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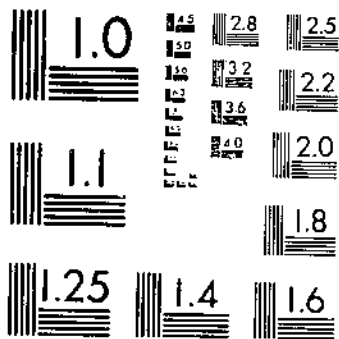
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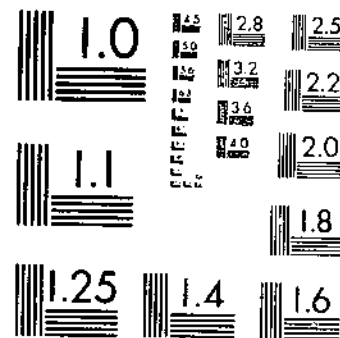
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OUTPUT PER MAN-HOUR IN FACTORIES PROCESSING FARM FOOD PRODUCTS  
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# Output Per Man-Hour In Factories Processing Farm Food Products

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UNITED STATES DEPARTMENT OF AGRICULTURE  
Agricultural Marketing Service

## Preface

Various legislative and economic groups concerned with agricultural policy have long been interested in the relation between charges for marketing farm food products and payments to the farmer-producer for his products. A marked decline in these payments relative to consumer expenditures for farm food products since World War II has focused attention on the need for additional information to analyze past and future trends in factors underlying changes in marketing costs.

The index of output per man-hour in factory production of domestic farm food products presented in this report was developed as part of a larger investigation of changes in output of marketing services related to domestic farm food products and changes in utilization of resources employed in providing these services. A major objective of this investigation is to develop long-range projections on the agricultural food marketing bill which will supplement Department of Agriculture long-range projections on the demand for and output of farm food products.

Labor costs in factories processing farm food products are a major component of total labor costs in marketing these products: Within recent years payrolls in factory processing accounted for about one-fourth of total direct labor costs in the marketing bill. This is the second report related to the investigation of output and utilization of resources in factory processing of farm food products; the first was "Output of Factories Processing Farm Food Products in the United States, 1909-58," Technical Bulletin No. 1223. Additional studies will be reported as they are completed.

Acknowledgment is made to Frank de Leeuw, Division of Research and Statistics, Board of Governors of the Federal Reserve System, and to Imogene Bright, Marketing Economics Research Division, Agricultural Marketing Service, for suggestions and review of technical aspects of the report, and to Clara Williams and Richard Suttor for their assistance with the statistical analysis.

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## Summary and Conclusions

During the postwar period 1947-58, output per man-hour worked in factories processing domestic farm food products increased at an average annual rate of 2.7 percent. Rates among industry groups differed widely: Output per man-hour rose 4.6 percent per year in factories processing fruits and vegetables compared with 1.4 percent per year in factories manufacturing bakery products. Output of factories processing farm foods rose slightly less than output per man-hour from 1947 to 1958 as the number of man-hours worked by all employees declined slightly during the period. The postwar rate of growth in output per man-hour did not set a new all-time high; the rate was equaled in the decade following World War I. During the four decades 1919-58 as a whole, output per man-hour in factories processing farm foods grew at an average rate of 2.0 percent per year.

The annual rate of growth of output per man-hour in food processing industries from 1947 to 1958 was significantly smaller than the annual rate (3.5 percent) for the total private economy, but about the same as the yearly rate in the private nonfarm sector. The smaller rate of growth in food processing industries than in the total private economy was caused, in part, by shifts in production from industries with higher levels to industries with lower levels of output per man-hour. Output per man-hour in food processing industries, adjusted for changes in the product mix, showed about the same yearly rate of growth as the series for the total private economy.

The postwar increase in output per man-hour in food manufacturing was accompanied by a substitution of total capital (fixed plus working capital) for labor. However, the increase in the stock of total capital per man-hour worked was apparently confined to working capital; the ratio of fixed capital to man-hours remained virtually unchanged. In fact, there was no substitution of fixed capital for labor from 1929 to 1957; technological improvements in food manufacturing after 1929 were at least as much fixed-capital saving as labor saving.

The estimates of the stock of total capital do not reflect changes in the quality of new machinery, equipment, and other kinds of capital goods employed in processing foods; in particular, the estimates do not reflect new technology. Surveys of food processing plants indicate that technological developments in materials handling, continuous processes, electronic temperature and humidity controls, packaging, grading, and other developments have had a dramatic impact on output per man-hour, particularly since the end of World War II. Development of frozen foods, blended and prepared flour mixes, and other new products also contributed to the rise in output per man-hour.

Changes in the "quality" of labor inputs through education, training, experience, and other kinds of investment in human capital contributed to the growth in output per man-hour. During the postwar period, the

number of engineers, technicians, and other highly trained employees working in food processing plants increased markedly; however, to some extent, interindustry shifts in employment offset the contribution of increased quality of labor inputs within plants.

Net output per man-hour in farming grew at an average annual rate of 6.2 percent from 1947 to 1958—dramatically faster than in food processing industries. However, between 1919 and 1939, output per man-hour rose about twice as fast in food processing plants as in farming. Because of the rapid rate of increase since the beginning of World War II, the average annual rate of growth of net output per man-hour in farm production during the four decades 1919-58 as a whole was 2.8 percent, substantially larger than in factory processing. The postwar era witnessed a large substitution of capital—mainly real estate and machinery—for labor in farming. In fact, the substitution was more than enough to explain the faster rate of growth of output per man-hour in farming than in food processing. Therefore, on the basis of available data on labor and capital, there is no indication that there was a larger rate of growth in resource efficiency or of technology in farming than in food processing during the post-World War II period or during the entire four decades since the end of World War I. (Indexes of output per unit of labor and capital combined—so-called “total productivity” indexes—in farming and in food manufacturing are discussed in appendix B.)

In 1958, hourly earnings of employees in factories processing farm food products (based on hours worked by all employees) were about 65 percent above the 1947-49 average, and output per man-hour was about 30 percent higher; consequently, unit labor costs were up nearly 30 percent. The sharp rise in hourly earnings was not confined to food manufactures, but was part of a sharp postwar increase in all manufactures. In fact, the postwar rise in unit labor costs in factory processing was about the same as the inflationary price rise in the economy as a whole (measured by the Implicit Price Deflator for Gross National Product). Hourly earnings in farming rose substantially less than in food manufacturing during the postwar period. In contrast to the experience in food processing plants, the postwar rise of output per man-hour in farming more than offset the rise in hourly earnings so that unit labor costs in farming declined. During the four decades 1919-58 as a whole, hourly earnings in factories processing farm food products rose about 335 percent, output per man-hour rose about 140 percent, and unit labor costs increased nearly 85 percent.

Nonlabor charges (including profits) per unit of output in 1958 were about 35 percent above the 1947-49 average, slightly more than the rise in unit labor costs. Between 1919 and 1958, unit nonlabor costs increased about 125 percent, again significantly more than unit labor costs. The long-term increase in nonlabor costs relative to labor costs in food processing reflects the substitution of capital, technology, and other produc-



tion inputs for labor; but it also reflects large increases in advertising and similar operating expenses, particularly in the postwar years.

Total unit processing costs ("value added" per unit of output) in 1958 were about one-third larger than in 1947-49. This rise was somewhat larger than the inflationary price rise in the total economy, and increased the spread between wholesale prices of processed food products and the farm price of the raw materials. From 1919 to 1958, unit processing costs rose about 110 percent.

Judging from Department of Agriculture studies of income elasticities of different food products, it appears that shifts in production from industries with higher levels to industries with lower levels of output per man-hour may continue for some time in the future, as they have in the past, to retard the yearly rate of growth of output per man-hour in factories processing farm foods. Discovery and adoption of new technology and expanded education and training of labor (including managerial) will undoubtedly continue to contribute to the rise in output per man-hour within food processing industries and plants. Unfortunately, however, nothing can be said about whether the annual rate of growth will increase, decrease, or remain the same. This depends in part upon the rate of substitution of capital for labor; but, much more importantly, it depends upon changes in new technology, quality of labor inputs, economies of scale, and other factors which cannot be statistically estimated. On the basis of current knowledge and several critical assumptions, about one-fifth of the rise in output of factory processing from 1919 to 1958 can be explained by the rise in labor-capital inputs; the remaining four-fifths are attributable to factors which are not amenable to separate statistical measurement.

# OUTPUT PER MAN-HOUR IN FACTORIES PROCESSING FARM FOOD PRODUCTS

By WILLIAM H. WALDORF, *economist*

Marketing Economics Research Division,  
Agricultural Marketing Service

## Introduction

### The Problem

Civilian consumers in the United States spent \$58.7 billion for domestic farm food products in 1959; \$39.0 billion went to agencies for assembling, transporting, processing, and distributing commodities; and \$19.7 billion went to farmer-producers for their products. Labor costs for marketing farm food products were \$18.5 billion—nearly half of the total marketing bill.<sup>1</sup> During the postwar period, payoffs in factories processing domestic farm food products accounted for one-fourth of total labor costs in the marketing bill. Except in 1950, consumer outlays to marketing agencies have increased each year since the beginning of World War II, and labor costs have paralleled this upward trend. Historically, the marketing bill has grown substantially faster than the farm value (4, 18).

The importance of labor costs in the total marketing bill and the fact that these costs have paralleled a continued upward trend in total marketing charges have focused attention on the need for information on changes in output per man-hour in marketing domestic farm food products (2). The major objectives of this report are to (1) gauge trends since 1919 in output per man-hour in factories processing domestic farm food products, (2) analyze factors underlying these trends, (3) compare developments in output per man-hour in factory processing with those in farming and (4) review the implications of these develop-

ments for changes in unit labor costs in factory production of farm food products.

### The Coverage

The series on factory production of farm food products, man-hours, and output per man-hour compiled for this report are for manufacturing establishments primarily engaged in processing domestically produced farm food products (except fluid milk, cream and eggs).<sup>2</sup> This production includes factory processing of foods for export, for members of the

<sup>1</sup> The labor cost figure does not include labor costs of railroads and other for-hire carriers; it includes an estimate for cost of fringe benefits. \* \* \* the marketing bill measures the difference between consumer expenditures for farm products and payments received by farmers for equivalent quantities of produce. In this context, marketing includes all operations involved in moving agricultural products from farms on which they are produced to consumers at the time and in the form they are bought." See Ogren (18). (Italic numbers in parentheses refer to items in Literature Cited, page 35.)

The total marketing bill for domestic farm food products is published annually in *The Marketing and Transportation Situation*, Agricultural Marketing Service, United States Department of Agriculture.

