trend of labor costs per unit of output plays a major role in determining the price per unit of output. If the effect of an increase in unit labor costs can be minimized by a greater increase in productivity, pressure to increase prices will obviously be lessened, although changes in profits or materials cost per unit of output may offset this effect.

On the other hand, changes in unit labor costs can be a result as well as a cause of price rises. Price increases that cause employee purchasing power to fall lead to pressure for higher wages. If the wage increases exceed productivity growth, unit labor costs will increase also.

These relationships come into play at all economic levels, ranging from competition within an industry to competition between countries. For this reason, achieving productivity growth is a matter of concern to workers and consumers as well as to employers and stockholders.

Trends in productivity, unit labor costs, and compensation

Due to the relative stability of growth in hourly compensation, changes in unit labor costs display a close inverse relation to changes in output per man-hour. The almost mirror image of chart 8 shows that unit labor costs tend to rise when productivity growth slows and to slow or decline when productivity growth accelerates.

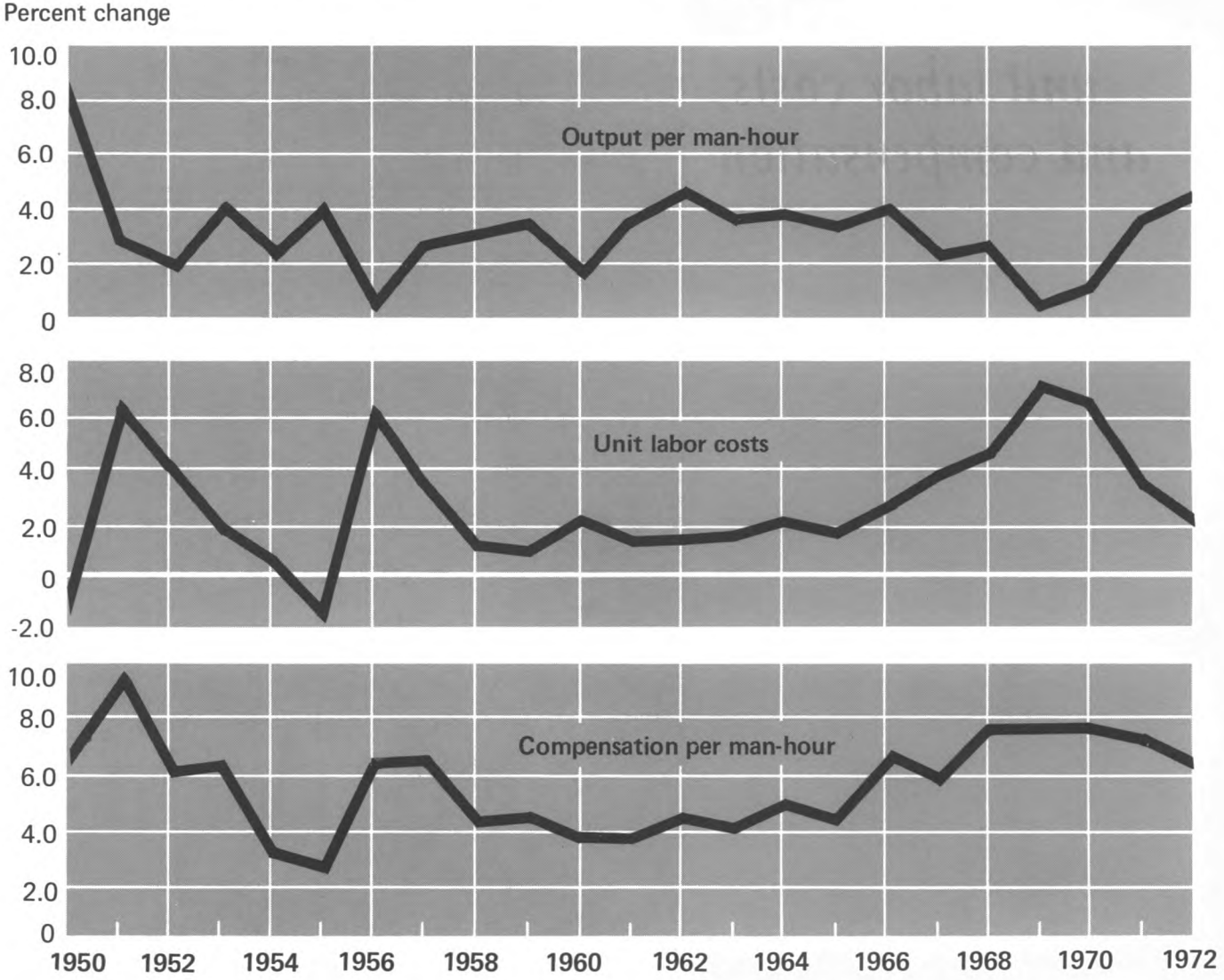
Total private economy

Average annual percent change

Year and period	Output per man-hour	Unit labor costs	Compensation per man-hour
1950-72	3.0	2.1	5.2
1950-60	2.8	2.2	5.0
1960-65	3.9	0.4	4.3
1965-72	2.3	4.7	7.1
1968-69	0.4	7.1	7.6
1969-70	1.0	6.5	7.6
1970-71	3.6	3.4	7.1
1971-72	4.2	2.0	6.2

Chart 8.

Average Annual Percent Change in Productivity and Labor Costs in the Private Economy, 1950-72



Recent trends in productivity, unit labor costs, and compensation

Unit labor cost movements are influenced by productivity change which, in turn, is influenced by shortrun changes in output. During 1971 and 1972, the economic recovery was reflected in productivity growth which offset gains in hourly compensation. As a result, quarterly increases in unit labor costs were generally smaller in these 2 years than they had been in the preceeding few years, when growth in compensation far exceeded growth in productivity.

Total private economy

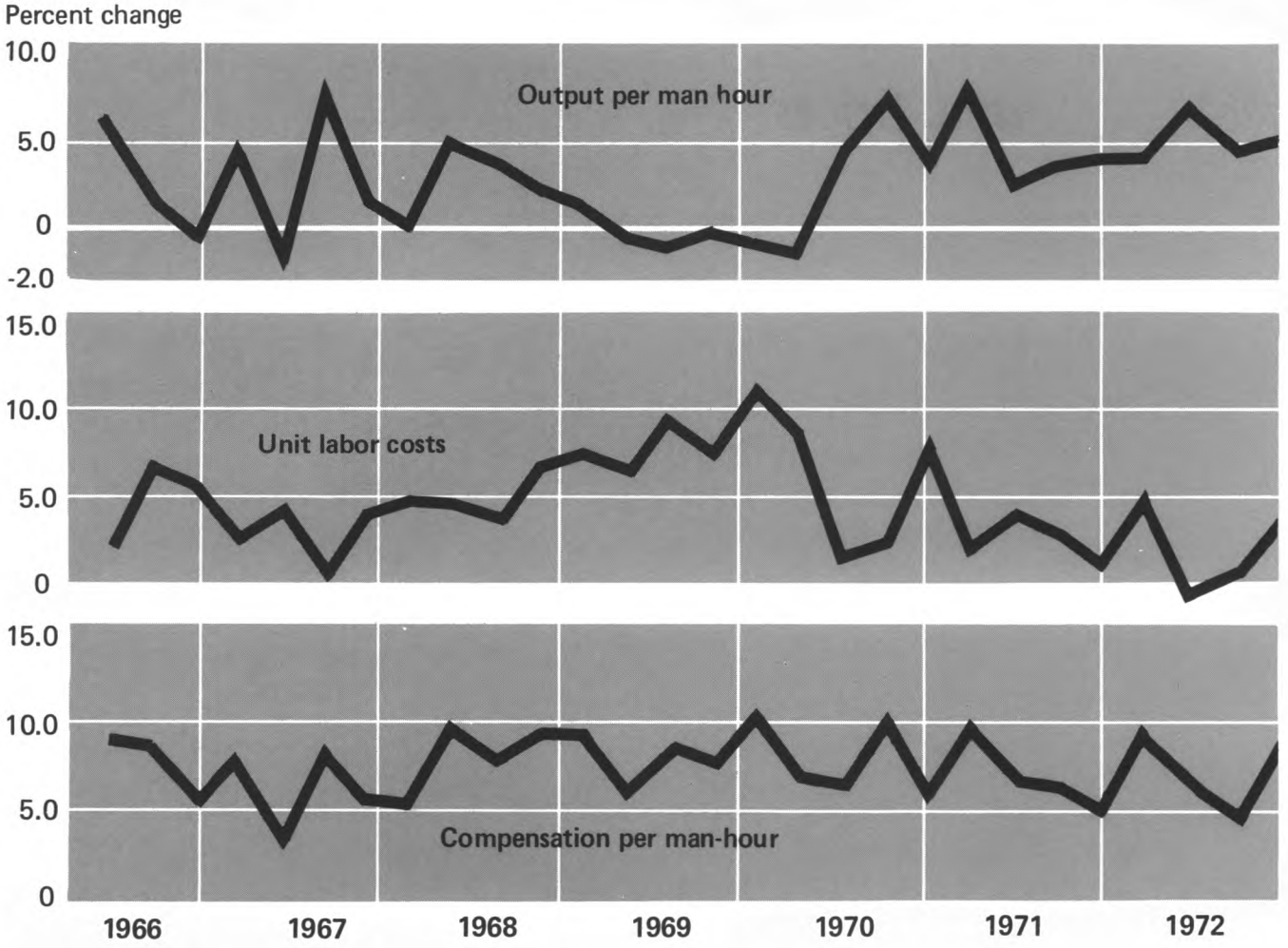
Quarterly percent change at annual rate

Year and quarter		Output per man-hour	Unit labor costs	Compensation man-hour
1969	I	-0.5	6.3	5.8
	II	-0.9	8.9	8.0
	III	-0.1	7.3	7.2
	IV	-0.8	10.7	9.9
1970	I	-1.3	8.3	6.9
	II	4.3	1.6	5.9
	III	6.9	2.4	9.4
	IV	-1.9	7.4	5.4
1971	I	7.5	1.7	9.2
	II	2.2	3.9	6.2
	III	3.2	2.6	5.8
	IV	3.7	1.0	4.7
1972	I	3.9	4.6	8.7
	II	6.2	-0.6	5.6
	III	4.1	0.3	4.4
	IV	4.7	3.0	7.9

Chart 9.

Productivity and Labor Costs in the Private Economy, 1966-72

Quarterly Changes at Annual Rates



Trends in productivity, unit labor costs, and prices

During the early 1960's the unit labor cost component of price change was slight – mainly because productivity increases kept pace with the growth in hourly compensation. As increases in productivity slowed in the late 1960's and increases in compensation speeded up, unit labor costs accelerated and came to represent a larger component of price growth, particularly in 1969 and 1970.

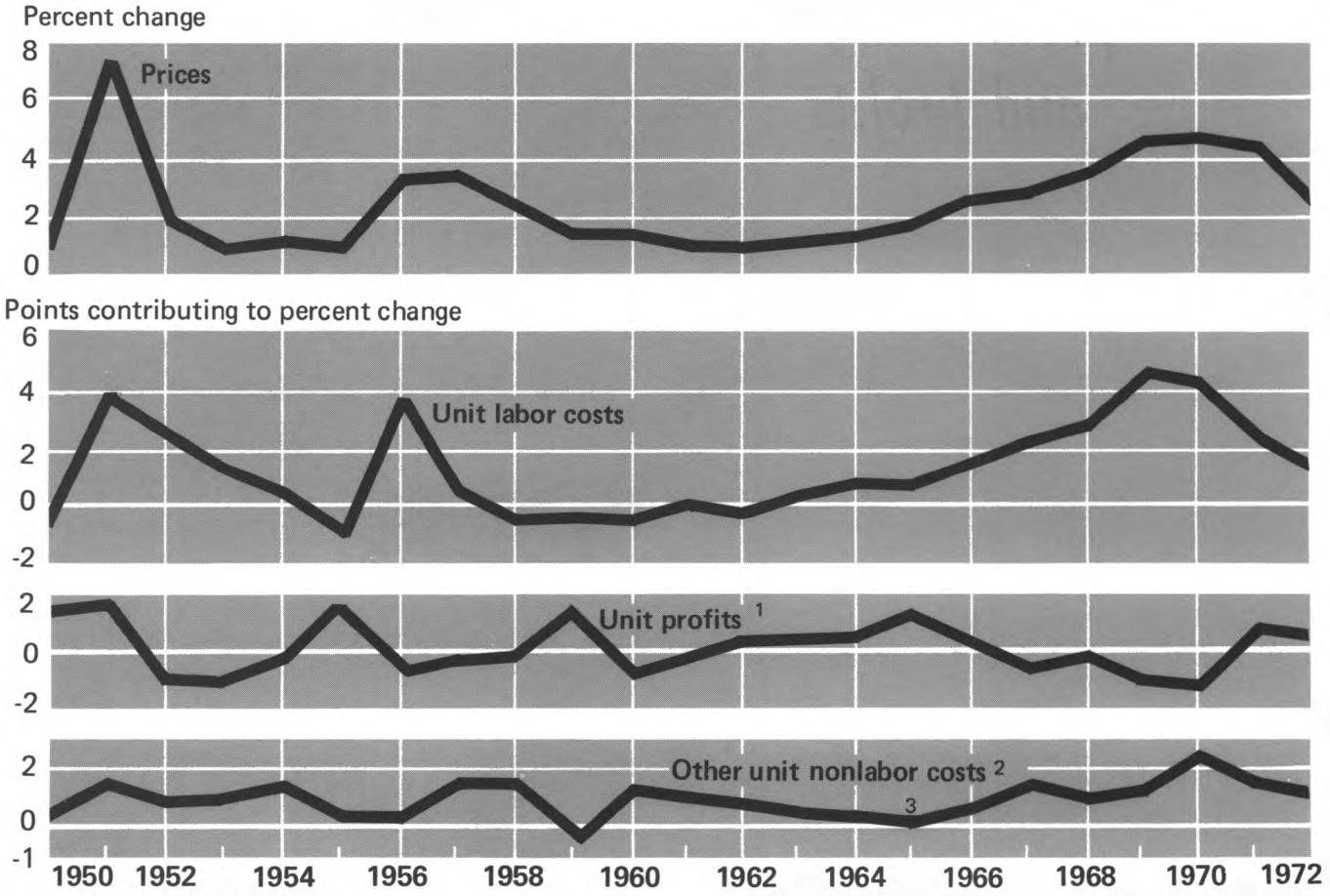
In 1971 and 1972, the trends reversed; productivity accelerated and the growth in hourly compensation slowed. Consequently, the effect of unit labor costs on price increases was much less than in the previous 4 years.