<sup>2</sup> This report excludes plants processing fluid milk, cream, and eggs because adequate employment data for these plants are not available. In the base period, 1917-19, fluid milk, cream, and processed eggs accounted for about 15 percent of (weighted) factory production of all domestic farm food products. The series used in this report also include output and man-hours in production of food by-products manufactured in establishments specializing in processing farm food products.

Armed Forces, and for Government purchases used in various relief programs as well as food for sale to civilian consumers. It excludes factory processing of imported foods, seafoods, and other foods not produced on domestic farms. It also excludes manufacture of alcoholic and nonalcoholic beverages.

### Definitions

Efficiency is generally defined as output divided by combined inputs of labor and other resources where other resources include fixed capital, working capital, management, and other factor inputs (19, 20). Changes in the quality of these factor inputs should also be reflected in changes in production inputs. This means that the index of output per man-hour is only a partial measure of changes in efficiency: It is affected by substitution among labor, capital, and other factor inputs; changes in the quality of factor inputs; and changes in efficiency resulting from changes in the extent of the market (economies of scale). Changes in the intensity of labor effort are also reflected; however, this probably accounts for only a minor proportion of the historical rise in output per man-hour.

Output per man-hour is a useful tool, along with others, for analyzing developments in labor inputs and labor costs: When consistently defined, unit labor costs are identically equal to average hourly earnings divided by output per man-hour. The reciprocal of output per man-hour—unit man-hour requirements—measures changes in labor utilization. If labor accounts for a large share of combined labor and capital inputs and there has been little or no substitution between capital and labor, long-term trends in output per man-hour may be a reasonable approximation to long-term trends in labor-capital productivity (output per combined unit of labor and capital); apparently, this has been the experience in food

manufacturing for the entire period since the end of World War I.

The index of factory production, the numerator of the output per man-hour ratio, is designed to measure changes in net physical output of factories engaged in processing domestic farm food products.<sup>3</sup> However, because of lack of data, it is only an approximate measure of net physical output.<sup>4</sup>

The series on man-hours used in computing output per man-hour is based on *all* employees and average hours worked, as defined in the Census of Manufactures. Data on man-hours for years prior to World War II were derived from published reports of the Bureau of the Census, Bureau of Labor Statistics, and studies made by trade and private research organizations.<sup>5</sup>

Estimates of the stock of capital invested in Food and kindred products (excluding Beverages) manufactures used in this report have been made especially available by Dr. Daniel Creamer (7, 15). These estimates are based on book value of invested capital reported to the Bureau of Internal Revenue deflated for price changes. This means that the estimates of the stock of total capital measure only physical assets shown in the balance sheet, not all physical assets used in food manufacturing. The figures omit

<sup>3</sup> That is, whenever possible, physical quantities were weighted by value added. "Value added," as used in the Census of Manufactures (U.S. Dept. Commerce), is "calculated by subtracting the cost of materials, supplies, containers, fuel, purchased electric energy, and contract work from the total value of shipments." For an analysis of the value added concept applied to components in consumer expenditures for food see Ogren (18).

<sup>4</sup> For a brief description of the index of factory production, see appendix A; for a detailed description of sources and methods used in constructing the index, see Waldorf (35).

<sup>5</sup> For definitions of all employees and hours worked, and for general description of sources of data and methods used in deriving the man-hours index, see appendix A.

plant and equipment rented or leased from other sectors of the economy; however, there has been no apparent shift to the use of rented capital goods by food manufacturers, judging from Internal Revenue data on rent and depreciation. The estimates are net of depreciation. Like all other data on the stock of capital, these estimates are subject to important limitations (5, 6). Because of inadequacy of the price deflators used to estimate the quantity of capital in constant dollars, changes in the stock of capital do not reflect increased quality (including new technology). Consequently, changes in

the stock of capital in food manufactures used in this report may be thought of as changes in a stock of capital measured in the quality of capital goods employed during the weight period. There is also the difficult accounting problem of estimating depreciation and obsolescence: Capital goods are sometimes still in use long after they have been depreciated "out of existence" as during the wartime and early postwar period. In periods marked by rapid technological change, fixed capital is often scrapped early—that is, earlier than expected—because of obsolescence.

### Trend in Production Per Man-Hour

Output per man-hour in factories processing domestic farm food products grew at an average rate of 2.7 percent per year during the postwar period, 1947-58, compared with 3.5 percent for the total private economy.<sup>6</sup> The rise in output per man-hour in factory processing of foods was slightly faster than the rise in production; the number of man-hours worked declined slightly during the period. The postwar trend in output per man-hour for all food processing reflects divergent trends among major food processing industries. In fact, the comparatively slow rate of growth in the all-food series was partly the result of shifts in production from food processing industries with higher rates of output per man-hour to industries with lower rates. Output per man-hour in all food processing, adjusted for changes in the product mix, was about the same as the annual rate for the total private economy. When we include depression, wartime, and postwar experiences from 1919 to 1958, output per man-hour in factories processing farm food products grew at an average annual rate of 2.0 percent.

#### All Processed Foods

Output per man-hour in factory production of domestic farm food products during 1958 was 29 percent above the 1947-49 average (table 1). Except for a small dip in 1948, output per man-hour increased during each of these postwar years (fig. 1). The annual rate of growth during 1947-58 was about the same as the rate during 1919-29. Production per man-hour leveled off during most of the thirties and climbed very slowly between 1939 and 1947, because of shortages of fixed capital and other resource inputs imposed by World War II. During the 40 years 1919-58, output per man-hour in factories processing food products rose nearly 140 percent.

The reciprocal of the index of output per man-hour measures changes in man-hour requirements per unit of output in factories processing domestic farm food prod-

<sup>6</sup> Unless otherwise noted, throughout this report average annual rates of growth were computed from least squares trend of the logarithms of the index numbers for years shown in table 1.

TABLE 1.—*Factory production of domestic farm food products, man-hours, and production per man-hour, United States, 1919-58*

[1947-50=100]

| Year      | Production <sup>1</sup> | Man-hours <sup>2</sup> | Production per man-hour <sup>3</sup> |
|-----------|-------------------------|------------------------|--------------------------------------|
| 1919..... | 53                      | 97                     | 54                                   |
| 1921..... | 47                      | 80                     | 59                                   |
| 1923..... | 55                      | 87                     | 63                                   |
| 1925..... | 58                      | 85                     | 68                                   |
| 1927..... | 60                      | 85                     | 70                                   |
| 1929..... | 65                      | 92                     | 71                                   |
| 1931..... | 60                      | 75                     | 80                                   |
| 1933..... | 55                      | 68                     | 80                                   |
| 1935..... | 60                      | 75                     | 81                                   |
| 1937..... | 68                      | 85                     | 80                                   |
| 1939..... | 72                      | 78                     | 92                                   |
| 1947..... | 101                     | 101                    | 100                                  |
| 1948..... | 99                      | 100                    | 99                                   |
| 1949..... | 100                     | 99                     | 101                                  |
| 1950..... | 103                     | 99                     | 104                                  |
| 1951..... | 106                     | 101                    | 105                                  |
| 1952..... | 108                     | 102                    | 106                                  |
| 1953..... | 112                     | <sup>5</sup> 97        | <sup>5</sup> 115                     |
| 1954..... | 113                     | 97                     | 117                                  |
| 1955..... | 117                     | 98                     | 119                                  |
| 1956..... | 124                     | 100                    | 124                                  |
| 1957..... | 124                     | 98                     | 126                                  |
| 1958..... | 126                     | 97                     | 130                                  |

<sup>1</sup> Measures physical output of manufacturing establishments processing domestically produced farm food products. Output excludes processing of fluid milk, cream, and eggs; it includes food byproducts.

<sup>2</sup> For all employees of manufacturing establishments, including those engaged in distribution and construction work; the extent to which such employees are included in figures for years before 1939 is not known.

Man-hours index for years since 1947 is based on hours worked; those for years between 1919 and 1923 based on prevailing hours, adjusted to approximate actual hours. Estimates of average weekly hours worked by employees other than production and related workers are based on assumed trend.

<sup>3</sup> Computations for production per man-hour are based on unrounded figures.

<sup>4</sup> Estimated from Bureau of Labor Statistics data.

<sup>5</sup> The Bureau of the Census revised the sampling plan and universe in Annual Surveys of Manufactures beginning in 1953, which somewhat offsets comparability of man-hours and output per man-

hours.<sup>7</sup> About four-fifths as many man-hours were required per unit of factory output in 1958 as in 1947. The annual rate of decline in unit man-hour requirements was about 2½ times as fast between 1919 and 1939 as between 1939 and 1947. This decelerated rate of decline during the war and early postwar period dramatizes the difficulty of extrapolating historical rates of change in unit man-hour requirements to periods marked by severe restrictions on other factor inputs. Between 1919 and 1958, unit man-hour requirements in factory production of farm food products decreased about three-fifths.

Factory production of domestic farm food products grew slightly less than output per man-hour during the postwar period 1947-58; the number of man-hours worked trended slightly downward. Both the direction and percentage changes in production and man-hours were about the same in the two postwar periods, 1947-58 and 1919-29. During the four decades 1919-58, production outpaced the growth in output per man-hour, and man-hours showed a small but significant upward trend.

The small rise in the number of man-hours employed in factory processing since the end of World War I was the result of an increase in number of employees that more than offset a decline in the average

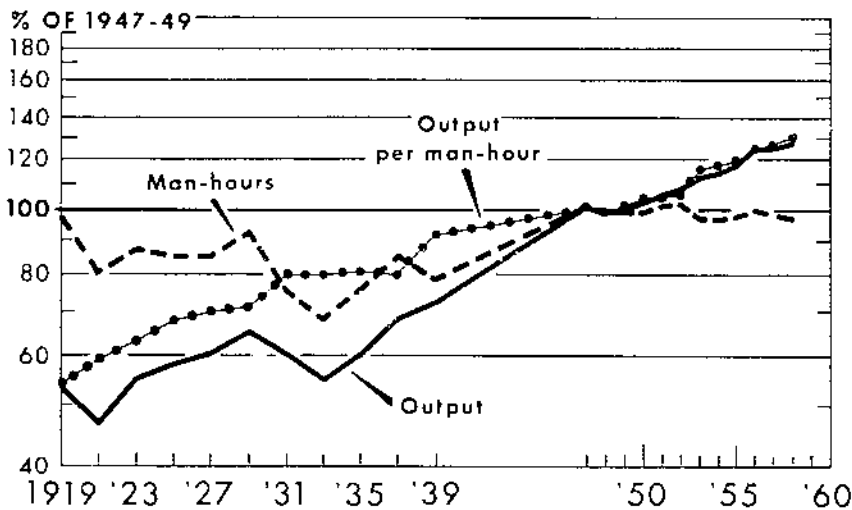
<sup>7</sup> More specifically, the reciprocal of output per man-hour as compiled in this report measures changes in unit man-hour requirements for a changing product "mix."

hour series with earlier years. Comparison of employment data reported in Annual Surveys and by the BLS suggests that average annual rate of growth in output per man-hour from 1947 to 1958 was not significantly affected by the revision.