Total private economy

Year and period	Annual percent change in prices	Composition of price change in percentage points		
		Unit labor costs	Unit profits	Other unit nonlabor payments
1960-65	1.2	0.3	0.5	0.4
1966	2.5	1.7	0.2	0.6
1967	2.9	2.2	-0.8	1.4
1968	3.6	2.8	-0.1	0.9
1969	4.5	4.4	-1.2	1.3
1970	4.8	4.1	-1.6	2.4
1971	4.3	2.2	0.6	1.5
1972	2.6	1.3	0.4	1.0

Chart 10.

Composition of Price Changes, Private Economy, 1950-72



[1]Unit profits includes corporate profits, estimated profits of unincorporated enterprises and net rental earnings of owner - occupied dwellings.

[2]Other unit nonlabor costs include depreciation, interest, and indirect taxes.

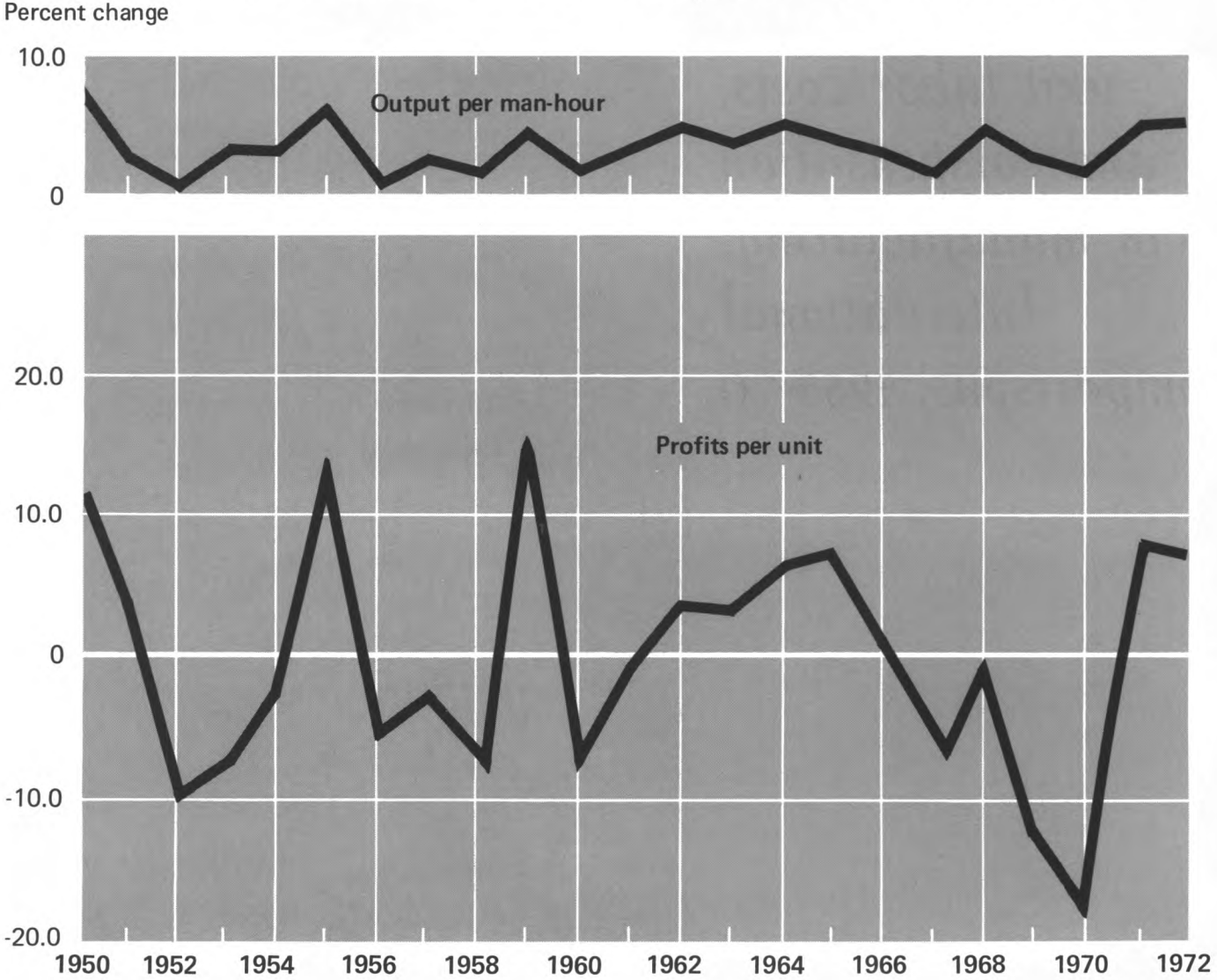
[3]No change.

Trends in productivity and profits

Profits per unit are affected by many different factors, and the rate of productivity improvement seems to be one of them. Profits have generally increased when productivity was growing rapidly; they have usually decreased during periods of reduced productivity growth.

Chart 11.

Average Annual Percent Change in Productivity and Profits in the Non-Financial Corporate Sector, 1950-72



Trends in productivity, unit labor costs, and compensation in manufacturing: International comparisons, 1965-70

Unit labor costs in manufacturing, measured in national currencies, rose more in the United States between 1965 and 1970 than in Canada, Japan, or Western Europe. Hourly compensation rose over 6 percent a year in the United States, while output per man-hour increased only 2 percent a year. The result was an average rise in U.S. unit labor costs of 4 percent a year. All of the foreign countries had larger percentage increases in hourly compensation than the United States, but they also had faster rates of productivity growth.

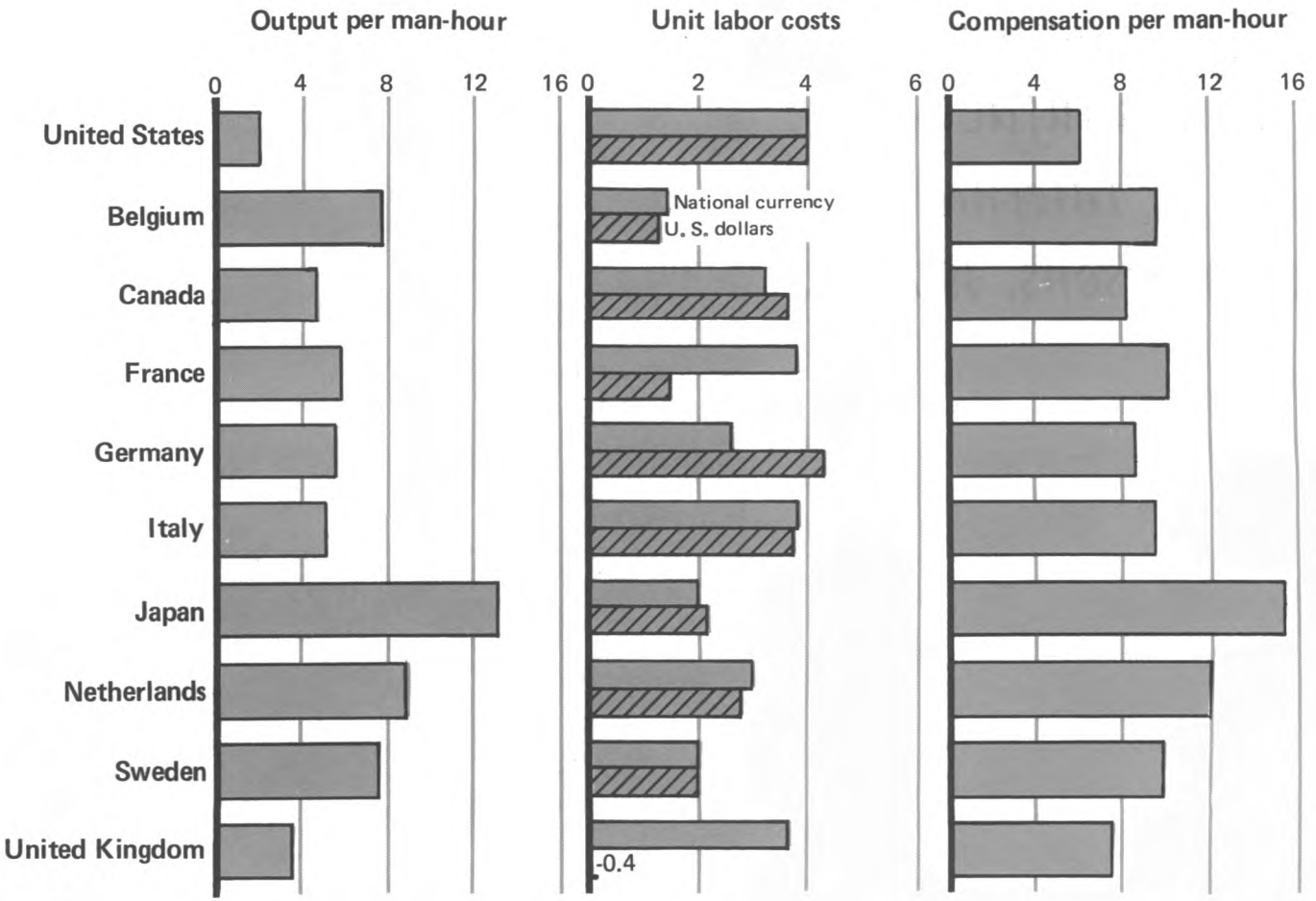
On a U.S. dollar basis, Canada and Germany had rates of increase in unit labor costs about as large as the United States because they revalued their currencies during the period. Similarly, the United Kingdom had a decline in unit labor costs and France a relatively small increase because they devalued their currencies.

Average annual percent change, 1965-70

Country	Output per man-hour	Unit labor costs		Compensation per man-hour
		National Currency	U.S. dollar basis	
United States	2.0	4.0	4.0	6.1
Belgium	7.9	1.4	1.3	9.4
Canada	4.7	3.2	3.7	8.1
France	6.0	3.8	1.5	10.0
Germany	5.7	2.6	4.1	8.4
Italy	5.3	3.9	3.8	9.4
Japan	13.2	2.0	2.2	15.4
Netherlands	8.9	2.8	2.7	11.9
Sweden	7.7	2.0	1.9	9.8
United Kingdom	3.9	3.6	-0.4	7.7

Chart 12.

Average Annual Percent Change in Output Per Man-Hour, Unit Labor Costs, and Compensation Per Man-Hour in Manufacturing, Ten Countries, 1965-70



Trends in productivity, unit labor costs, and compensation in manufacturing: International comparisons, 1970-72

Beginning in 1970, the position of U.S. unit labor costs relative to other industrial countries improved. This reversal was due to a speedup in output per man-hour in the United States and sharp increases in hourly compensation in the other countries. Though productivity continued to grow at a faster rate in most of the foreign countries than in the United States, growth rates in hourly compensation abroad exceeded productivity growth rates by wider margin than was the case in the United States.

The relative cost position of the United States was further improved by the general realignment of the world's major currencies that took place in 1971. After taking these changes in currency values into account, the average 1970 to 1972 rates of increase in unit labor costs abroad ranged from about 6 percent in Canada to 17 percent in Japan, compared with 1.4 percent in the United States.

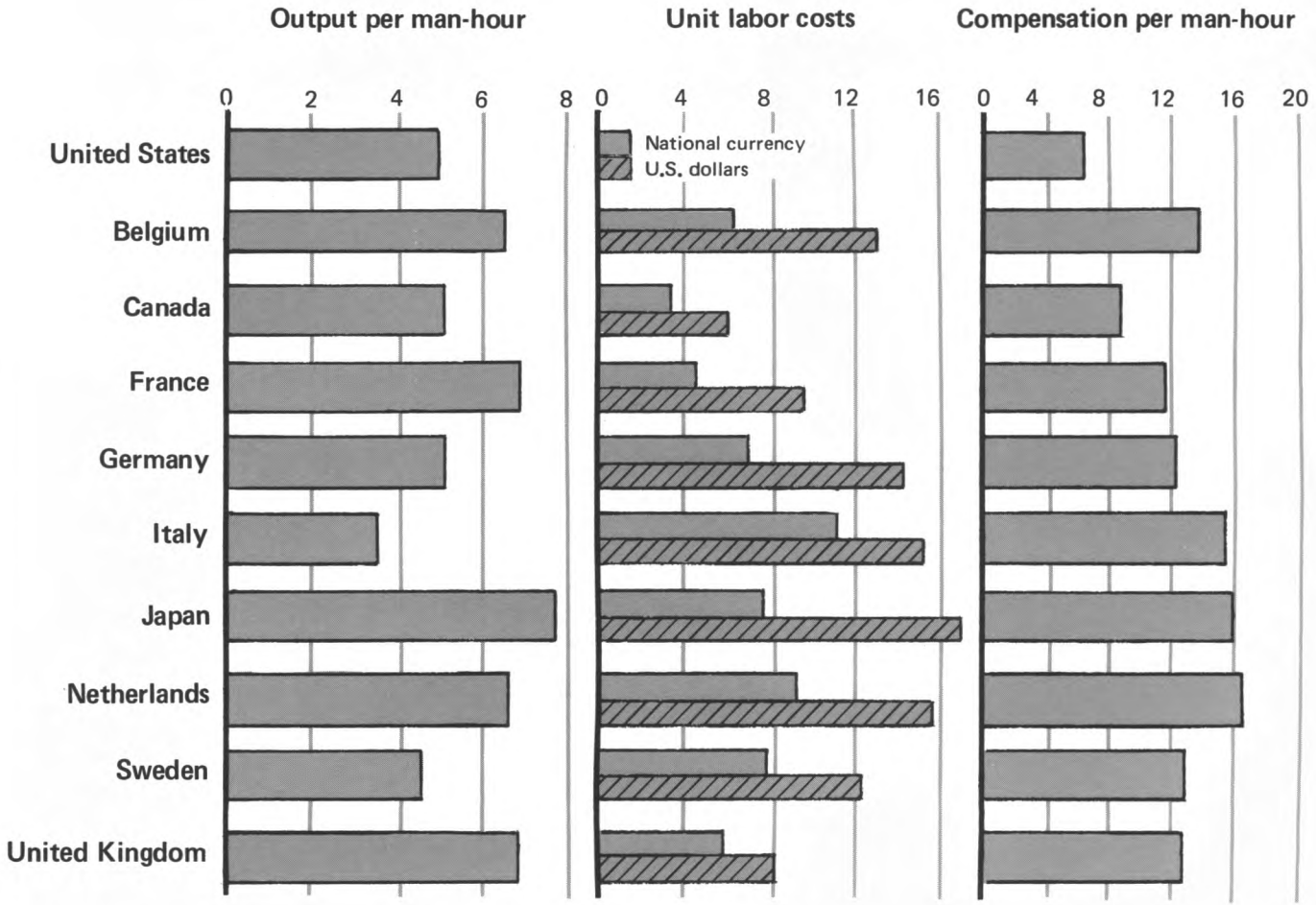
Average annual percent change, 1970-72[1]

Country	Output per man-hour	Unit labor costs		Compensation per man-hour
		National Currency	U.S. dollar basis	
United States	4.9	1.4	1.4	6.5
Belgium	6.5	6.3	13.0	13.3
Canada	5.1	3.4	6.1	8.8
France	6.9	4.6	9.5	11.8
Germany	5.1	6.9	14.3	12.3
Italy	3.5	11.3	15.4	15.3
Japan	7.7	7.7	17.0	16.0
Netherlands	6.6	9.2	15.9	16.4
Sweden	4.5	7.8	12.5	12.6
United Kingdom	6.6	5.7	8.0	12.5

[1] For many of the foreign countries, 1972 estimates are based on data for less than the full year.