Compiled from Biennial and Decennial Censuses of Manufactures (31, 32) Annual Surveys of Manufactures (29) and data published by the Departments of Labor and Agriculture.

Factory Processing of Farm Foods

# OUTPUT PER MAN-HOUR



U. S. DEPARTMENT OF AGRICULTURE

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FIGURE 1

number of hours worked.<sup>8</sup> Among production and related workers, most of the decline in the average workweek took place within about the first three decades; within the last decade, average weekly hours worked by production and related employees have declined only slightly.

Since World War II, there has been a shift from production to non-production workers employed in factories processing domestic farm food products (3): The number of production and related workers reported in the Census and Annual Surveys of Manufactures declined

<sup>8</sup> Data on average weekly hours are available for production and related workers only. During the period 1919-58, production and related workers accounted for at least three-fourths of all employees. Production and related workers as defined in the Census of Manufactures for 1954 include workers up through the working foreman level engaged in production operations or in services closely associated with these operations (for example, watchmen, janitors, record keepers).

5 percent between 1947 and 1958, whereas the number of all other employees rose 25 percent. Despite changes in Census definitions, it appears that between 1919 and 1929, when the rise in output per man-hour equaled the rise during the post-World War II period, the number of production workers showed little or no change, whereas the number of nonproduction workers declined substantially. The shift from production to nonproduction workers since 1947 reflects the introduction of new, more complex technology that requires especially trained technicians and engineers, along with greater emphasis on sales, management, and related functions.

## Comparison With the Total Private Economy

Output per man-hour worked in the total private economy grew at an average annual rate of 3.5 percent during the postwar period 1947-58 (38), substantially faster

than in factories processing domestic farm food products (table 2). The larger rate of increase in the total private economy resulted mainly from the sharp rise of output per man-hour in farming. The postwar annual rate of growth of output per man-hour in the private nonfarm sector of the economy (2.9 percent) was roughly the same as in food processing industries. During the entire four decades following the end of World War I, output per man-hour worked in the total private economy increased at an average rate of 2.7 percent per year; this was also substantially greater than the yearly rate of growth in factories processing farm foods. The average annual rate of growth in the private nonfarm sector of the economy (2.3 percent) during the four decades as a whole was somewhat higher than in food processing.

TABLE 2.—Average annual percentage change in output per man-hour in factories processing farm food products and in the total private economy, United States, 1917-58 and 1919-58

| Series                              | 1917-58     | 1919-58 <sup>1</sup> |
|-------------------------------------|-------------|----------------------|
| Factory processing of farm foods    | Percent 2.7 | Percent 2.0          |
| Private nonfarm sector <sup>2</sup> | 2.9         | 2.3                  |
| Total private economy <sup>2</sup>  | 3.5         | 2.7                  |

<sup>1</sup> Average annual rates for each sector are based on biennial and annual data for years shown in table 1. Average annual rates for the total private economy and for the private nonfarm sector would be about the same if computed from annual data.

<sup>2</sup> Computed from Bureau of Labor Statistics estimates of "real product per man-hour in the private economy" (33). Real product per man-hour for total private economy and for private nonfarm sector based on estimates for gross national product in constant dollars constructed by Office of Business Economics, U.S. Department of Commerce; man-hours data from *Monthly Report of the Labor Force*, Bureau of the Census, and based on personal interviews of a sample of households.

## Postwar Trends Among Industry Groups

Average annual rates of growth in output per man-hour shown in this report reflect changes resulting from shifts in production among plants manufacturing the same or different kinds of food products with different rates of output per man-hour as well as increases in output per man-hour within individual plants. Data are not available for separating these sources of change; it is evident, however, that the aggregate index averages extremely divergent trends among individual food plants and industries. Postwar trends in output per man-hour varied widely among major industry groups (table 3). Output per man-hour in factories processing fruits and vegetables, domestically grown sugar, manufactured dairy products, and grain-mill products rose faster than the average for all farm foods (fig. 2).<sup>9</sup> On the other hand, output per man-hour in factory production of confectionery products, meat products, and bakery products rose at a slower rate than the average for all processed foods.

Production trends among industry groups also ranged widely between 1947-49 and 1958. At the lower extreme, industries manufacturing grain-mill products registered only a slight rise in production; at the upper extreme, production of processed fruits and vegetables rose about 50 percent (table 3).<sup>10</sup> The

<sup>9</sup> The average annual rates of growth shown by the slopes of the lines in figure 2 are, of course, affected by the choice of years (1917-49 average and 1958); therefore, reference should also be made to table 3 for comparison with other years.

<sup>10</sup> Production of poultry products rose roughly 250 percent from 1947-49 to 1958. Comparable data on man-hours are incomplete and cannot be shown separately; nevertheless, it is apparent from available information that output per man-hour in poultry dressing plants grew at a substantially faster rate than in any industry group shown in table 3.

## OUTPUT PER MAN-HOUR BY INDUSTRY GROUPS

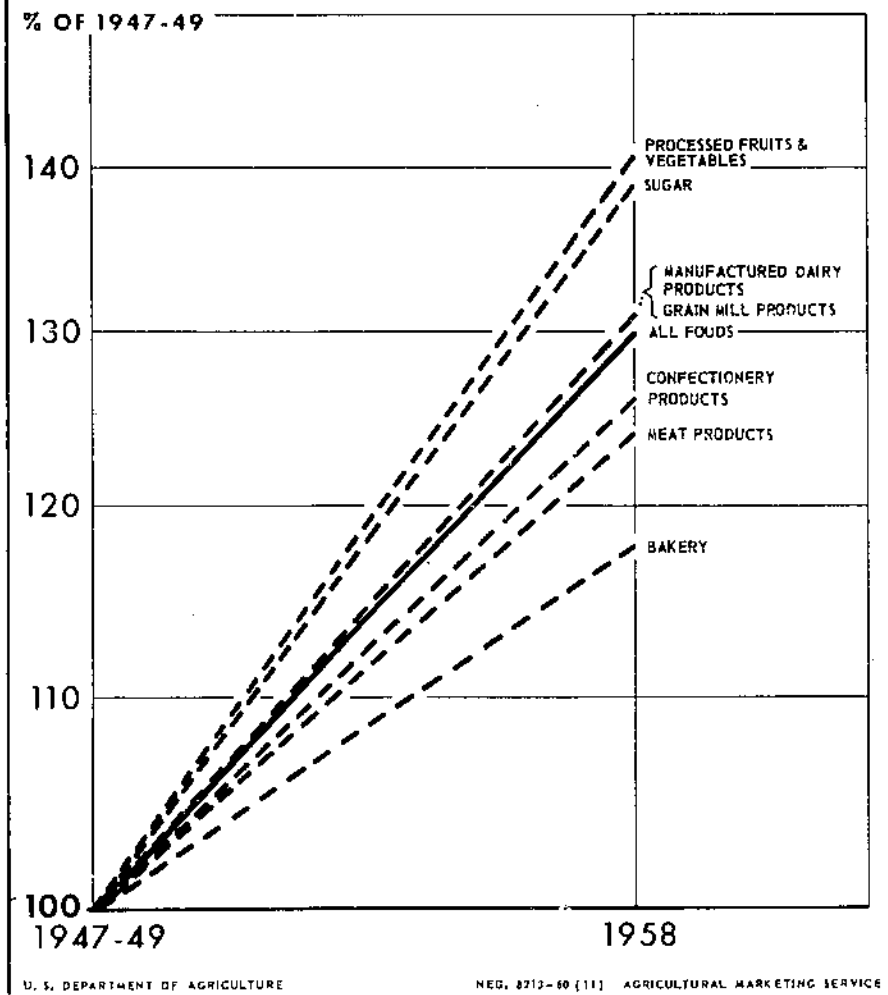


FIGURE 2

index of output per man-hour for all processed foods used in this report is affected by changes in the product "mix." For example, the postwar shift from grain-mill products, where output per man-hour is above the average for all processed foods, to meat products, where it is below the average, retarded

the rate of growth of output per man-hour for all food products. Elimination of the effects of changes in the product "mix" among the major industry groups on the growth in output per man-hour for all farm foods indicates that there have been substantial shifts in output from those industry groups in which out-



TABLE 3.—*Factory production, man-hours, and production per man-hour, by industry group, United States, 1947-58* <sup>1</sup>

[1947-49=100]