Chart 13.

Average Annual Percent Change in Output Per Man-Hour, Unit Labor Costs, and Compensation Per Man-Hour in Manufacturing, Ten Countries, 1970-72



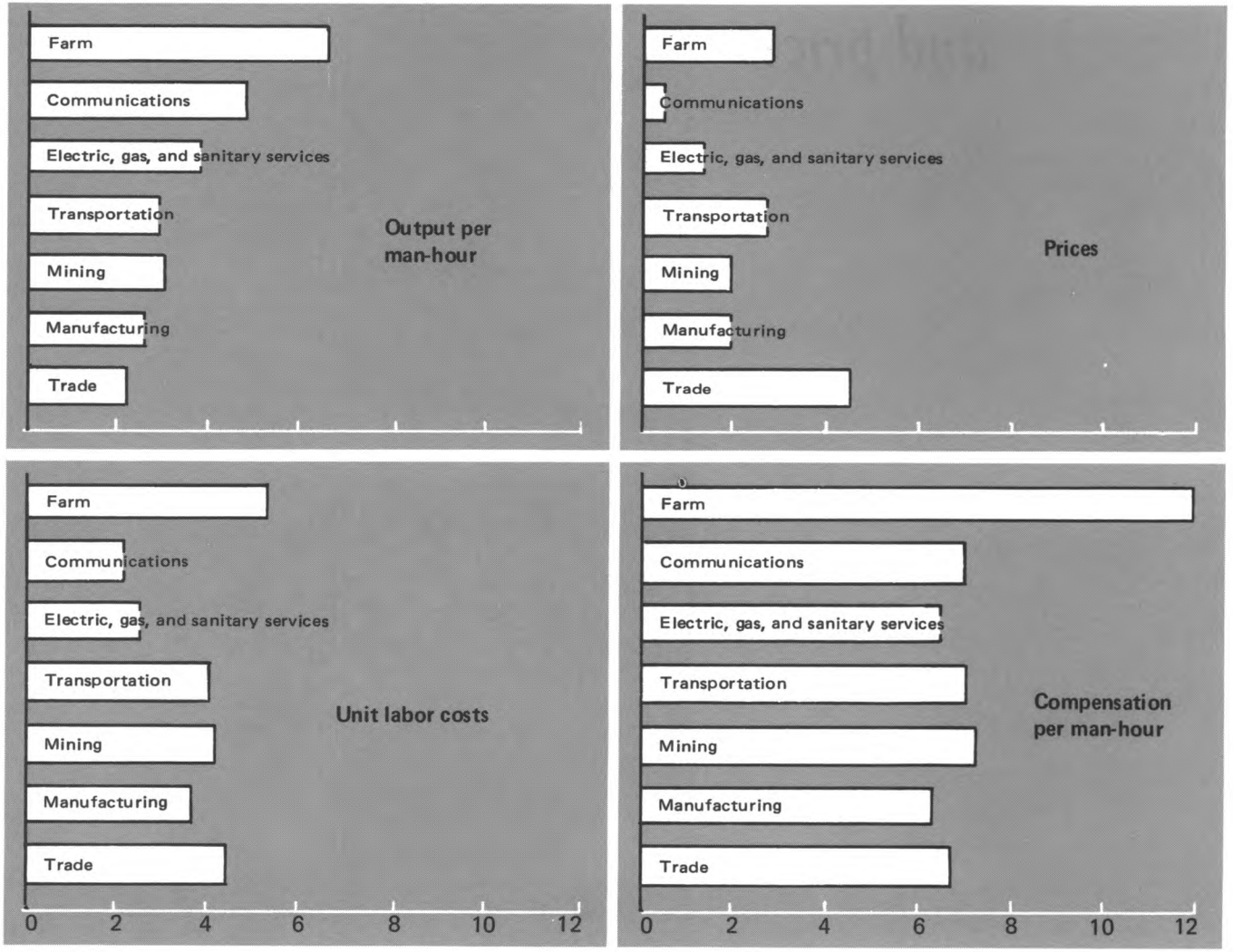
Recent trends in productivity, prices, unit labor costs, and compensation in major sectors

The rate of productivity growth in a sector is generally related directly to increases in the prices and costs of a sector's production. Unit labor costs and prices usually rise most in sectors where productivity growth is lagging and least in sectors where productivity growth is rising. Between 1965 and 1971, prices rose most in trade, a sector with a relatively low rate of productivity growth, and least in communications, a sector with a very high rate of productivity growth.

Chart 14.

Average Annual Percent Change in Output Per Man-Hour, Prices, and Costs by Major Sectors, 1965-71

Percent

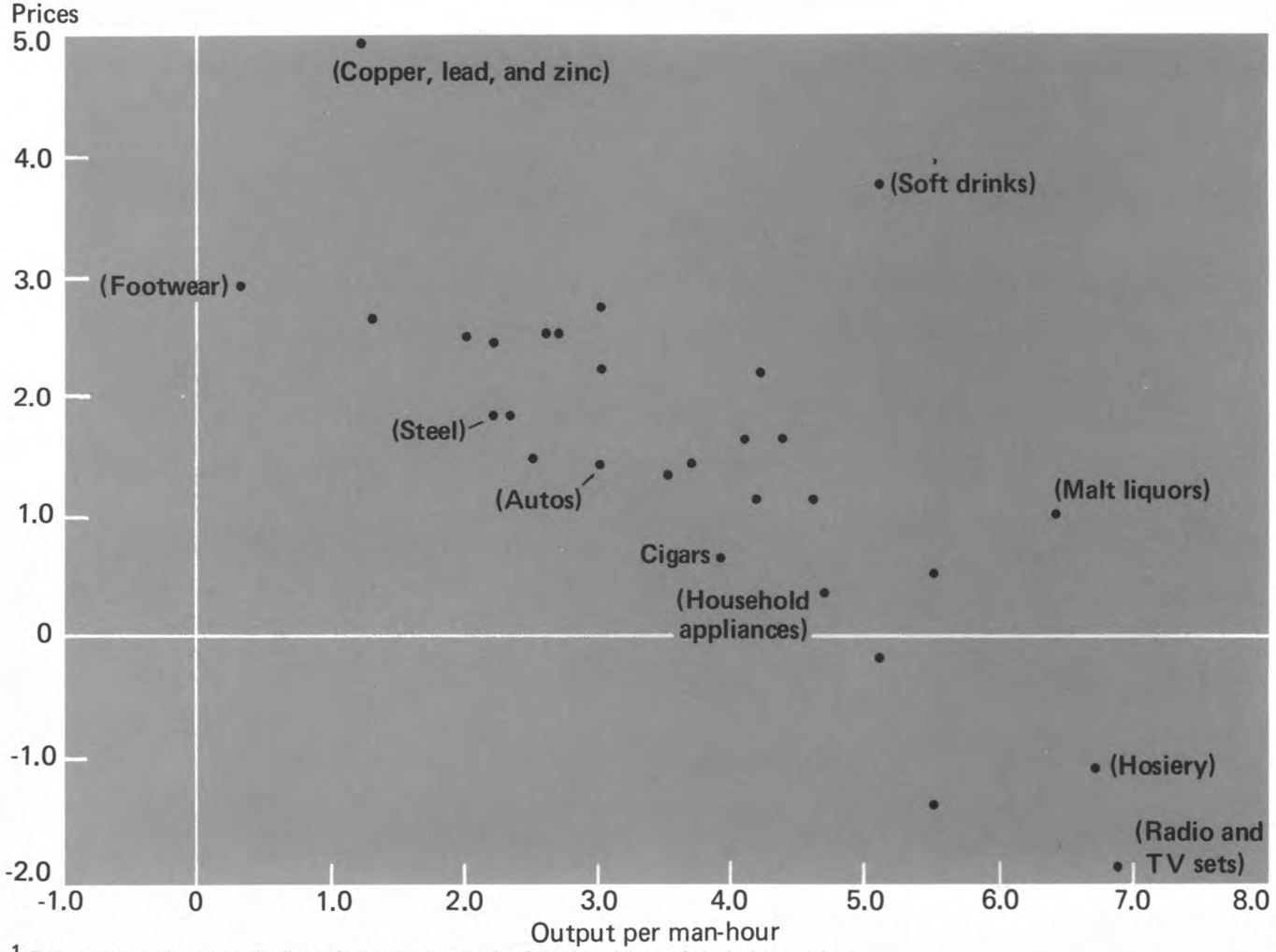


Trends in industry productivity and prices

A close inverse relationship between changes in prices and changes in productivity exists at the industry level, too. Prices declined between 1960 and 1971 in industries such as hosiery and radio and TV sets, where the rate of productivity gain was larger than the average. At the same time, prices increased in industries such as footwear where productivity advances were small. Although there are some exceptions, the pattern shows that as productivity grows faster, prices tend either to decline or increase at slower rates.

Chart 15.

Annual Average Rates of Change[1] in Output Per Man-Hour and Prices for Selected Industries, 1960-71



[1] Rate of change based on the linear least squares trends of the logarithms of the index numbers.

Part II-b. Other implications of productivity growth

One of the best known effects of productivity growth is the increase it makes possible in workers' incomes. Labor compensation expressed in terms of its buying power – real compensation – has risen at about the same rate as output per man-hour over the post-World War II period.

Productivity growth not only provides workers with more income, but also increases the amount of goods and services available for the population as a whole to consume. The increase in per capita product since World War II has largely been due to the increase in real product per man-hour, though the effect of productivity growth has been offset somewhat by the continued decline in man-hours.

This situation shows that two potential benefits of productivity growth are alternatives: Increases in output per man-hour mean either that a given amount of labor time can produce more output, or that a given amount of output can be produced with less labor time. Though these two alternatives are theoretically exclusive, in practice the benefits of productivity growth have been divided between them.

A third alternative has received a good deal of attention during periods of unemployment. Increases in output per man-hour can result in producing a given output with fewer workers. Though this alternative has prevailed in some industries such as railroads or coal mining, experience has shown that many industries increase employment as productivity grows because demand for their product grows even more.

Trends in productivity and real compensation

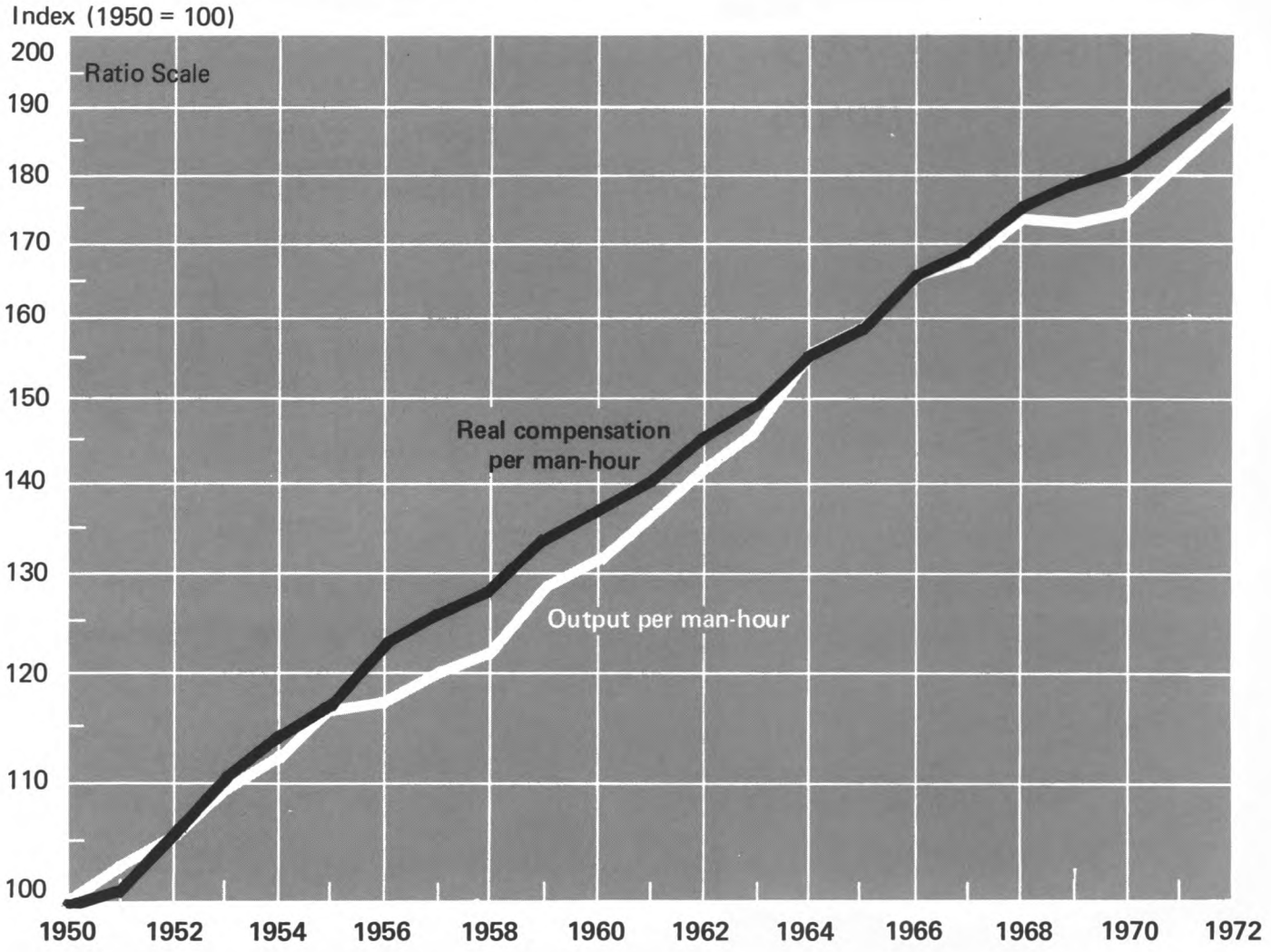
Over the long run, labor has shared in the steadily increasing productivity of the nation: Hourly compensation, adjusted to take account of changes in purchasing power (real hourly compensation), has risen at about the same rate as output per man-hour. In 1972, real hourly compensation was almost 85 percent higher than it was in 1950.

Changes in productivity and compensation do not always parallel each other over the short run. In general, when productivity rises rapidly, as in 1971 and 1972, increases in real hourly compensation tend to lag behind. Conversely, in times of low productivity improvement, such as 1969 and 1970, increases in real wages tend to out pace increases in productivity.

Year and Period	Total private economy Average annual percent change	
	Output per man-hour	Real compensation per man-hour
1950-72	3.0	3.0
1950-60	2.8	3.3
1960-65	3.9	3.0
1965-72	2.3	2.6
1968-69	0.4	2.3
1969-70	1.0	2.1
1970-71	3.6	1.5
1971-72	4.2	2.7

Chart 16.

Output Per Man-Hour and Real Compensation Per Man-Hour, Private Economy, 1950-72



Trends in product per person and average weekly hours

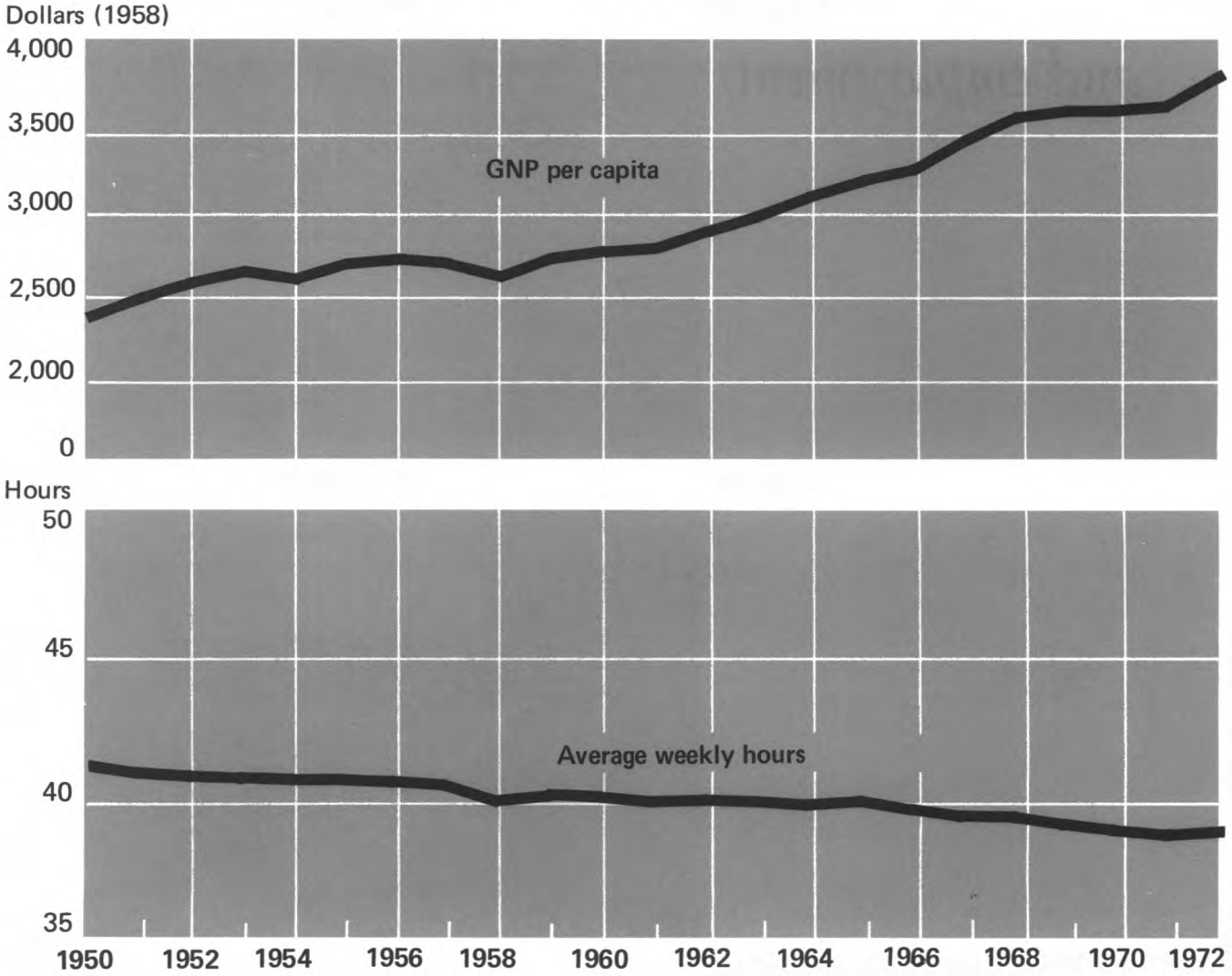
One benefit of productivity improvement is an increase in amount of goods produced and thus available for purchase by each member of the population. Gross national product per person rose an average of 2.1 percent a year between 1950 and 1972. The most rapid increase occurred during the 1960's, when productivity growth was particularly high.

Though productivity growth is the major factor influencing trends in product per person, it is not the only one. Two other factors – the proportion of the population in the labor force and the proportion of the labor force that is employed – did not change very much between 1950 and 1972. The third factor, average hours per worker, declined 0.4 percent a year and thus partially offset the effect of productivity growth on the rise in product per capita. (The decline in hours varied from sector to sector; hours did not decline at all in manufacturing.)

If the entire gain in output per man-hour during the last 2 decades had been taken in leisure time, average weekly hours would have decreased by an average of 3 percent a year. Estimating the actual change in average weekly hours due to productivity growth is difficult since economic fluctuations affect average hours so strongly; nevertheless, the slight decline in average weekly hours, compared with the large increase in per capita product, indicates that increased income had greater appeal than increased leisure.

Chart 17.

GNP Per Capita and Average Weekly Hours Per Worker, Private Economy, 1950-72



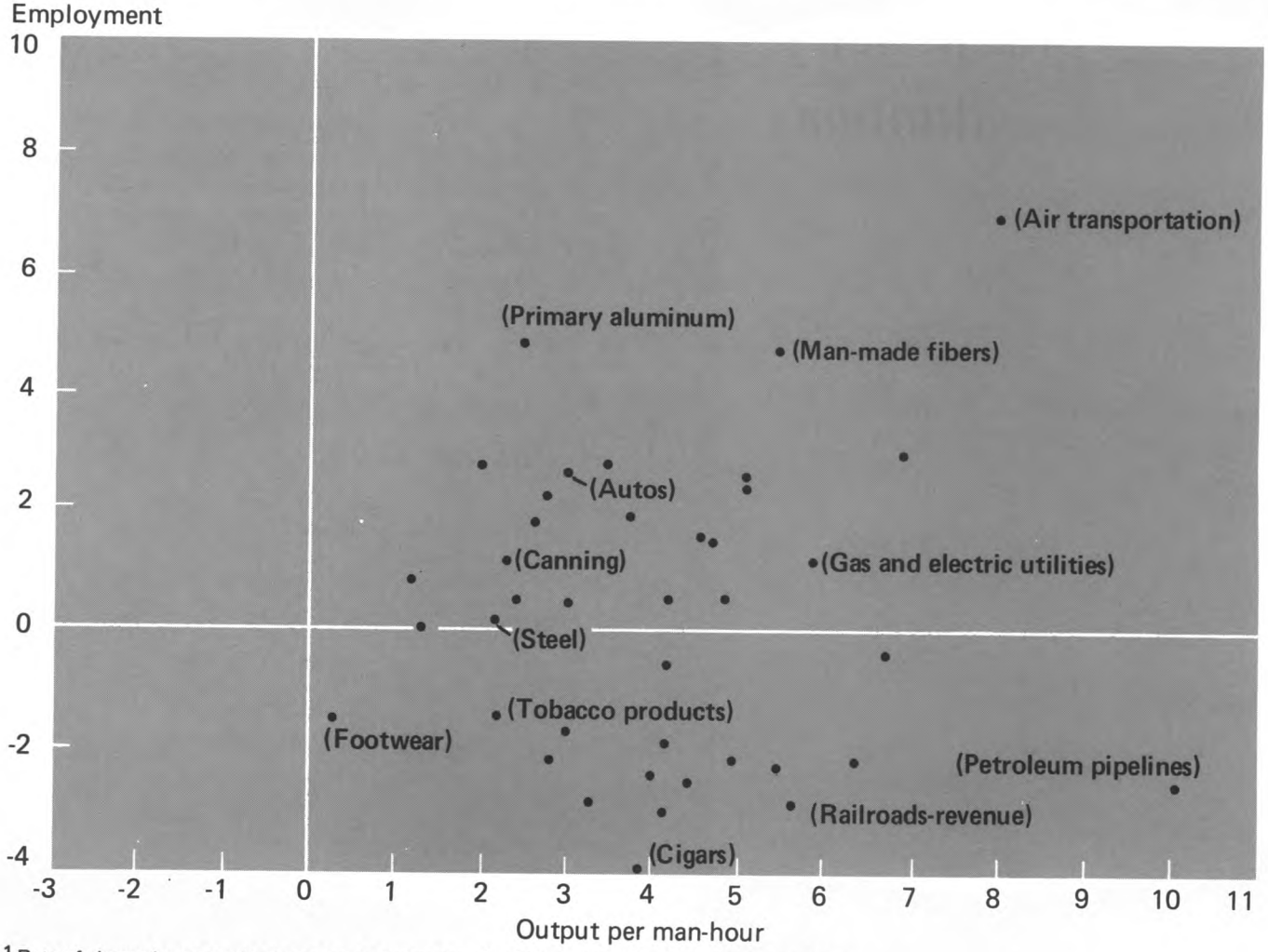
Trends in productivity and employment

Some people think that increases in productivity automatically lead to decreases in employment, but the chart shows that this is not necessarily true. Between 1960 and 1971, for example, productivity went up in every industry studied by the BLS and employment grew in over half of them.

In many industries, large productivity increases are accompanied by large increases in output that require increases in employment. This situation occurred in the air transportation and man-made fibers industries. Productivity growth in petroleum pipelines was also associated with a large increase in output, but technological improvements in this highly mechanized industry enabled it to expand production while further reducing its already low employment. On the other hand, in some industries such as cigars and railroads employment reductions were associated with high productivity gains and only moderate increases in output.

Chart 18.

Average Annual Rates of Change[1] in Output Per Man-Hour and Employment for Selected Industries, 1960-71



[1] Rate of change based on the linear least squares trends of the logarithms of the index numbers.

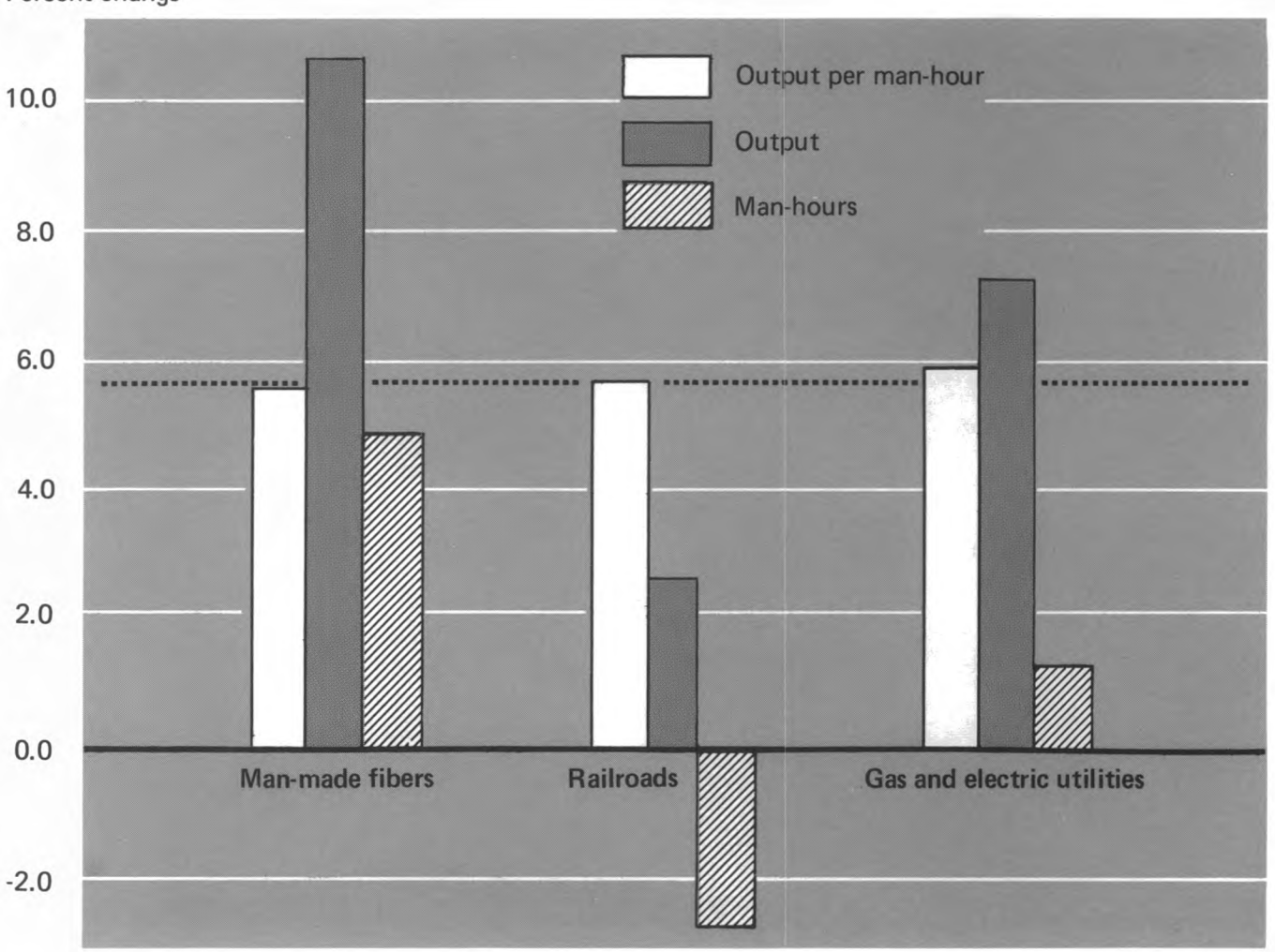
Differences in industry productivity situations

Industries with similar trends in output per man-hour may have vastly different trends in output and employment. For instance, between 1960 and 1971, productivity grew at an average rate of nearly 6 percent a year in man-made fibers, railroad transportation, and gas and electric utilities, but each one of these industries has a different productivity story. High productivity growth in man-made fibers represented a big increase in output, accompanied by substantial growth in man-hours, while the same rate of productivity growth was achieved in railroads by a large reduction in man-hours, coupled with a small increase in output. The rate of productivity increase for gas and electric utilities stayed close to the rate of output growth, as man-hours barely changed.