| Year      | All foods <sup>2</sup>           |                  |                                       | Meat products <sup>3</sup>   |                   |                                       | Manufactured dairy products <sup>4</sup> |                  |                                       | Processed fruits and vegetables <sup>5</sup> |                  |                                       |
|-----------|----------------------------------|------------------|---------------------------------------|------------------------------|-------------------|---------------------------------------|--|------------------|---------------------------------------|--|------------------|---------------------------------------|
|           | Production                       | Man-hours        | Production per man-hour <sup>10</sup> | Production                   | Man-hours         | Production per man-hour <sup>10</sup> | Production                               | Man-hours        | Production per man-hour <sup>10</sup> | Production                                   | Man-hours        | Production per man-hour <sup>10</sup> |
| 1947..... | 101                              | 101              | 100                                   | 105                          | 102               | 103                                   | 105                                      | 109              | 97                                    | 97   | 103              | 93                                    |
| 1948..... | 99                               | 100              | 99                                    | 96                           | 98                | 98                                    | 98                                       | 100              | 97                                    | 99   | 100              | 99                                    |
| 1949..... | 100                              | 99               | 101                                   | 99                           | 100               | 99                                    | 97                                       | 91               | 106                                   | 104  | 97               | 108                                   |
| 1950..... | 103                              | 99               | 104                                   | 101                          | 100               | 101                                   | 95                                       | 96               | 98                                    | 106  | 98               | 108                                   |
| 1951..... | 106                              | 101              | 105                                   | 100                          | 104               | 97                                    | 91                                       | 90               | 101                                   | 124  | 107              | 115                                   |
| 1952..... | 108                              | 102              | 106                                   | 105                          | 105               | 100                                   | 91                                       | 88               | 104                                   | 122  | 102              | 119                                   |
| 1953..... | 112                              | <sup>11</sup> 97 | <sup>11</sup> 115                     | 113                          | <sup>11</sup> 102 | <sup>11</sup> 111                     | 96                                       | <sup>11</sup> 90 | <sup>11</sup> 106                     | 129  | <sup>11</sup> 98 | <sup>11</sup> 131                     |
| 1954..... | 113                              | 97               | 117                                   | 116                          | 101               | 115                                   | 96                                       | 83               | 115                                   | 128  | 97               | 132                                   |
| 1955..... | 117                              | 98               | 119                                   | 125                          | 103               | 120                                   | 99                                       | 84               | 117                                   | 135  | 98               | 137                                   |
| 1956..... | 124                              | 100              | 124                                   | 130                          | 107               | 122                                   | 102                                      | 83               | 123                                   | 151  | 102              | 148                                   |
| 1957..... | 124                              | 98               | 126                                   | 124                          | 101               | 124                                   | 104                                      | 82               | 126                                   | 144  | 103              | 139                                   |
| 1958..... | 126                              | 97               | 130                                   | 119                          | 95                | 124                                   | 104                                      | 79               | 131                                   | 147  | 104              | 141                                   |
| Year      | Grain-mill products <sup>6</sup> |                  |                                       | Bakery products <sup>7</sup> |                   |                                       | Sugar <sup>8</sup>                       |                  |                                       | Confectionery <sup>9</sup>                   |                  |                                       |
|           | Production                       | Man-hours        | Production per man-hour <sup>10</sup> | Production                   | Man-hours         | Production per man-hour <sup>10</sup> | Production                               | Man-hours        | Production per man-hour <sup>10</sup> | Production                                   | Man-hours        | Production per man-hour <sup>10</sup> |
| 1947..... | 105                              | 104              | 101                                   | 99                           | 98                | 101                                   | 110                                      | 113              | 97                                    | 100  | 99               | 101                                   |
| 1948..... | 104                              | 100              | 104                                   | 100                          | 100               | 99                                    | 90                                       | 96               | 94                                    | 102  | 102              | 100                                   |
| 1949..... | 91                               | 96               | 95                                    | 101                          | 102               | 100                                   | 100                                      | 91               | 109                                   | 98   | 99               | 99                                    |
| 1950..... | 90                               | 95               | 95                                    | 104                          | 101               | 102                                   | 122                                      | 102              | 119                                   | 106  | 105              | 100                                   |
| 1951..... | 94                               | 95               | 99                                    | 107                          | 105               | 101                                   | 92                                       | 96               | 96                                    | 101  | 88               | 114                                   |
| 1952..... | 95                               | 105              | 90                                    | 106                          | 107               | 99                                    | 96                                       | 93               | 104                                   | 102  | 92               | 111                                   |

|           |     |      |       |     |      |       |     |       |       |     |      |       |
|-----------|-----|------|-------|-----|------|-------|-----|-------|-------|-----|------|-------|
| 1953----- | 94  | " 91 | " 103 | 106 | " 97 | " 109 | 110 | " 100 | " 110 | 102 | " 87 | " 117 |
| 1954----- | 95  | 84   | 113   | 105 | 97   | 108   | 118 | 85    | 138   | 97  | 85   | 114   |
| 1955----- | 94  | 87   | 109   | 107 | 99   | 108   | 103 | 80    | 128   | 95  | 86   | 110   |
| 1956----- | 98  | 84   | 117   | 111 | 100  | 111   | 113 | 78    | 144   | 98  | 88   | 111   |
| 1957----- | 101 | 80   | 126   | 114 | 100  | 114   | 122 | 80    | 151   | 104 | 85   | 122   |
| 1958----- | 104 | 79   | 131   | 117 | 99   | 118   | 126 | 90    | 139   | 104 | 83   | 126   |

<sup>1</sup> Man-hour indexes based on *all employees and hours worked*; figure for 1948 interpolated from Bureau of Labor Statistics data on *all employees and hours paid for*. See footnotes to table 1.

<sup>2</sup> Includes poultry dressing plants and establishments primarily engaged in manufacturing leavening compounds, shortening and cooking oils, margarine, corn wet milling products, flavorings, macaroni and spaghetti, and peanut butter, as well as industry groups shown in table.

<sup>3</sup> Includes meatpacking plants and establishments specializing in prepared meat products.

<sup>4</sup> Includes establishments primarily engaged in manufacturing creamery butter, natural cheese, concentrated milk, ice cream and ices, and special dairy products; it excludes processing of fluid milk and cream.

<sup>5</sup> Includes establishments primarily engaged in manufacturing canned fruits and vegetables, dehydrated fruits and vegetables, pickles and sauces, and frozen fruits and vegetables.

<sup>6</sup> Includes establishments primarily engaged in manufacturing flour and meal, cereal products, rice milling, and blended and prepared flour.

<sup>7</sup> Includes establishments primarily engaged in manufacturing biscuits and crackers, wholesale bakeries, grocery chain bakeries, house-to-house bakeries, and retail multi-outlet bakeries (exclud-

ing those with direct sales to consumers on premises). In 1954, establishments which were part of a chain and were producing for direct sale on premises were reclassified from the Census of Manufactures to the Census of Retail Trade; however, this did not significantly affect comparability of the series between 1947 and 1954. Establishments which bake primarily for direct sale to consumers are not included.

<sup>8</sup> Includes establishments primarily engaged in manufacturing raw cane sugar from domestically grown sugarcane and plants mainly engaged in production of beet sugar. The index of raw cane sugar also includes an adjustment for refining domestic cane sugar.

<sup>9</sup> Includes establishments primarily engaged in manufacturing candy and other confections.

<sup>10</sup> Computations for production per man-hour are based on unrounded figures.

<sup>11</sup> Census Bureau revised sampling plan and universe in Annual Survey of Manufactures beginning in 1953 which somewhat offsets comparability of man-hours and output per man-hour series with earlier years.

Compiled from Census of Manufactures, Annual Surveys of Manufactures and data published by the Departments of Labor and Agriculture.

put per man-hour is higher to those in which it is lower. If the 1947 product mix had remained constant through 1957 and each industry group had experienced its same rate of growth in output per man-hour, the average annual rate of increase of factory production per man-hour would have been 3.3 percent instead of 2.7 percent.<sup>11</sup> The adjusted figure (3.3 percent) for food processing is about the same as the postwar figure (3.4 percent) for the total private economy adjusted for intersector shifts in output between farming and the total private non-farm sector of the economy (33). This means there is no evidence that, on the average, output per man-hour within individual food industries or plants grew at a slower rate than the average within individual industries or establishments for the total private economy.

It appears that changes in the product mix may continue for some time to exert a dampening effect on the growth of output per man-hour in factory processing of farm food products. Comparison of income elasticities for farm foods estimated by the Department of Agriculture (8, 11) indicates that as "real" per capita income rises (other things remaining the same) consumers will tend to shift to meat products where output per man-hour is currently below the average for all processed foods and to

shift from grain-mill products where output per man-hour is currently above the average. In the base period 1947-49, meat products accounted for nearly 20 percent, and grain-mill products for nearly 10 percent of total (weighted) factory production of processed farm foods. To some extent, these dampening influences will be tempered by probable developments in manufactured dairy products where income elasticity and output per man-hour are both higher than the averages for all processed foods. Among the other major food groups—bakery products, fruits and vegetables, and sugar and confectionery products—output per man-hour is roughly the same and close to the all-food average.

The number of man-hours worked within each industry group in 1958 was either the same or smaller than in the base period 1947-49. The number of man-hours worked remained the same in industry groups that experienced substantial increases in production; the number declined among groups in which production declined or stayed the same. In all groups, output per man-hour increased. These developments indicate that food manufacturers tended to substitute other inputs—capital, new technology, entrepreneurship, more highly skilled employees, and other inputs—for man-hours.

### Factors Affecting Output Per Man-Hour

Apparently food manufacturers did not substitute fixed capital for labor in food manufactures from 1929 to 1957. Changes in technology were at least as much fixed capital saving as labor saving during the period. Between 1948 and 1957, the stock of working capital rose substantially relative to the

<sup>11</sup> If the 1957 product mix is held constant, the estimated average yearly increase is 3.5 percent.

number of man-hours worked and contributed to the postwar growth in output per man-hour. Industry surveys and other indicators point to a dramatic growth in new technology in food processing, particularly since the end of World War II, but information is not available to measure the impact of new technology on the rise in output per man-hour.

Changes in the extent of educa-

tion, training, experience, and other forms of investment in human capital also affect changes in output per man-hour. A man-hours series by occupation weighted by wages and salaries would reflect changes in the "quality" and composition of labor inputs. As a first approximation to such a series, the number of man-hours of production workers and of nonproduction workers within each industry were separately weighted by average hourly earnings. The weighted man-hours index showed the same average annual rate of change as the unweighted man-hours series during the postwar years 1947-58 because interindustry shifts offset intra-industry shifts from production to nonproduction workers. The weighted and unweighted man-hour indexes also showed about the same annual rate of change for the entire four decades, 1919-58.

### Capital in Food Manufactures

Estimates of the stock of total capital (fixed plus working capital) and the stock of fixed capital in Food and kindred products (excluding Beverages) manufactures have been constructed by Daniel Creamer (7, 15) for selected years; data on the stock of capital employed in factories primarily engaged in processing domestic farm food products are not available.<sup>12</sup> This information can be used to gauge trends in capital inputs (that is, capital of base-period quality) and the extent of substitution between capital and labor in factories processing farm food products. In order to eliminate effects of business fluctuations on trends in capital per worker and capital-output ratios, Creamer selected years representing

<sup>12</sup> In 1957, value added by manufacturing establishments included in the output per man-hour index for factory processing of domestic farm food products accounted for 83 percent of total value added by all establishments classified in Food and kindred products (excluding Beverages) manufactures.

similar positions in the business cycle (6). Therefore, the effect of changes in capacity utilization on trends in capital per worker, capital per man-hour, and capital per unit of output are probably minimized for long-term comparisons; the effect on short-term comparisons, particularly in the postwar period, may be significant, however.

During the postwar period, 1948-57, the stock of total capital used in Food and kindred products (excluding Beverages) manufactures increased substantially (table 4).