These three industries show the major types of high productivity growth situations. They indicate that the implications of productivity growth for employment are closely associated with trends in output: Industries that have large increases in output tend to increase man-hours too, while industries that have small output growth tend to reduce man-hours.

Chart 19.

Change in Output and Man-Hours for Selected Industries with Similar Productivity Growth, 1960-71



Part III. Factors affecting productivity growth

The factors to which changes in productivity can be attributed vary according to whether the movements are short term or long term. As many of the charts in part I show, short-term movements in productivity are directly related to the business cycle because productive capacity, including the work force, is not so flexible that producers can adjust it immediately to changes in demand.

Long-term productivity growth reflects basic changes in the factors underlying productivity improvement, such as increased availability of capital, improvement in the quality of labor, and advances in technology. Other factors include improvements in the allocation of resources, increased economies of scale, and advances in managerial know-how. Some economists attempt to analyze all of these factors, however difficult they may be to quantify and measure, and the results of some of these attempts are presented on the next page. Another approach is to measure those factors that are readily quantifiable and to treat them as indicators of the sources of growth.

Capital investment makes an important contribution to growth in output per man-hour. Most researchers have concluded that output per man-hour has increased in large part because the amount of capital supporting each worker has increased substantially. The role of capital investment is outlined by measures such as capital investment as a proportion of output and, most revealing for productivity analysis, capital stock per man-hour in the private economy.

Technological innovation is another important source of growth in output per man-hour. Much of this innovation is a result of organized research and development (R&D) programs, and the amount, rate, and location of spending on R&D gives some idea of the importance placed on this activity by both government and industry. An even better approximation of the pace of technological development can be attained by tracing the rate of diffusion of important innovations that have had a clear and direct effect on productivity growth. Otherwise, measuring the effects of so generalized a process as technological change is difficult, if not impossible.

A third important contributor to growth in output per man-hour is improvement in the quality of the labor force. This improvement can be seen clearly in the statistics which compare the skills of the jobs at which Americans work now with those of an earlier period, or which trace the rise in the median level of education. And, since worker motivation plays as important a part as worker skill in improving productivity, surveys of worker attitudes are extremely illuminating, particularly when prospects for future productivity growth are being estimated.

The sources of growth

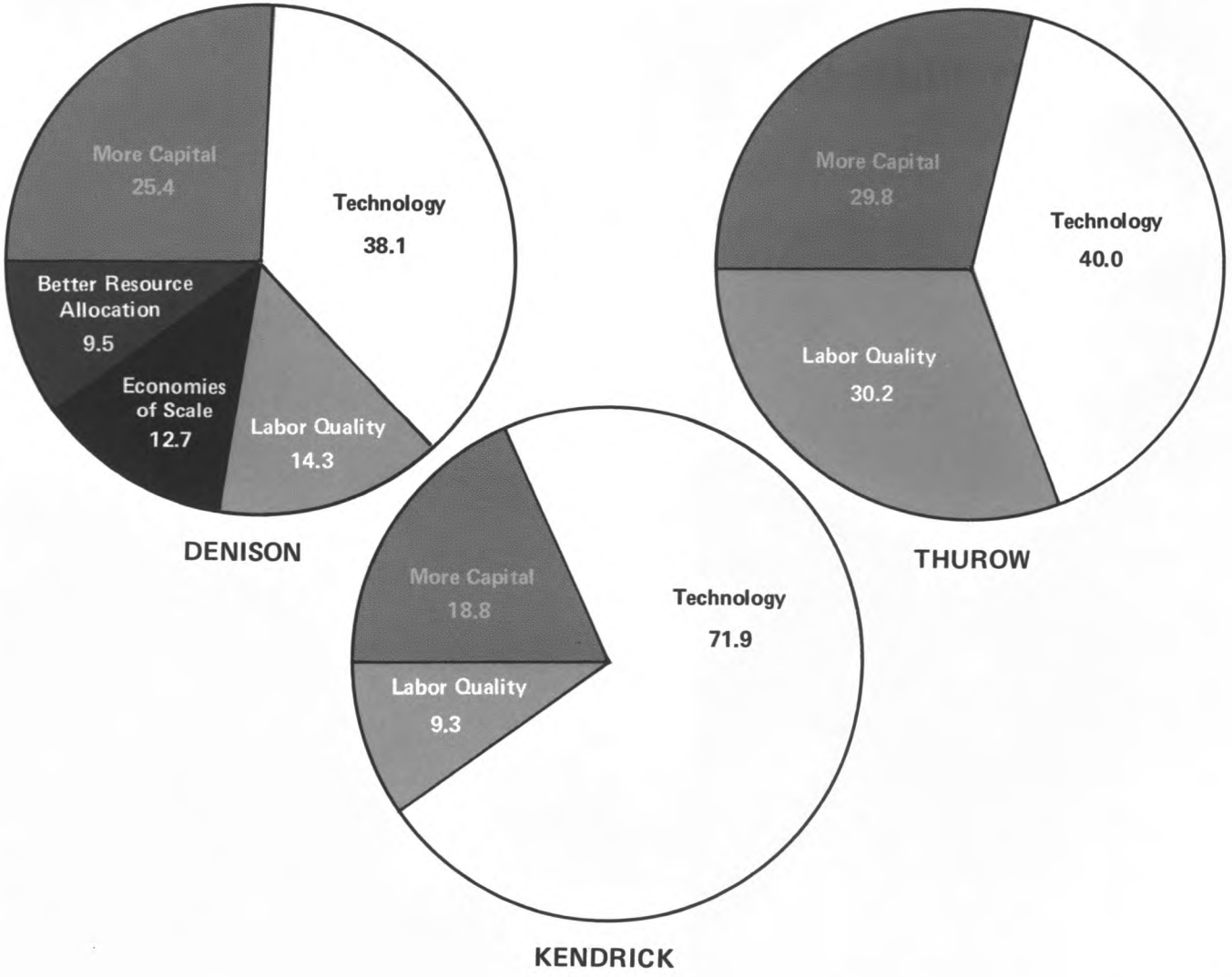
The factors affecting productivity growth are so interrelated that determining the separate effect of each one is difficult. Moreover, the economists who have attempted this task – Denison, Kendrick, Thurow, Grilliches, Jorgensen, and Christiansen, among others – have come up with different measures because of differences in definitions, concepts, and assumptions.

It is not possible to compare the results of all the research undertaken to date in this area, since not all researchers have focused on the same factors. However, three studies – those by Edward Denison, John Kendrick, and Lester Thurow – encompass similar factors and thus provide a good idea of current thought in this area. Though their measures differ, they all conclude that improved technology and the availability of more capital per worker have been the major sources of productivity growth.

For all three researchers, technology refers not to the measured effect of technological improvements but to the residual – the part of productivity growth not accounted for by the other factors measured. One reason that Kendrick's residual exceeds Denison's is that it includes the effects of economies of scale and improved resource allocation, which Denison measured separately. Thurow's residual is smaller than Kendrick's mainly because he assigned technological progress embodied in labor or capital to the part of productivity growth that he attributed to those two factors.

Chart 20.

Factors Affecting Productivity



Capital Investment

Trends in capital stock per man-hour

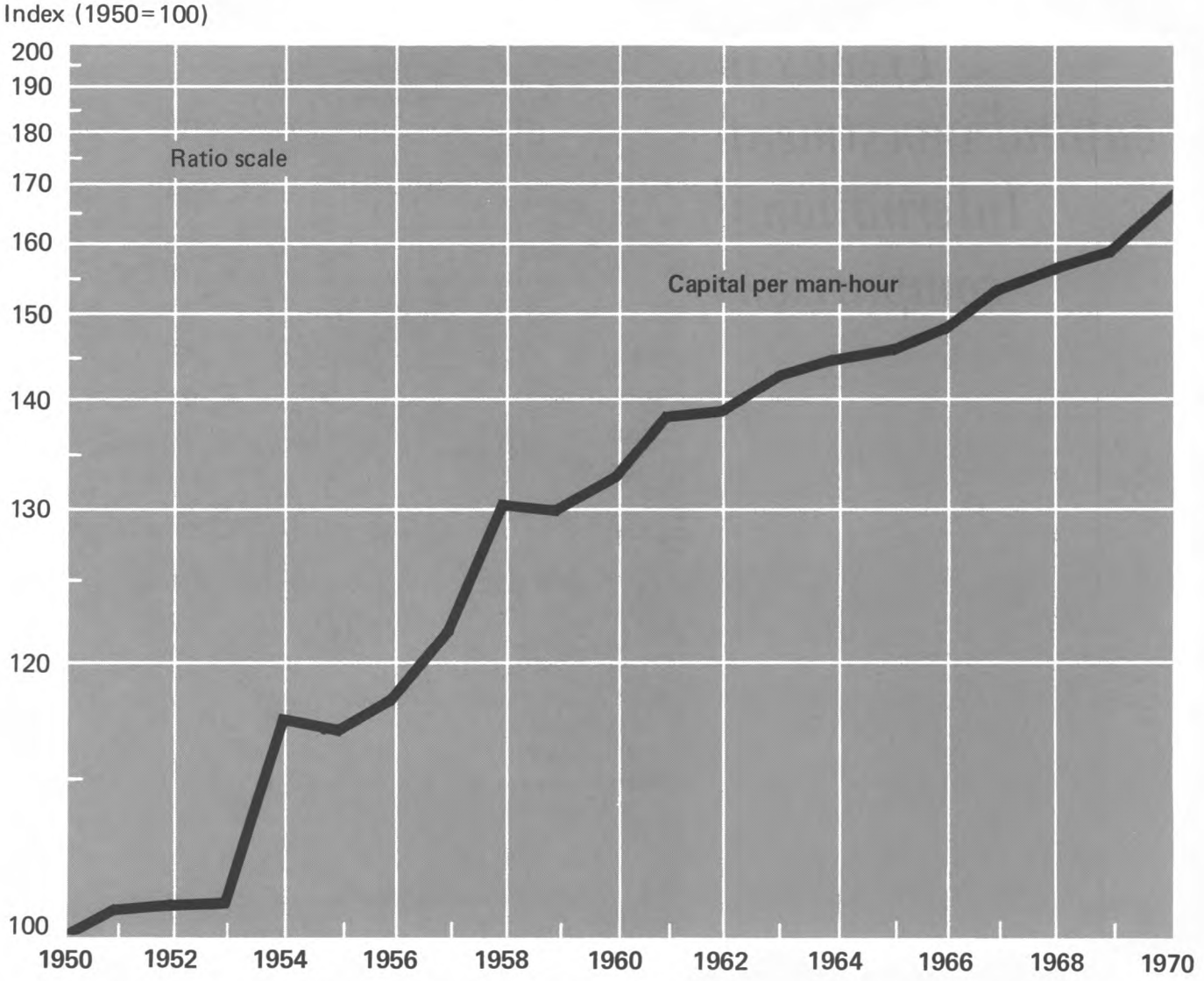
Growth in capital per man-hour has been an important factor in productivity improvement, since more and better equipment allows a worker to perform his job more effectively. Capital per man-hour rose 2.5 percent a year between 1950 and 1970, as capital increased almost four times as fast as man-hours did. The increase in the capital-labor ratio contributed about one percentage point to the 3-percent average annual increase in output per man-hour between 1950 and 1970.

The growth in the capital-labor ratio was faster in the 1950's than in the 1960's. Although capital growth accelerated in the 1960's, the rate of increase in man-hours almost tripled.

Period	Capital per man-hour	Capital	Man-hours
1950-70	2.5	3.2	0.7
1950-60	3.1	3.3	0.2
1960-70	2.0	3.6	1.4

Chart 21.

Capital Per Man-Hour in the Private Economy, 1950-70



Source: U.S. Department of Commerce.

Capital Investment

Trends in capital investment: International comparisons

Since growth in output per man-hour is closely related to the amount of capital supporting each worker, the ratio of capital investment to output is a precursor of potential growth in productivity. Productivity is more likely to increase rapidly in countries where this ratio is high than in countries where it is low.

During the 1960's, the United States, Canada, and the United Kingdom had the lowest average capital investment ratios in manufacturing as well as the lowest average increases in manufacturing productivity. At the other end of the scale, Japan had the highest investment ratio and the highest rate of productivity gain.

Data on capital investment in manufacturing are not available for most of the Common Market countries. Consequently, capital investment ratios for industry as a whole – mining, manufacturing, construction, and public utilities – are substituted in the chart even though they can be imprecise indicators of capital investment ratios in manufacturing. For instance, Canada has a very high capital investment ratio for all industry, but a relatively low ratio for manufacturing.

Country	Average annual percent change in output per man-hour in manufacturing, 1960-72[1]	Capital investment as percent of output, 1960-70	
		All industry	Manufacturing
United States	3.1	[2]14.5	12.3
Belgium	6.6	19.9	19.6
Canada	4.4	21.0	15.1
France	5.8	21.2	N.A.
Germany	5.8	[3]22.2	N.A.
Italy	6.0	17.9	N.A.
Japan	10.4	28.1	31.4
Netherlands	7.2	21.4	N.A.
Sweden	7.1	18.8	16.7
United Kingdom	4.2	16.6	13.4

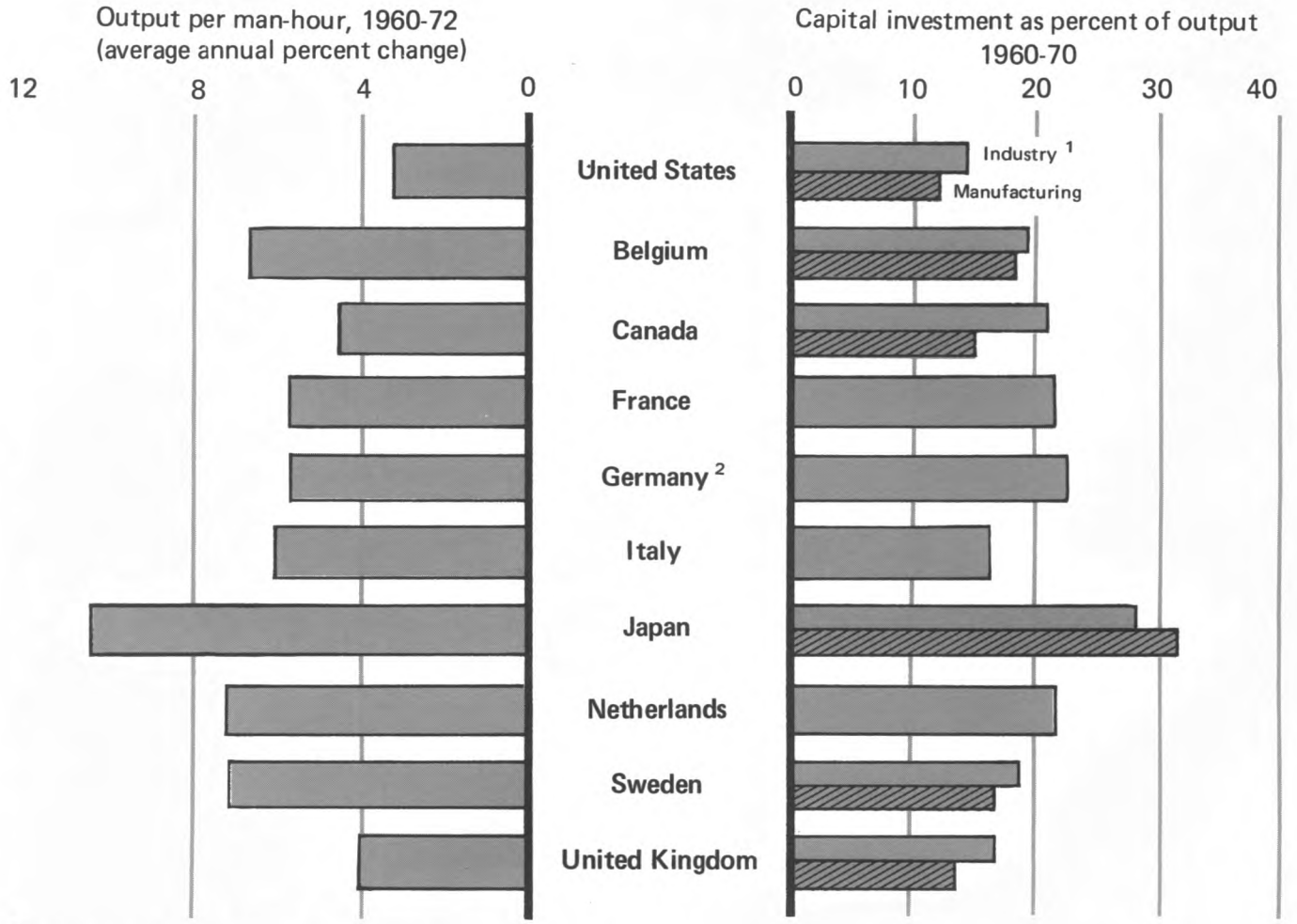
[1] For many of the foreign countries, 1972 estimates are based on data for less than the full year.

[2] Excludes construction.

[3] Capital investment, excluding residential dwellings, as percent of total output.

Chart 22.

Growth in Output Per Man-Hour in Manufacturing and Rate of Capital Investment, Ten Countries



[1] Includes manufacturing, mining, construction, and public utilities.

[2] Capital investment as percent of total output.

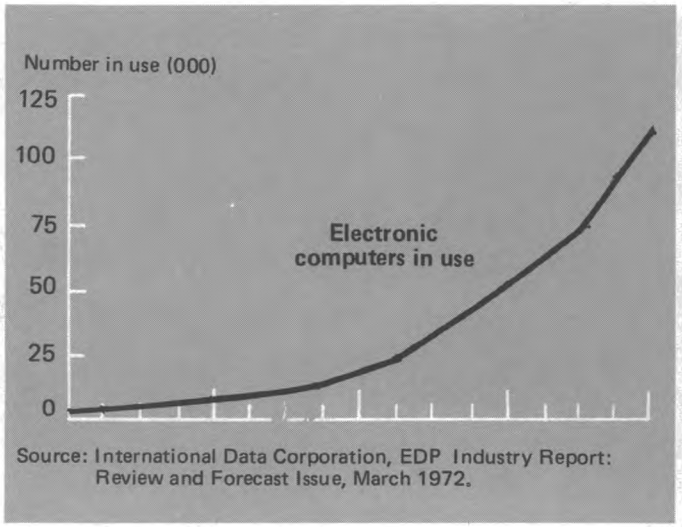
Trends in diffusion of major technological innovations

Productivity growth is directly affected by the rate of acceptance of a new technology. Researchers generally concur that the rate of diffusion of any major new technology varies considerably within and between industries, but disagree as to the specific factors causing this variation and their relative importance. Factors which are reported to affect the diffusion rate include cost and profitability of the innovation, size of the firm, and level of output of the firm.

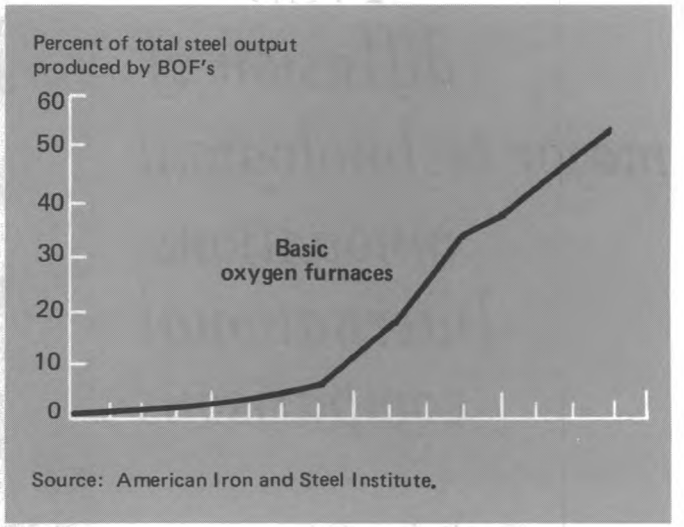
The accompanying chart shows trends in the diffusion of four major technological innovations of the post World War II period: The electronic computer, which has achieved significant productivity gains in industry, business, and government; the basic oxygen furnace (BOF), a steelmaking process which reportedly lowers production and capital costs and increases output; numerical control, a system for the automatic operation of machine tools which has increased productivity in the metalworking industries; and the production of electricity by nuclear energy.

Chart 23.

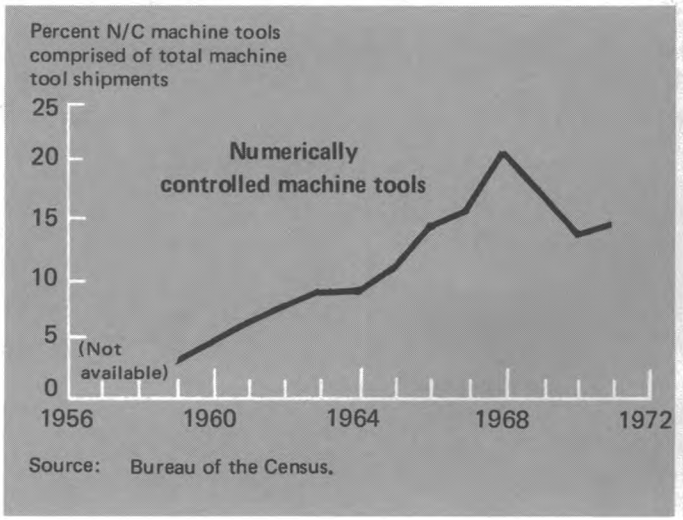
Growth in Use of Some Key Technological Innovations, 1956-72



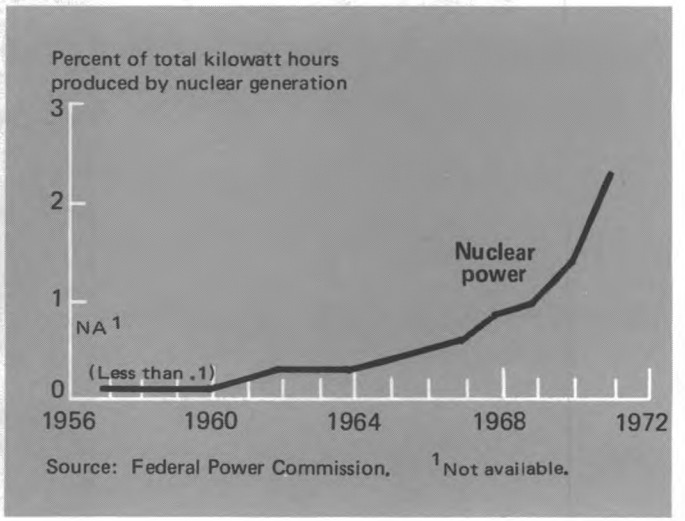
Source: International Data Corporation, EDP Industry Report: Review and Forecast Issue, March 1972.



Source: American Iron and Steel Institute.



Source: Bureau of the Census.



Source: Federal Power Commission. [1] Not available.

Technological Change

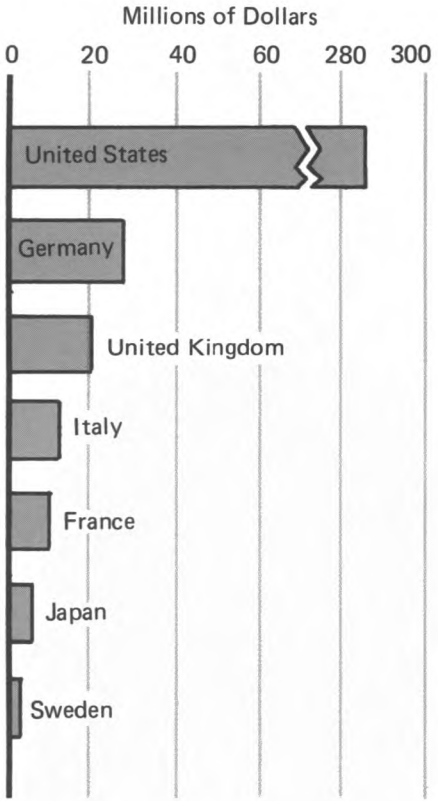
Trends in diffusion of major technological innovations: International comparisons

Productivity improvement that results from technological change is an important element in international competition. Information available for three of the innovations examined in the preceding section shows that the United States leads other major industrial countries in both computer installations and the production of numerically-controlled machine tools, but that it trails Japan and Germany in the proportion of steel produced in basic oxygen furnaces.

Chart 24.

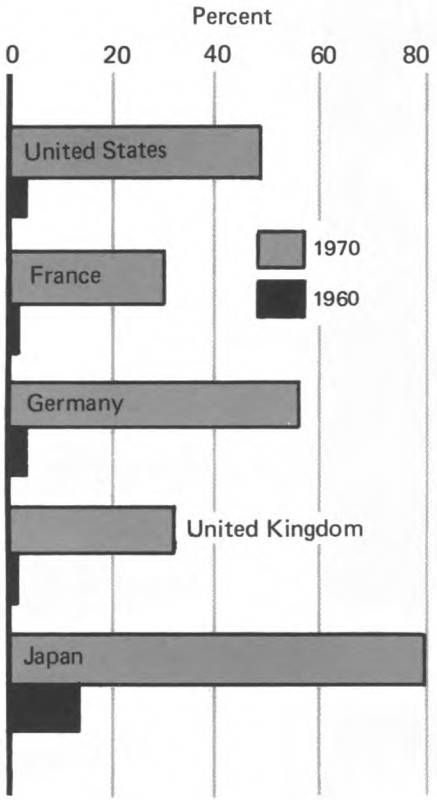
Diffusion of Three Innovations, Selected Countries

Value of numerically controlled machine tool production in selected countries, 1967



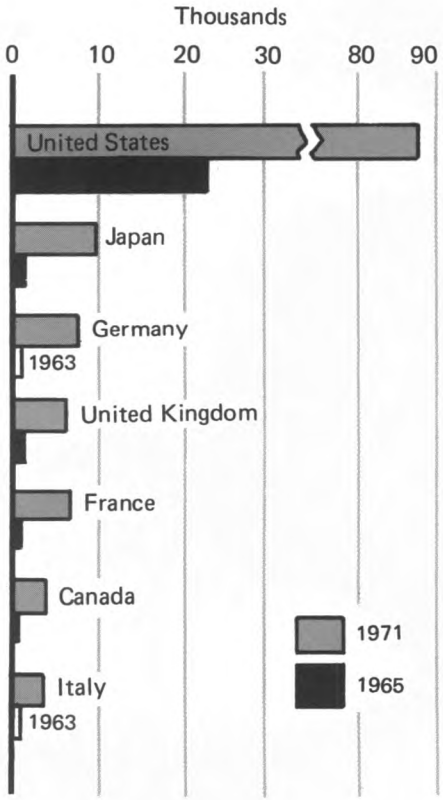
Source: Organization for Economic Cooperation and Development.