TABLE 4.—Stock of total capital in Food and kindred products (excluding Beverages) manufactures, United States, selected years, 1919-57

| Year      | Total capital <sup>1</sup> | Total capital per—         |                           |                                |
|-----------|----------------------------|----------------------------|---------------------------|--------------------------------|
|           |                            | Em-<br>ployee <sup>2</sup> | Man-<br>hour <sup>3</sup> | Unit of<br>output <sup>4</sup> |
| 1919..... | 78                         | 76                         | 76                        | 95                             |
| 1929..... | 100                        | 100                        | 100                       | 100                            |
| 1937..... | 86                         | 77                         | 93                        | 83                             |
| 1948..... | 91                         | 68                         | 85                        | 57                             |
| 1953..... | 192                        | 77                         | 98                        | 56                             |
| 1957..... | 120                        | 88                         | 113                       | 60                             |

<sup>1</sup> Includes fixed capital (land, buildings, machinery, and equipment) and working capital (cash, inventories, and accounts receivable). Data made available by Dr. Daniel Creamer: 1919, 1929, 1937, and 1948 from *Capital in Manufacturing and Mining: Its Formation and Financing*, by Creamer, Dobrovolsky, and Borenstein (7); 1953 and 1957 from *Study in Business Economics*, National Industrial Conference Board (15).

<sup>2</sup> Index based on number of all employees in Food and kindred products (excluding Beverages) manufactures reported in Census of Manufactures and in Annual Survey of Manufactures.

<sup>3</sup> Based on estimate of man-hours worked by all employees.

<sup>4</sup> Based on approximate net output index for Food and kindred products (excluding Beverages) manufactures employing same method used to compute index of factory production of domestic farm food products for years between 1919 and 1948. For years after 1948, the Industrial Production Index for Food Products (Food and kindred products, excluding Beverages) compiled by the Federal Reserve Board was used (22).

This rise was accounted for by an increase in the stock of working capital (cash, inventories, and accounts receivable); the stock of fixed capital (land, buildings, machinery, and equipment) remained virtually unchanged (table 5). In contrast to the postwar experience nearly all of the decline in total capital stock between 1929 and 1948 was due to a change in the stock of fixed capital.

In sum, trends in capital per man-hour and per employee in food manufacturing indicate that (1) there has apparently been no substitution of fixed capital for labor in the postwar period 1948-57, and, in fact, none since 1929, the first year for which these data are available; but (2) there has been a substantial rise in the stock of working capital relative to the number of man-hours employed during those years. The increase of working capital relative to labor contributed to the rise in output per man-hour in the postwar period; however, the leveling off of fixed capital per

man-hour indicates that, at least since 1929, the rise in output per man-hour in food manufacturing resulted mainly from other factors such as new technology, a more skilled labor force, economies of scale, and other factors.

During both the postwar period 1948-57 and the period 1929-57 as a whole, technological improvements in food manufacturing seem to have led to savings in both fixed capital and labor per unit of output. The fixed capital-output ratio in 1957 was three-fifths below the 1929 figure (table 5); unit man-hour requirements in Food and kindred products (excluding Beverages) manufactures declined about one-half in the same period. During the postwar years 1948-57, both the fixed capital-output ratio and unit man-hour requirements in food manufactures declined by about one-fifth. Working capital per unit of output increased in the postwar period.

### Technology

New technology is probably the most dramatic factor contributing to the growth in output per man-hour in factory processing of farm food products, particularly since World War II. Data for gaging the impact of new technology on output per man-hour are not available. A brief industry survey of major developments suggests that technological changes in food manufacturing during the last three decades were both labor saving and fixed-capital saving. Between 1953 and 1957, firms engaged in manufacturing Food and kindred products substantially increased their outlays for research and development. These outlays are largely for development of new food products, some of which contributed to the increase in output per man-hour.

A Department of Agriculture survey of technology in marketing of food products (28) lists major technological developments in commercial processing between 1930

TABLE 5.—Stock of fixed capital in Food and kindred products (excluding Beverages) manufactures, United States, selected years, 1929-57

| Year      | Fixed capital <sup>1</sup> | Fixed capital per—         |                           |                                |
|-----------|----------------------------|----------------------------|---------------------------|--------------------------------|
|           |                            | Em-<br>ployee <sup>2</sup> | Man-<br>hour <sup>2</sup> | Unit of<br>output <sup>2</sup> |
| 1929..... | 100                        | 100                        | 100                       | 100                            |
| 1937..... | 73                         | 66                         | 79                        | 70                             |
| 1948..... | 81                         | 61                         | 75                        | 50                             |
| 1953..... | 79                         | 60                         | 76                        | 44                             |
| 1957..... | 79                         | 58                         | 74                        | 39                             |

<sup>1</sup> Includes land, buildings, machinery, and equipment shown in the balance sheet of food manufacturing corporations; excludes fixed capital which is leased or rented from other sectors of the economy. Judging from Internal Revenue data, there was no significant trend in the use of rented capital in food manufacturing. Statistics obtained from Dr. Daniel Creamer; see table 4, footnote 1, and references (7, 15). Data for 1949 not available.

<sup>2</sup> See table 4, footnotes 2, 3, and 4.

and 1950—developments in materials handling, continuous processes, packaging, grading, sanitation, and others. In materials handling the trend has been towards bulk handling. This includes the introduction of hydroconveying, pneumatic conveying, and the extension of the dump truck principle to grains and other products. The adoption of bulk handling probably has been largely labor saving.

The development and adoption of continuous processes replaced much of the old-fashioned discontinuous batch and vat methods. These continuous processes also gave impetus to development of techniques for short-time sterilization at high temperatures, packaging equipment, and other innovations. Introduction of electronic temperature and humidity controls have also enlarged the usefulness of electric control systems. Technological changes associated with continuous processes suggest the importance of capital-saving innovations as well as labor-saving innovations in food processing.

Growth in kilowatt hours of electric power used also suggests the importance of new technology in increasing output per man-hour in food manufacturing. During the postwar period 1948-57, the stock of fixed capital remained unchanged and the number of man-hours worked declined slightly whereas the number of kilowatt hours consumed in food manufacturing rose about 50 percent. This rise in electric power consumed reflects increases in air-conditioning, lighting, and other electric appliances; however, in addition, it also reflects the employment of more electric power-driven equipment in bulk handling, continuous production processes, and other technological changes in production.

The National Science Foundation has sponsored several sample surveys (16, 17) during the postwar years which estimate employment

and outlays for research and development by United States industries. According to these reports, the estimated cost of research and development within the Food and kindred products industries in 1956 was \$75.9 million, about 40 percent greater than in 1953. These industries employed 15,400 engineers, chemists, and other natural scientists as of January 1957, about 5 percent above the number in January 1954. These figures on costs and employment within food manufacturing industries are largely for research and development of new products. New products often contribute to increased output per man-hour. In production of prepared and blended flour mixes, for example, output per man-hour is much greater than in white flour milling, and in the postwar period output of prepared flour increased much faster than white flour production. Similarly, the dramatic growth of frozen foods contributed to the substantial postwar rise in output per man-hour in the processed fruits and vegetables industry group. At any rate, the figure for Food and kindred products manufactures substantially understates total outlays for research and development related to food manufactures; it excludes research and development related to food processing undertaken by the chemical industry, the food machinery products industry, the electrical equipment industry, universities, Government agencies, and other groups.<sup>13</sup>

<sup>13</sup> Comparison with data for Food and kindred products manufactures published in the Annual Survey of Manufactures for 1956 indicates that research and development costs as reported by the National Science Foundation accounted for about 0.5 percent of value added and that the total number of physical scientists accounted for about 1 percent of all employees (nearly 3 percent of nonproduction workers). The ratios for employees would not be significantly larger if the estimates also included technicians engaged directly in research and development.

## Output Per Weighted Man-Hour

The index of output per man-hour reflects changes in "quality" of labor—that is, changes in the degree of education, experience, and other kinds of investment in labor employed in processing farm food products. The man-hours series used to compute the index of output per man-hour is a simple aggregate of hours worked by employees with heterogeneous skills and training—corporate executives, engineers, secretaries, production line workers, janitors, and others. This means that an hour worked by an engineer has the same weight as an hour worked by an unskilled laborer. In order to gage some of the effect of the change in quality of labor inputs, the number of man-hours worked by production and nonproduction workers has been weighted by average hourly earnings by industry (9, 12) (table 6). In this weighted man-hour series, an hour worked by an employee who earns \$2 per hour is counted as equivalent to two hours worked by an employee who earns \$1 per hour. At best, these computations are only suggestive: The classification of

TABLE 6.—Average annual percentage change in man-hours worked and in production per man-hour in factories processing domestic farm food products, based on weighted and unweighted man-hours, 1947-58 and 1919-58

| Series                               | 1947-58         | 1919-58 <sup>1</sup> |
|--------------------------------------|-----------------|----------------------|
| Man-hours:                           |                 |                      |
| Weighted <sup>2</sup> .....          | Percent<br>-0.3 | Percent<br>0.6       |
| Unweighted.....                      | - .3            | . 6                  |
| Production per                       |                 |                      |
| Weighted man-hour <sup>2</sup> ..... | 2.7             | 2.0                  |
| Unweighted man-hour.....             | 2.7             | 2.0                  |

<sup>1</sup> Based on years shown in table 1.

<sup>2</sup> Man-hours for production and nonproduction workers by industry weighted by average hourly earnings estimated from Census of Manufactures data.

nonproduction workers includes salesmen, secretaries, engineers, clerks, corporate executives, and other groups of employees with highly divergent skills. The man-hours series should be classified by occupation and should be weighted by wages and salaries, not by average hourly earnings.

During the postwar period 1947-58, the index of weighted man-hours worked in factory processing of domestic farm food products decreased at an average annual rate of 0.3 percent—the same as the unweighted man-hours index (table 6). The decline in the weighted man-hours index resulted from two contrasting movements: An inter-industry shift in man-hours worked by all employees, from higher to lower paying industries, more than offset the intra-industry shift from production and related jobs to other jobs that, on the average, paid more. Factory production per weighted man-hour rose an average of 2.7 percent per year from 1947 to 1958, also the same as output per unweighted man-hour. During the entire period 1919-58, the picture was much the same: The weighted man-hour index paralleled the unweighted man-hour index and, consequently, output per weighted man-hour and output per unweighted man-hour showed the same average annual rate of growth (2.0 percent). In sum, it appears that increases in output per man-hour caused by increased quality of labor within individual industries were at least partially offset by interindustry shifts.<sup>11</sup>

<sup>11</sup> The weighted man-hour index reflects interindustry shifts by all employees and intra-industry shifts between production and nonproduction workers only; "upgrading" within production and nonproduction workers separately would not be reflected. The comparison of the weighted and unweighted man-hours series probably understates increases in "quality" of labor inputs because of the necessity of using broad classifications.

## Comparison With Farming

Net output per man-hour in farming grew at an average annual rate of 6.2 percent during the postwar period 1947-58, nearly 2½ times as fast as in factories processing farm food products (table 7). During the 40 years between 1919 and 1958, output per man-hour in farming rose at an average annual rate of 2.8 percent, about 1½ times as fast as in factory processing. The markedly faster rate of growth in output per man-hour in farming than in factory processing can be accounted for by a large substitution of capital for labor in farming, particularly since World War II.<sup>15</sup>

1919-39; however, since the beginning of World War II net output per man-hour rose faster in farming than in factory processing. During the period 1919-58 as a whole, net output per man-hour increased about 210 percent in farm production and about 140 percent in factory processing.