Proportion of steel output produced in basic oxygen furnaces, selected countries, 1960 and 1970



Source: United Nations

Electronic digital computers in use, selected countries, 1965 and 1971



Source: U.S.: *EDP Industry Report,* March 1972. Other countries: 1963 and 1965: National Bureau of Standards; 1971: *EDP Industry Report,* December 17, 1971 (except Japan); Japan: Japan Information Processing Center.

Technological Change

Trends in research and development expenditures

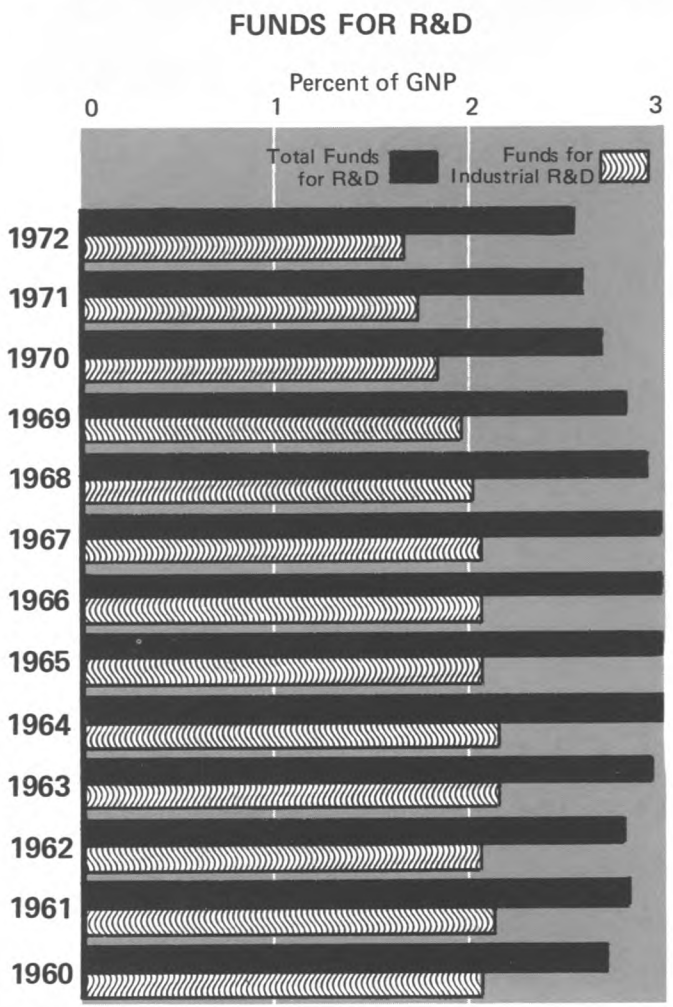
Expenditures for research and development can generate increases in productivity through the development and subsequent application of more efficient equipment and processes. One indicator of the relative importance of R&D is the proportion of GNP devoted to it. Over the past decade, this proportion remained relatively stable for both total R&D spending and spending on industrial R&D.

R&D funds come from both government and private sources. During the early part of the 1960's, the Federal government provided the major part of R&D spending. Most of the Federal funds came, as they did throughout the decade, from the Department of Defense. Beginning in 1968, however, company-supplied funds exceeded Federal financing. This shift reflected a sharp increase in company spending of 157 percent between 1960 and 1972, compared with a moderate increase of 34 percent in Federal spending.

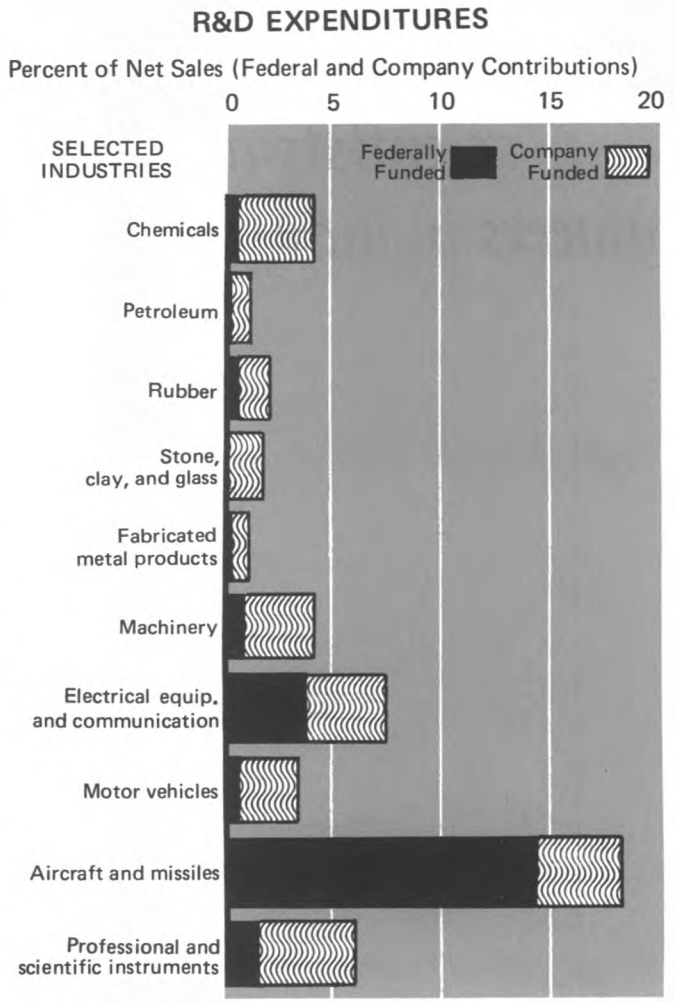
The amount and rate of spending for R&D varied between major industries. For instance, two industries heavily involved in Federal contract work for defense and space programs – aircraft and missiles and electrical equipment and communication – spent proportionately much more on R&D in 1971 than other industries did. Federal funding was a much less significant element in other industries where R&D expenditures were proportionately large.

Chart 25.

Funds for R&D as a Percent of GNP, 1960-72 and R&D Expenditures as a Percent of Net Sales, 1970



Source: National Science Foundation and U.S. Department of Commerce.



Source: National Science Foundation

Technological Change

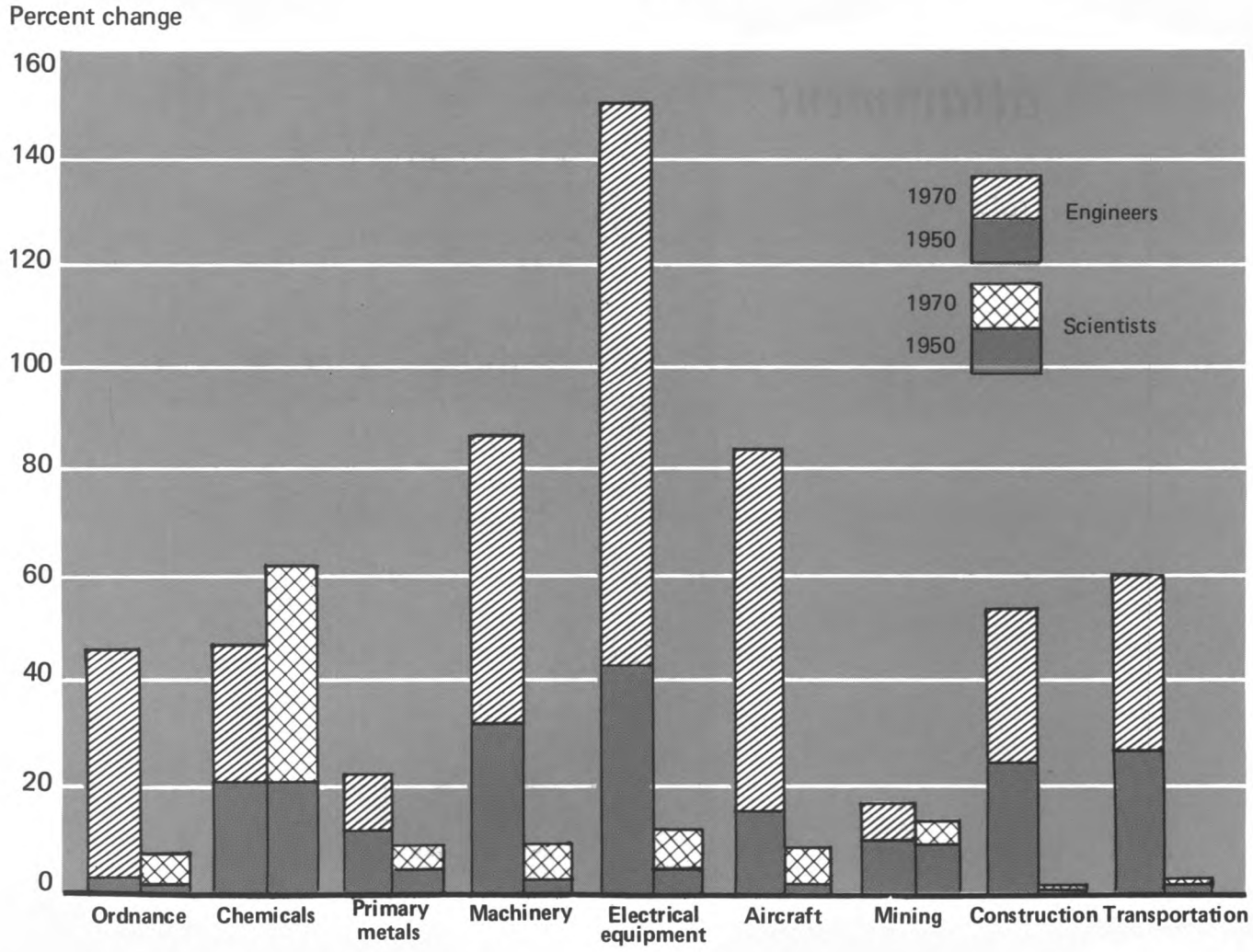
Trends in employment of scientists and engineers in industry

Another precursor of potential growth in productivity is the trend in employment of scientists and engineers in industry. These employees are primarily responsible for devising and implementing new technology.

Employment of scientists and engineers increased throughout industry between 1950 and 1970. Increases were particularly pronounced in industries such as aircraft, machinery, and electrical equipment which already had large numbers of employees in this category.

Chart 26.

Percent Change in Number of Scientists and Engineers Employed in Selected Industries, 1950 and 1970



Labor Quality

Trends in educational attainment

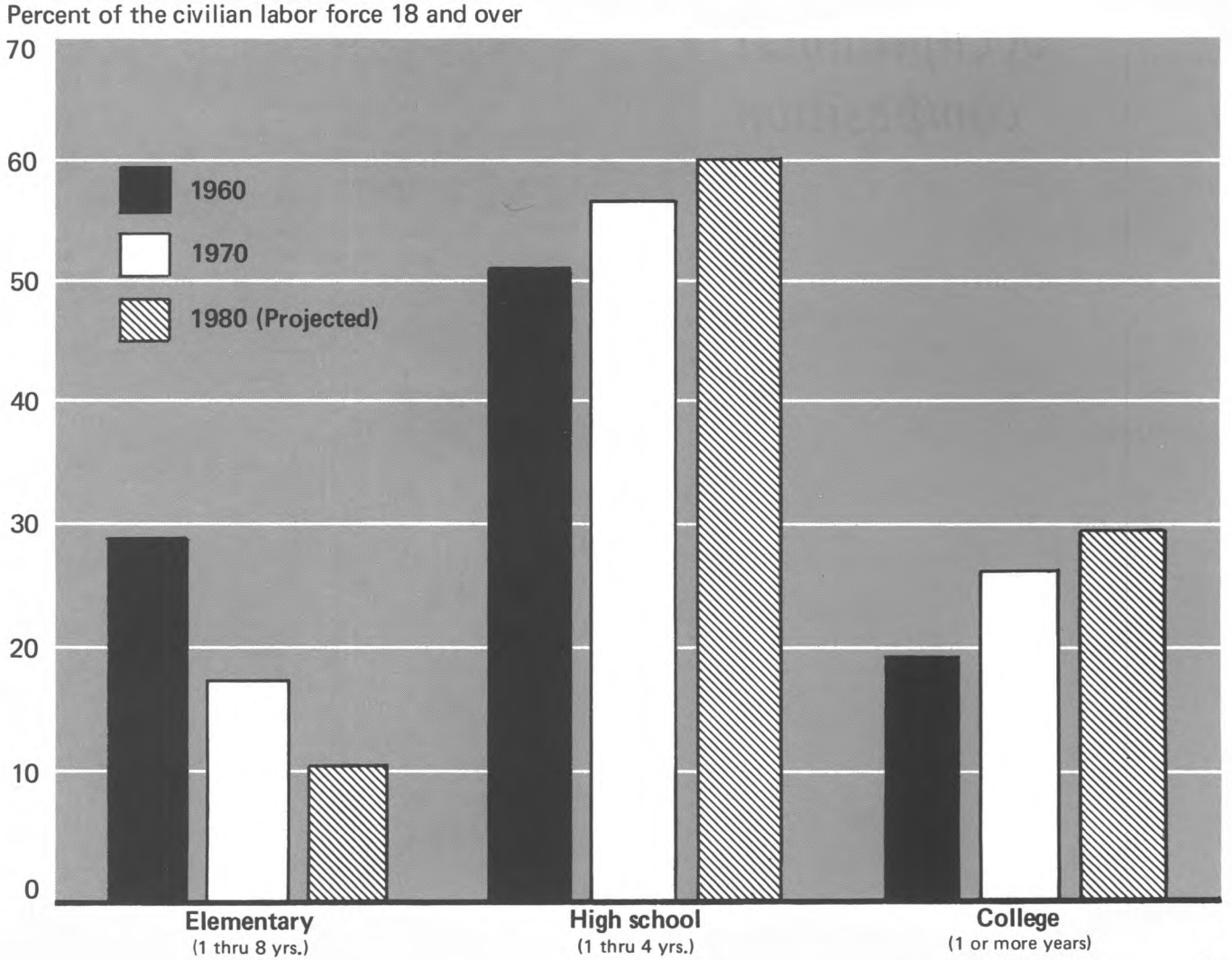
The general upgrading of the work force over time is usually considered an important factor in productivity growth. This upgrading occurs primarily in two ways: Increases in the proportion of the work force employed in higher-skilled occupations and improvements in the level of education of the working population.

The level of education of the American work force has risen steadily and is expected to rise even more, largely because young people have been spending more time in school. The proportion of the working population that has not completed high school has been dropping; by 1980, almost three-fourths of the work force will have a high school diploma.

Years of School Completed	1960	1970	Projected 1980
Elementary: less than 5 years	5.1	2.4	1.5
5 to 7 years	9.8	5.9	3.5
8 years	14.4	9.2	5.3
High school: 1 to 3 years	19.6	17.3	16.6
4 years	31.2	39.0	43.4
College: 1 to 3 years	9.7	13.3	14.5
4 years or more	10.1	12.9	15.3

Chart 27.

Estimated and Projected Years of School Completed, the Civilian Labor Force 18 and Over, 1960, 1970, and 1980 Projected



Labor Quality

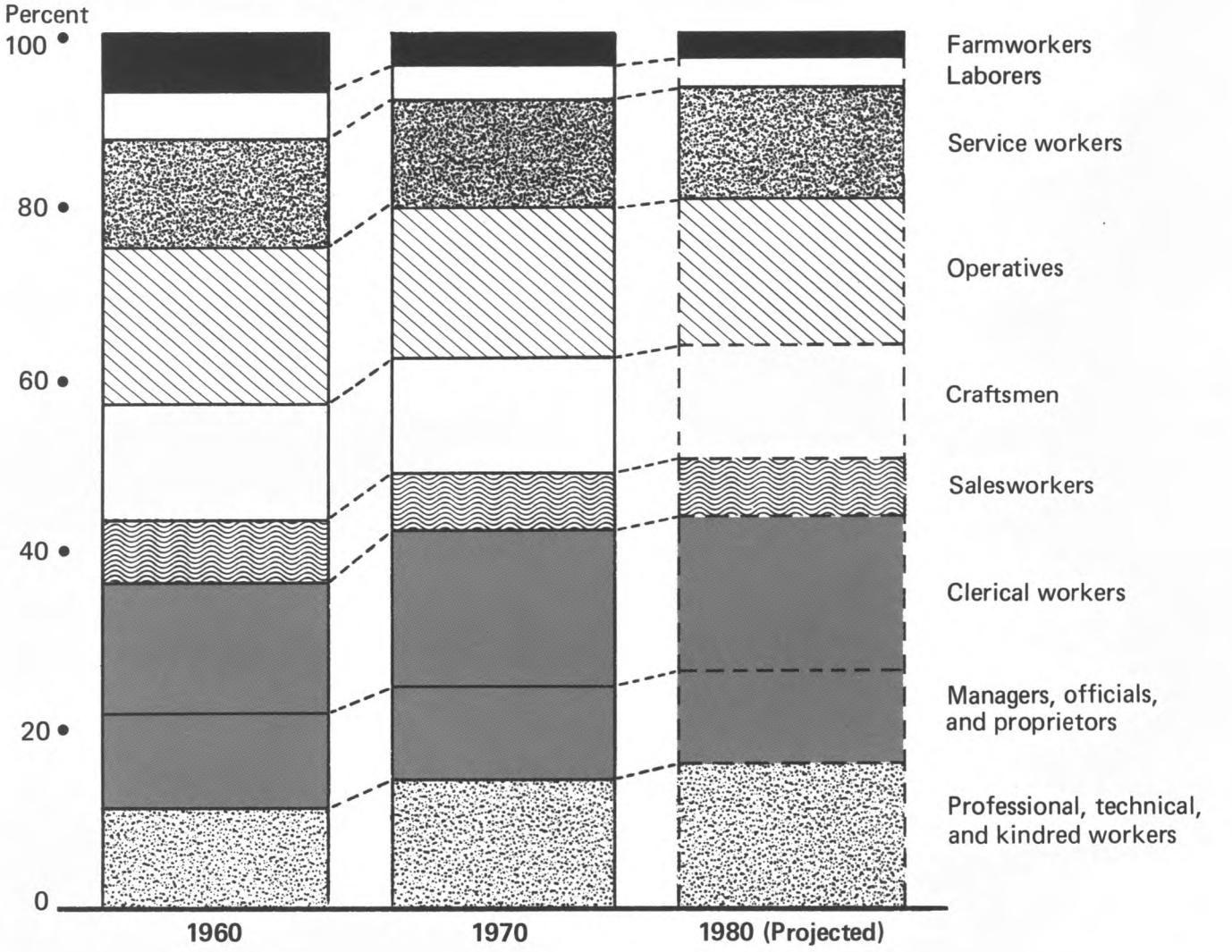
Trends in occupational composition

The occupational groups which are growing in importance – professional, clerical, and service workers – are characterized by fairly high educational requirements. Similarly, the occupational groups which account for a decreasing proportion of the work force – operatives, laborers, and farmers – require relatively little education.

Occupational groups	Occupational distribution of labor force (In percent)		
	1960	1970	1980
Professional, technical, and kindred workers	11.4	14.2	16.3
Managers, officials, and proprietors	10.7	10.5	10.0
Clerical and kindred workers	14.8	17.4	18.2
Salesworkers	6.4	6.2	6.1
Craftsmen, foremen, and kindred workers	13.0	12.9	12.9
Operatives and kindred workers	18.2	17.7	16.2
Service workers	12.2	12.4	13.7
Laborers, except farm and mine	5.4	4.7	3.9
Farmers and farmworkers	7.9	4.0	2.7

Chart 28.

Changes in the Occupational Composition of the Labor Force, 1960, 1970, and Projected 1980



Labor Quality

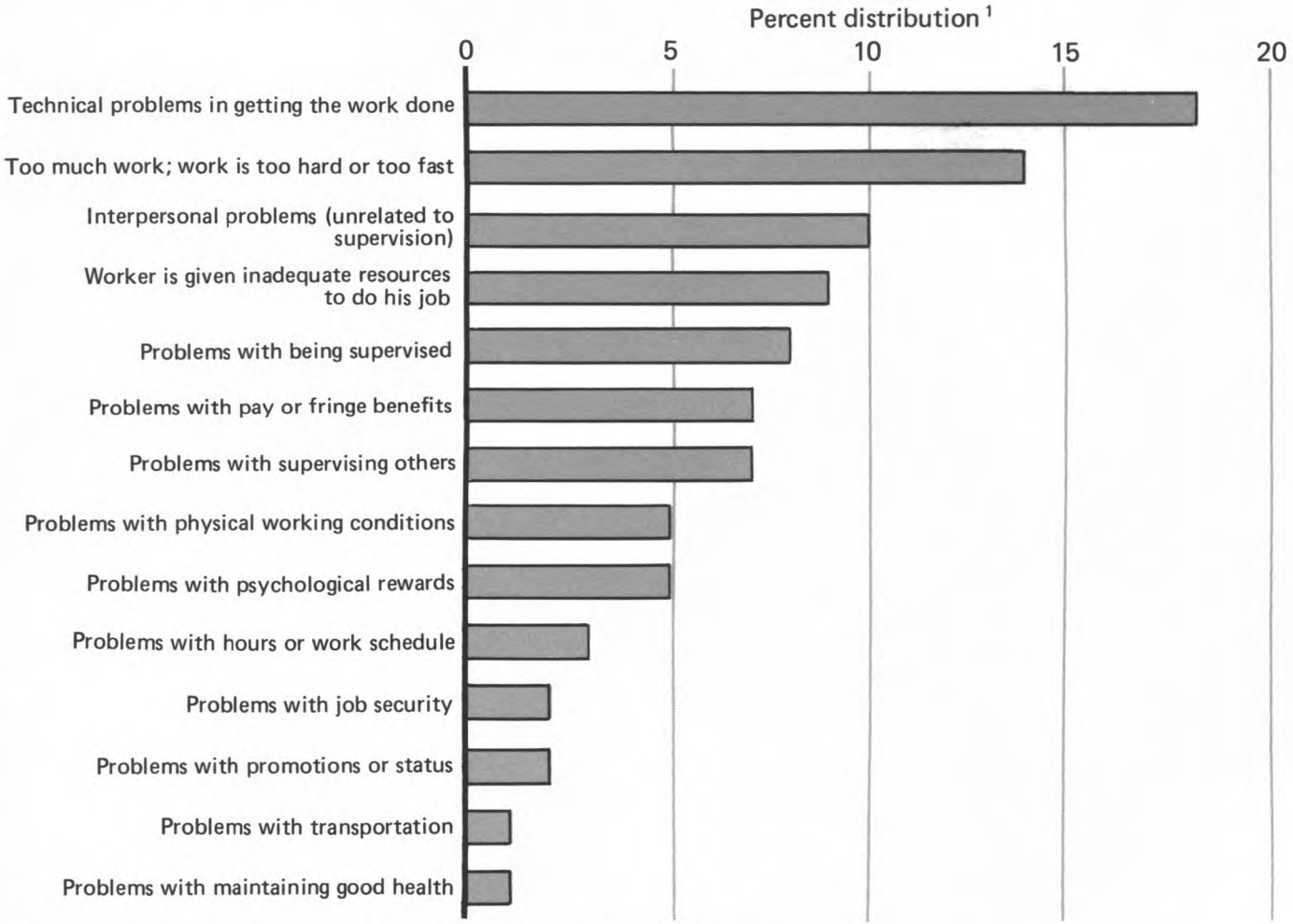
Worker attitudes and productivity

Worker attitudes are an important key to productivity improvement: Given conditions in which he can produce more, a worker's attitude determines whether he will do it. A survey of worker attitudes conducted for the Department of Labor indicated that workers are more concerned with production-oriented goals than has previously been thought. When asked the question, "All in all, what do you feel is the single biggest problem or difficulty you encounter on your job?" most workers answered in terms of day-to-day difficulties in getting their work done. The largest cluster of "biggest problems" included obstacles such as technical problems, work overload, and inadequate resources.

The survey also found high correlations between the content of job (worker's concern with resource adequacy, autonomy, challenge, and so on) and worker's job satisfaction. These findings suggest that workers are considerably motivated toward productivity and achievement.

Chart 29.

Workers' Reports of "Single Biggest Problem They Faced on Their Jobs"



[1] Percentages do not add to 100 percent, since miscellaneous problems were included.

Source: "The Working Conditions Survey", *Monthly Labor Review,* April 1971.

Users of this chartbook interested in keeping abreast of current information on productivity can find up-to-date statistics on productivity, prices, wages, costs, and profits in the U.S. economy in the Quarterly Review of Productivity, Wages, and Prices and the Quarterly Review of Productivity and Costs, as well as in the chartbook on Prices, Wages, and Productivity, a monthly supplement to the more detailed quarterly reports. These reports are free and are available from the Bureau of Labor Statistics. Many of the same tables also appear in the Monthly Labor Review and Employment and Earnings, two monthly publications of the Bureau of Labor Statistics that are available by subscription from the Superintendent of Public Documents or from any of the BLS regional offices.

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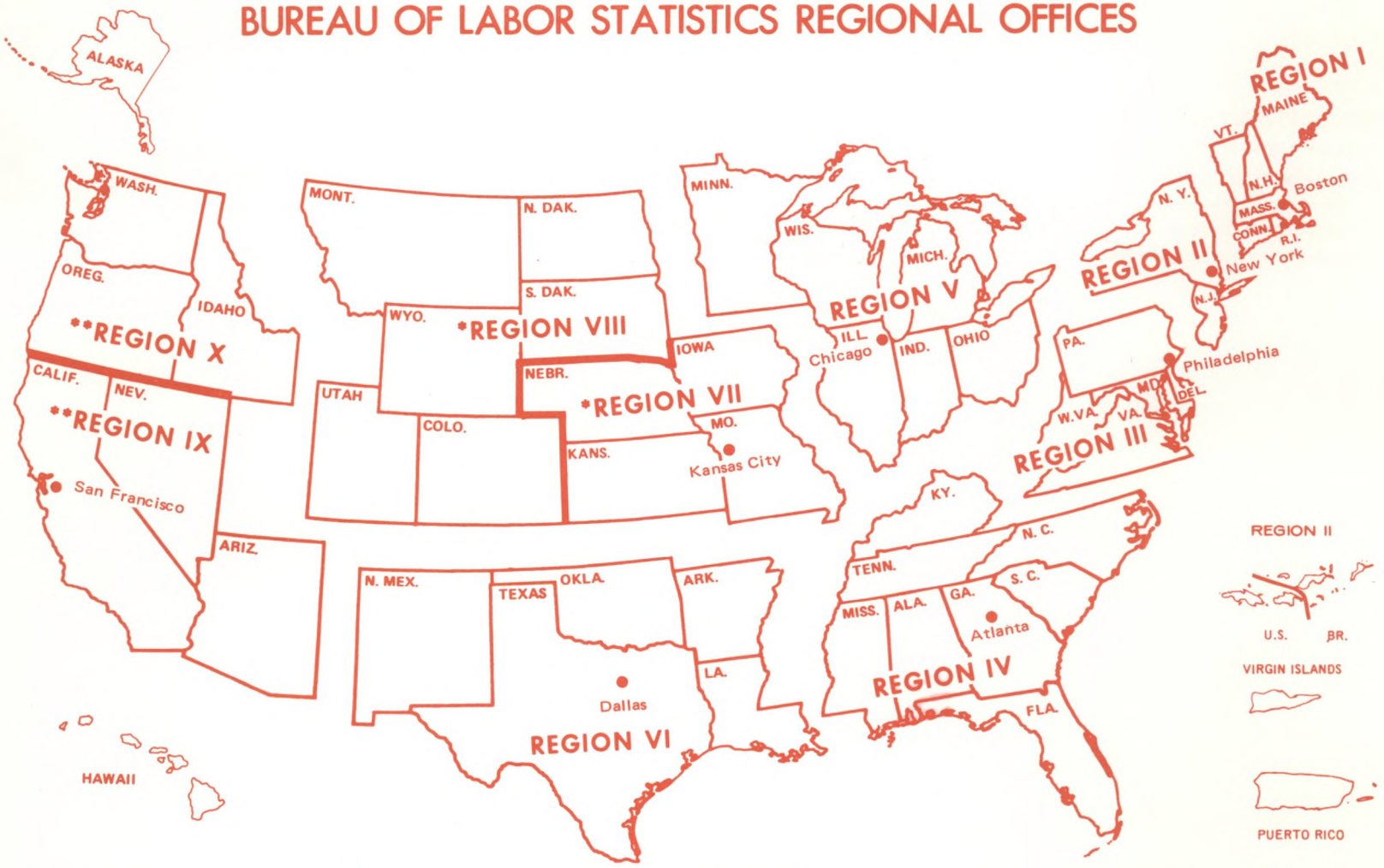

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