### Capital in Farming

In contrast to Food and kindred products (excluding Beverages) manufactures, the sharp rise in output per man-hour in farming since about the beginning of World War II was accompanied by a large substitution of fixed capital for labor. Estimates by the Agricultural Research Service (23, 25) of value of assets employed in farm production (in 1947-49 dollars) indicate that total capital per farm worker rose about 80 percent and capital per man-hour rose about 125 percent between 1940 and 1957

<sup>15</sup> For comparison of trends of output per man-hour and labor-capital productivity between food manufacturing and farming, see appendix B.

<sup>16</sup> Net farm output per man-hour is based on estimates of "gross national farm product" compiled by the Office of Business Economics, U.S. Department of Commerce (30). Gross national farm product (in 1954 dollars) measures total value of farm output net of the value of nonfarm materials (gasoline, chemical fertilizers, etc.) and services (rents, etc.) used in farm production. Conceptually, gross national farm product, in constant prices, is analogous to the index of factory production of farm food products. The index of output per man-hour in farming used in this report differs conceptually from the production per man-hour index compiled by Agricultural Research Service, USDA. According to ARS estimates, gross farm output per man-hour rose about 105 percent in the postwar period 1947-58, and 300 percent in the four decades 1919-58 (24).

In the period 1947-49, farm production of food products, our primary interest in this report, accounted for roughly 90 percent of total farm production; the percentage was the same in the period 1935-39 (26).

### Comparative Trends

During the postwar period 1947-58, net output per man-hour rose about 110 percent in farming, as estimated by the Bureau of Labor Statistics (33), compared with about 30 percent in factories processing farm food products (fig. 3).<sup>16</sup> Output per man-hour rose significantly faster in factory processing than in farming in the interwar period,

TABLE 7.—Average annual percentage increase in output per man-hour in factories processing farm food products and in farming, United States, 1947-58 and 1919-58

| Series                                | 1947-58 <sup>1</sup> |         | 1919-58 <sup>1</sup> |         |
|---------------------------------------|----------------------|---------|----------------------|---------|
|                                       | Percent              | Percent | Percent              | Percent |
| Factory production of farm foods..... | 2.7                  | 2.0     | 2.7                  | 2.0     |
| Farming <sup>2</sup> .....            | 6.2                  | 2.8     | 6.2                  | 2.8     |

<sup>1</sup> Based on annual and biennial data for years shown in table 1; the average annual rate of growth in output per man-hour for farming based on annual data is the same as that shown in this table.

<sup>2</sup> Computed from Bureau of Labor Statistics estimates of "real product per man-hour in farming" (33). BLS series based on estimates of gross national farm product, compiled by the Office of Business Economics, U.S. Department of Commerce.



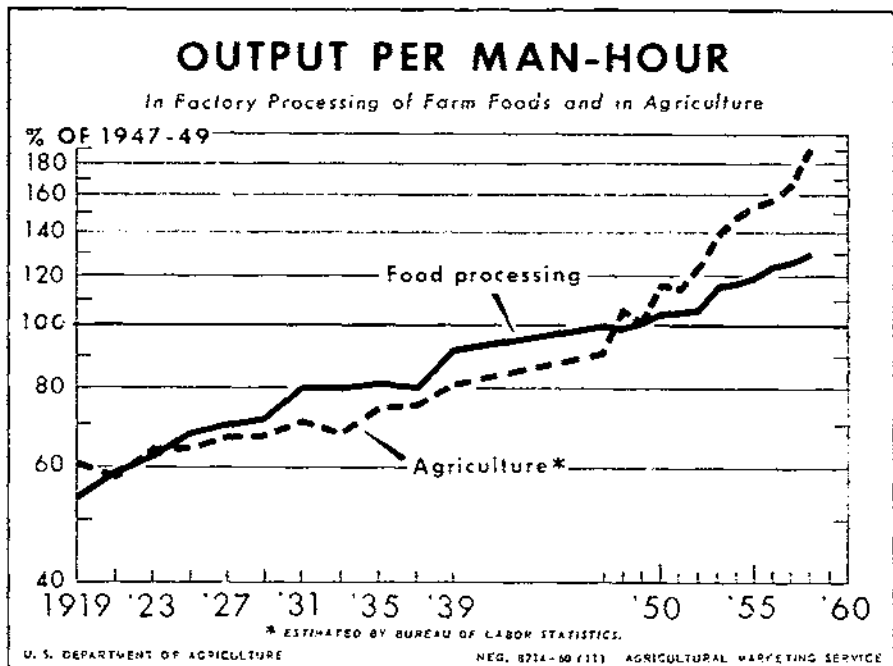


FIGURE 3

(table 8). More than three-fourths of the increase in total capital per man-hour was accounted for by an increase in real estate and machinery per man-hour; between 1937 and 1957, fixed capital per man-hour in food manufactures remained virtually unchanged. Further comparison of capital-output ratios and unit man-hour requirements indicates that improvements in technology in farming during this period were largely labor saving and very little fixed-capital saving; in food manufactures, improvements in technology tended to be somewhat more fixed-capital saving than labor saving.

Data for earlier years on capital in farming estimated by Alvin S. Postlebe (21) indicate that there was a significant upward trend in total capital per farm worker and per man-hour between the two World Wars. The total stock of capital per employee in food manufactures also rose from 1919 to 1929, but by 1937 it had dropped back to the 1919 level. During the entire four decades since the end of World War I, percentage increases in the stock of total capital per worker and per man-hour have been much larger in farming than in food manufactures.

### Unit Costs in Factory Processing

From 1939 to 1958, hourly earnings based on hours worked in factories processing farm food products substantially outpaced the rise in output per man-hour and, as a result, unit labor costs rose sharply.

In contrast, during the interwar period, 1919-39, output per man-hour in food processing rose faster than hourly earnings, and unit labor costs declined. The marked upward trend in average hourly

TABLE 8.—*Capital used in farm production, in constant prices, United States, selected years, 1920-57*

| Year      | Capital <sup>1</sup> | Capital per—             |                       |                             |
|-----------|----------------------|--------------------------|-----------------------|-----------------------------|
|           |                      | Farm worker <sup>2</sup> | Man-hour <sup>2</sup> | Unit of output <sup>3</sup> |
| 1920..... | 101                  | 94                       | 96                    | 101                         |
| 1930..... | 100                  | 100                      | 100                   | 100                         |
| 1940..... | 100                  | 113                      | 111                   | 86                          |
| 1948..... | 108                  | 130                      | 146                   | 84                          |
| 1953..... | 121                  | 170                      | 199                   | 93                          |
| 1957..... | 125                  | 206                      | 251                   | 91                          |

<sup>1</sup> Beginning in 1940, indexes based on value of assets used in farm production, in 1947-49 prices, computed by Agricultural Research Service (23); includes farm real estate, less value of dwelling; livestock; machinery and motor vehicles, less 60 percent of the value of automobiles; crop inventories held for livestock feed; and a portion of the demand deposits determined for each year by adjusting deposits of Jan. 1, 1942, by an index of production costs. Indexes for earlier years based on estimates made by Alvin S. Tostlebe (21). The two series are somewhat differently defined; however, the series linked in 1940 can be used to gauge long-term trends in capital used in farm production.

<sup>2</sup> Based on farm employment (family plus hired workers) and man-hours estimated by the U.S. Department of Agriculture.

<sup>3</sup> Based on farm output net of intermediate goods and services purchased from the nonfarm sector ("gross national farm product"), estimated by the U.S. Department of Commerce (30).

earnings in food manufactures in the last two decades was part of a similar trend in all manufactures. During both the postwar period 1947-58 and the four decades 1919-58, nonlabor charges (including profits) per unit of output in food processing rose significantly more than unit labor costs.

Unlike the marked postwar rise of unit labor costs in factories processing farm food products, unit labor costs in farming declined substantially from 1947 to 1958. The decline of unit labor costs in farming was the result of a moderate

rate of increase in average hourly earnings—substantially slower than in factory processing—that was more than offset by the rapid rate of growth in output per man-hour.

Unit processing costs in factories manufacturing farm food products rose slightly faster than unit labor costs from 1947 to 1958. This postwar rise in unit processing costs contributed to an increase in the wholesale price of processed foods relative to the farm prices of the raw products. Unit processing costs and unit labor costs have shown roughly the same long-term pattern; however, between 1919 and 1958, unit processing costs rose significantly faster than unit labor costs.

### Unit Labor Charges

Hourly earnings per employee based on hours worked in factories processing domestic farm food products were about 65 percent larger in 1958 than in the base period (table 9), 1947-49; however, because of a 30-percent rise in output per man-hour, unit labor costs were only about 30 percent above the base period average (fig. 4).<sup>17</sup> Between 1919 and 1939, output per man-hour grew faster than hourly earnings and, consequently, unit labor costs declined. For the entire period 1919-58, hourly earnings rose about 335 percent, output per man-

<sup>17</sup> The index of hourly earnings based on hours worked is the ratio of an index of total payrolls, as reported in the Census of Manufactures, and the index of man-hours worked by all employees, shown in table 1. Conceptually this series differs from average hourly earnings for production workers published by the Bureau of Labor Statistics, which is based on hours paid for (that is, including paid vacations, sick leave, etc.). There are other conceptual as well as statistical differences between the two series. Both series on hourly earnings omit fringe benefits which have grown as a percentage of total labor compensation, particularly since World War II (27). According to estimates of the Department of Commerce, total payrolls accounted for about 93 percent of total employees' compensation in Food and kindred products manufactures during 1957.

TABLE 9.—Hourly earnings, unit labor costs, unit nonlabor costs, and unit processing costs in factory production of farm food products, United States, 1919-58

(1947-49=100)

| Year      | Hourly earnings <sup>1</sup> | Unit labor costs <sup>2</sup> | Unit non-labor costs <sup>3</sup> | Unit processing costs <sup>4</sup> |
|-----------|------------------------------|-------------------------------|-----------------------------------|------------------------------------|
| 1919..... | 38                           | 70                            | 60                                | 63                                 |
| 1921..... | 42                           | 72                            | 52                                | 60                                 |
| 1923..... | 42                           | 66                            | 56                                | 60                                 |
| 1925..... | 42                           | 62                            | 62                                | 61                                 |
| 1927..... | 44                           | 62                            | 62                                | 61                                 |
| 1929..... | 43                           | 61                            | 69                                | 65                                 |
| 1931..... | 42                           | 53                            | 59                                | 56                                 |
| 1933..... | 37                           | 46                            | 52                                | 49                                 |
| 1935..... | 44                           | 55                            | 50                                | 51                                 |
| 1937..... | 46                           | 57                            | 53                                | 54                                 |
| 1939..... | 47                           | 51                            | 58                                | 55                                 |
| 1947..... | 94                           | 94                            | 99                                | 97                                 |
| 1948..... | <sup>5</sup> 101             | 103                           | <sup>6</sup> 98                   | <sup>6</sup> 100                   |
| 1949..... | 105                          | 103                           | <sup>6</sup> 103                  | <sup>6</sup> 103                   |
| 1950..... | 110                          | 106                           | 107                               | 107                                |
| 1951..... | 121                          | 115                           | 110                               | 112                                |
| 1952..... | 127                          | 120                           | 117                               | 119                                |
| 1953..... | 134                          | 117                           | 119                               | 118                                |
| 1954..... | 140                          | 119                           | 111                               | 115                                |
| 1955..... | 145                          | 122                           | 122                               | 122                                |
| 1956..... | 152                          | 123                           | 128                               | 126                                |
| 1957..... | 158                          | 126                           | 134                               | 130                                |
| 1958..... | 166                          | 128                           | 136                               | 132                                |

<sup>1</sup> Obtained by dividing index of payrolls by index of man-hours worked by all employees (table 1). Changes in amount of paid vacations, paid sick leave, and extra pay for overtime work result in changes in hourly earnings. Conceptually this series differs from the Bureau of Labor Statistics published series on average hourly earnings which is based on hours paid for.

<sup>2</sup> Obtained by dividing index of payrolls by factory production index shown in table 1.

<sup>3</sup> Obtained by dividing index of non-labor costs (value added minus payrolls) by factory production index shown in table 1. Nonlabor costs include profits.

<sup>4</sup> Obtained by dividing index of value added as defined by the Census Bureau by factory production index shown in table 1.

<sup>5</sup> Hourly earnings interpolated from BLS series on average hourly earnings.

<sup>6</sup> Value added estimated from data published in *Statistics of Income*, Internal Revenue Service.

Payroll and value-added data com-

hour rose about 140 percent and, as a consequence, unit labor costs in factories processing farm food products were about 80 percent greater in 1958 than at the end of World War I.

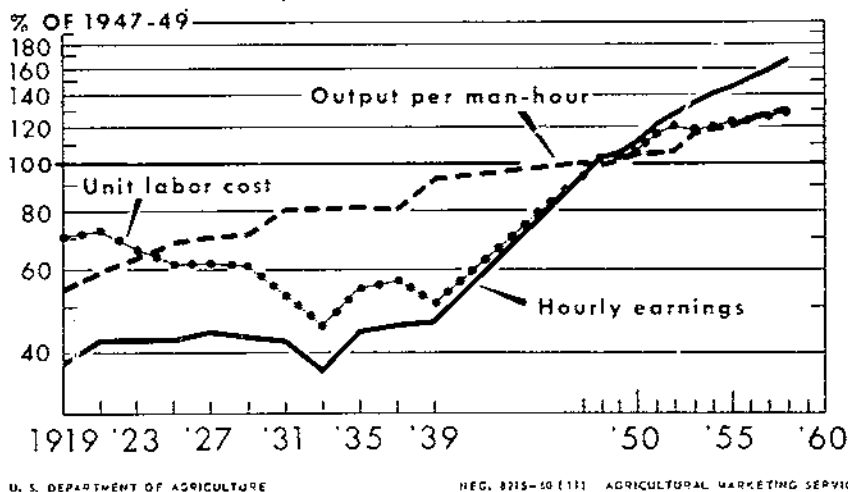
Data on hourly earnings based on hours worked are not available for other sectors of the economy; however, data on average hourly earnings based on hours paid for, published by the Bureau of Labor Statistics, can be used to compare trends in average hourly earnings between food manufactures and other sectors of the economy. These statistics indicate that, on the whole, the sharp increase in hourly earnings in food manufactures since the beginning of World War II paralleled a similar increase in all manufactures. Between 1939 and 1958, average hourly earnings in Food and kindred products manufactures rose about 230 percent, the same as in all manufactures. Average hourly earnings in food manufactures lagged somewhat behind the rise in all manufactures from 1939 to 1947; between 1947 and 1958, they rose somewhat faster than in all manufactures.

The sharp postwar increase in hourly earnings reflects, among other things, inflationary price and wage rises in the economy as a whole. The Department of Commerce series on the Implicit Price Deflator for Gross National Product, the most comprehensive price series available, rose about 28 percent from 1947-49 to 1958. Comparison with the rise in hourly earnings in food processing between 1947-49 and 1958 (table 9) indicates that roughly half of the rise in hourly earnings can be attributed to the general price and wage inflation. The remaining half resulted from a shift to more tech-

piled mainly from Biennial and Decennial Censuses of Manufactures and Annual Surveys of Manufactures. Other data obtained from U.S. Departments of Labor and Agriculture.

Factory Processing of Farm Foods

# HOURLY EARNINGS, OUTPUT PER MAN-HOUR, AND UNIT LABOR COST



U. S. DEPARTMENT OF AGRICULTURE

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FIGURE 4

nical, higher paid jobs, which increased the all-employee average, and "normal" market forces which require food manufacturers to pay competitive wages in order to attract and hold employees. The noninflationary increase in hourly earnings in food processing from 1947-49 to 1958 was about the same as the growth of output per man-hour. This suggests that if there had been no overall inflation, unit labor cost in food processing industries would have remained fairly constant during the postwar years.

The picture was notably different in farming.<sup>15</sup> Average hourly earnings in the postwar period 1947-58, rose about 70 percent in Food and kindred products manufactures and about 40 percent in farming. This reversed an earlier trend between 1939 and 1947 when average hourly earnings in food manufactures rose about 85 percent and average hourly earnings in farming rose about 230

percent. For the entire period, 1939-58, average hourly earnings in Food and kindred products manufactures rose 230 percent compared with a 355-percent rise in agriculture. Despite this trend toward closing the gap, average hourly earnings in 1958 were about \$2 in food manufacturing and only 76 cents in farming.

It is apparent that, in contrast to the rapid increase of unit labor costs in factories processing farm food products during the postwar years,

<sup>15</sup> Average hourly earnings in farming are based on a weighted average of all farm wage rates on a per-hour basis. As compiled by AMS, the farm wage rate series measures only cash rates; it contains no allowance for such perquisites as the free use of house or free room and board which are commonly furnished to hired workers on farms. In 1959, these noncash wages were estimated at about a half billion dollars compared to \$2.6 billion in cash wages. That is, cash wages accounted for about 85 percent of total labor costs.

unit labor costs in total farm production declined.<sup>19</sup> Comparison of the rise in average hourly earnings and the rise in output per man-hour in farming indicates that unit labor costs—based on cash wages—declined about 35 percent from 1947 to 1958.<sup>20</sup> By contrast, during the war and early postwar period 1939-47, unit labor costs in farming rose nearly 200 percent—about 2½ times as fast as in factories processing farm food products. For the entire period 1939-58, unit labor costs rose nearly 200 percent in farming and about 150 percent in factory processing.

### Unit Nonlabor Charges

Measured by "value added" minus payrolls, nonlabor charges (including profits) per unit of output in factory processing during 1958 were about 35 percent above the 1947-49 average (fig. 5)—somewhat greater than the rise in unit labor costs.<sup>21</sup> Unit nonlabor charges comprise profits, depreciation, maintenance and repair, rent, interest charges, advertising outlays, taxes, and other operating expenses. In 1957, these nonlabor charges accounted for about 55 percent of total value added. During the four decades 1919-58 as a whole, unit nonlabor charges rose about 125 percent and unit labor costs about 85 percent. The historical increase in unit nonlabor costs relative to unit labor costs reflects, among other things, the substitution of capital, new technology, and other inputs for labor; however, it also reflects sharp increases in advertising outlays and similar operating expenses.

### Unit Processing Charges

Unit processing charges (value added per unit of output) in factory production of domestic farm food products were 32 percent greater in 1958 than during the base period 1947-49 (table 9). This percentage increase was somewhat larger than the relative increase in unit labor

costs, but less than the rise in unit nonlabor charges. The increase in unit processing charges was somewhat larger than the inflationary price rise in the economy as a whole, as shown by the Implicit Price Deflator for Gross National Product. The postwar rise in unit processing charges increased the spread between the price of farm raw food materials and the wholesale price of processed foods. In 1958, the Wholesale Price Index for processed food products published by the Bureau of Labor Statistics was 11 percent above the 1947-49 average; the Wholesale Price Index for crude foodstuffs and feedstuffs, most of which are used in manufacturing foods, was 7 percent below the 1947-49 average (fig. 6). The gen-

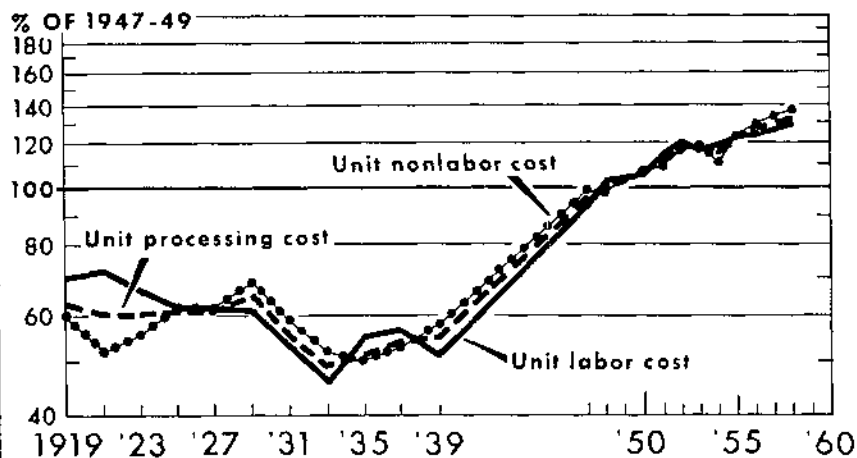
<sup>19</sup> There are important definitional problems in comparing average hourly earnings in food manufacturing and in farming. Average hourly earnings in food manufactures omit fringe benefits, and average hourly earnings in farming omit noncash wages; therefore, the two series are only qualified measures of labor costs per man-hour in the two sectors. Historically, fringe benefits have grown at a faster rate than total payrolls in food manufacturing and cash wages have grown at a faster rate than noncash wages in farming, indicating that the biases introduced by using the two qualified series on average hourly earnings result in an understatement, rather than an overstatement, of the conclusions in the text.

<sup>20</sup> The index of output per man-hour is based on net farm output (table 7). The percentage decline in unit labor costs in agriculture during the postwar period 1947-58, is about the same whether based on net or gross farm output. The general conclusions would probably be the same for a comparison between farm production of food products only and food processing industries.

<sup>21</sup> Unit processing charges were derived by dividing an index of "value added" by the index of factory production. This ratio is, of course, subject to the statistical errors and biases inherent in both the numerator and the denominator. The analysis in this report excludes factory processing of fluid milk, cream, and eggs; therefore, estimates of changes in unit value added shown in this study differ from those given in an earlier technical report (35) which included data for these plants.

Factory Processing of Farm Foods

## PROCESSING, LABOR, AND NONLABOR COSTS PER UNIT OF OUTPUT



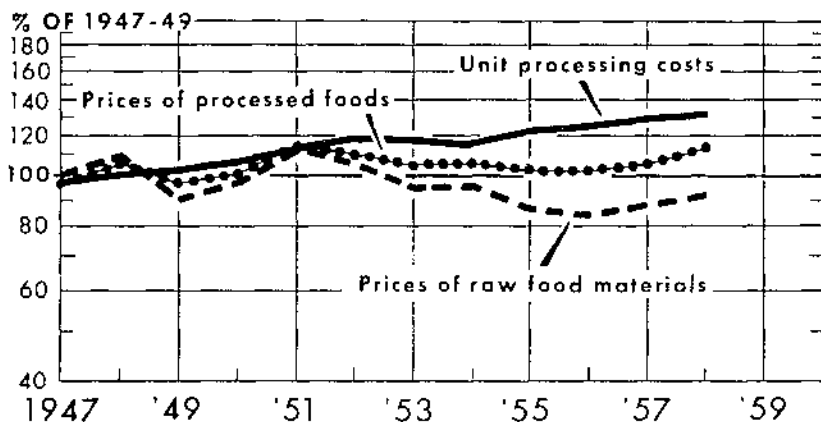
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FIGURE 5

Factory Processing of Farm Foods

## WHOLESALE PRICES AND UNIT PROCESSING COST



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FIGURE 6

erally continuous upward trend in unit processing charges also dampened the response of wholesale prices for processed food products relative to changes in farm prices

for food raw materials. During the period 1919-58 as a whole, unit processing charges rose 110 percent, more than unit labor costs but less than unit nonlabor charges.

## Appendix A: Method and Sources

### Factory Production

The index of factory production of domestic farm food products is designed to measure changes in the net physical output of establishments primarily engaged in processing domestic farm food products (except fluid milk and cream and processed eggs) entering commercial channels. The index includes processing for commercial and Government stocks, for export, for Government purchase for relief and other programs, for military use, and for civilian consumption. It excludes factory processing of imported foods, seafoods, and other foods not produced on domestic farms. It also excludes manufacture of alcoholic and nonalcoholic beverages.

The index of factory production was constructed in two stages. First, annual data for individual products were weighted by value added per unit of product or by average factory prices in order to obtain indexes for individual (Census 4-digit) industries. At the second stage, these individual industry indexes were weighted by industry unit value added in order to derive indexes for industry groups and total food processing. Coverage adjustments were made at both stages to take account of missing products and missing industries, and to put the indexes on an industry—not product—basis. That is, the index of output of meat products shown in this report measures the output of establishments specializing in slaughtering and curing meats; it does not measure the output of meat products wherever manufactured. The index-number

formula used in computing the series at both stages is a modified cross-weighted formula. The series have been weighted decennially between 1909 and 1939, and in 1947 and 1954.

The annual factory production index was computed from data published regularly by the Department of Agriculture, other Government agencies, and private organizations. Most of the output indexes of the component industries (Census 4-digit) are benchmarked to factory production indexes constructed from data reported in decennial and biennial Censuses of Manufactures. In general, the scope of the output index is the same as the scope of the Census of Manufactures.

The factory production index is subject to the following conceptual qualifications:

1. The formula used is only an approximate measure of net output.
2. Like all physical output indexes, it does not fully reflect changes in quality.
3. The series includes byproducts of food processing establishments.
4. The index applies to factory processing only; it excludes processing within establishments primarily engaged in wholesale and retail trade.

Among these four qualifications, the first two are the most important, the third is, on the whole, statistically small, and the importance of the fourth depends upon the use made of the index. The earlier technical report (35) contains a detailed appendix on method and sources used in compiling the factory production index. The earlier

report also measures factory processing of fluid milk, cream, and eggs, which are excluded from this report because of inadequate data on man-hours.

### Man-Hours

The man-hours index is designed to measure changes in man-hours worked by all employees. Nearly all of the basic data are from the Census of Manufactures; this assures comparability with the output index. Data were also obtained from the Bureau of Labor Statistics and published studies by private research organizations. In general, statistics for years since 1947 are notably more complete than those for earlier years.

### Employment

Data on the average number of all employees in factory production of domestic farm food products are from the Census and Annual Survey of Manufactures for the postwar years 1949-58; for the prewar years 1919-39, data on all employees are from the decennial and biennial Censuses of Manufactures. In effect, the Census figure on average number of employees measures *equivalent full time* number of workers—that is, it measures the number of persons who would have been employed if the work actually done were performed by persons engaged in full and continuous employment (10).

Conceptually, the number of employees included in the man-hours index should comprise the total number of persons contributing to value added in manufactures, as defined for the output index. Such complete coverage has never been available; however, coverage in the Census of Manufactures has been nearly complete and consistent since 1939. In the Census of Manufactures for 1954, all employees were defined to include (1) production and related workers, (2) force account construction work-

ers, and (3) administrative, sales, supervision, technical, office, and other personnel. Officers of corporations are included as employees whereas proprietors and partners of unincorporated firms are excluded. This Census definition indicates the scope of the all-employees series used in the man-hour index since 1947; no estimates were made of the number of proprietors and partners of unincorporated firms in food manufactures, but these firms accounted for only a small percentage of total production during the period studied.

In general, Census data on the number of production and related workers are consistent in scope and coverage since 1919. The numbers of production and related workers were used essentially as published in the Census volumes since 1919. In the Biennial Censuses of 1935 and 1937, and particularly in the Census of 1939, the Bureau of the Census changed the wording of the schedules sent to manufacturing firms, which seriously affected the coverage of distribution and other nonproduction workers employed by manufacturing establishments. The extent of this problem is illustrated by the fact that the total number of nonproduction workers reported by the Census in all food manufacturing increased from 61,000 in 1937 to 148,000 in 1939. In order to link the man-hours series for pre- and post-World War II years the number of nonproduction employees for certain food industries had to be estimated for 1935, 1937, and 1939 using the *Census* definition (terminology) employed in Census questionnaires from 1919 to 1933; nearly all of the estimates pertain to 1939. The pre-1939 series with the less inclusive coverage was linked in 1939 to post-1939 series with more inclusive coverage.

In sum, the man-hours series since 1939 includes employees of manufacturing establishments who



are engaged in distribution and construction work; the extent to which the man-hours series between 1919 and 1939 includes such employees is not known. Because the number of nonproduction workers accounts for only a minor proportion of all employees, the effect of this discontinuity on the all-employees man-hour series is small. In 1939, the estimated number of all employees based on the definition used since 1939 was about 5 percent above the number of all employees based on the definition used for the period 1919-39.

### Average Hours

Data on average hours worked by production and related workers are from Censuses and Annual Surveys of Manufactures for years between 1947 and 1958, and from the Bureau of Labor Statistics and other sources for years between 1919 and 1939. Statistics on average hours worked by employees other than production workers are not available and a trend for this series had to be determined on the basis of qualitative information.

In the Census of Manufactures, the Bureau of the Census defined the number of man-hours worked by production and related workers to include actual overtime hours (not straight-time equivalent hours), and to exclude hours paid for vacations, for holidays, and for sick leave when the employee is not at the plant. Conceptually, this differs from Bureau of Labor Statistics data on average weekly hours for production workers which are based on hours *paid for* rather than on hours *worked*. The Bureau of Labor Statistics series include overtime hours on straight-time equivalent bases, and hours for paid vacations, for paid holidays, and for paid sick leave (33). The data actually reported by the Bureau of the Census and the Bureau of Labor Statistics also reflect differences

in statistical methods used in collecting the information. In fact, statistics on average weekly hours for production workers in Food and kindred products manufactures reported by the two agencies showed the same postwar trend from 1947 to 1958 (table 10).

Statistics on average hours for production and related workers in food manufacturing industries are sparse and of varying definitions for the prewar years 1919-39. The question of using hours worked or hours paid for is important only for years since World War II; for the prewar period, the problem is to obtain data on actual hours worked

TABLE 10.—Average weekly hours in food and kindred products manufactures as reported by the Bureau of the Census and by the Bureau of Labor Statistics, United States, 1947-58

| Year | Bureau of the Census <sup>1</sup> | Bureau of Labor Statistics <sup>2</sup> |
|------|-----------------------------------|---|
|      | Hours                             | Hours                                   |
| 1947 | 41.0                              | 43.0                                    |
| 1948 | (3)                               | 42.1                                    |
| 1949 | 39.7                              | 41.6                                    |
| 1950 | 39.7                              | 41.6                                    |
| 1951 | 39.5                              | 41.9                                    |
| 1952 | 39.6                              | 41.6                                    |
| 1953 | 39.2                              | 41.2                                    |
| 1954 | 39.1                              | 41.0                                    |
| 1955 | 39.0                              | 41.2                                    |
| 1956 | 39.2                              | 41.0                                    |
| 1957 | 39.1                              | 40.5                                    |
| 1958 | 39.0                              | 40.7                                    |

<sup>1</sup> Census figures on average weekly hours worked were computed from data published in the Censuses and Annual Surveys of Manufactures on man-hours and number of production and related workers; the average annual number of hours was divided by 52.

<sup>2</sup> BLS series on average weekly hours paid for were obtained from Bureau publication, *Employment and Earnings, Annual Supplement Figures*. There are also unexplained differences between the Census and BLS series due to differences in scope, coverage, and unexplained statistical factors.

<sup>3</sup> Not available.

rather than on prevailing hours. Prevailing hours, which represent average or scheduled hours, tend to be higher and less flexible than actual hours (36). For most food manufacturing industries, data on actual hours between 1933 and 1939 are available from published data of the Bureau of Labor Statistics (34). Data for earlier years were obtained from a variety of special studies on hours and earnings (14, 36) and on output per man-hour (1,9,13) in manufacturing.

In general, statistics on average hours for earlier years, particularly 1919-29, are for prevailing hours. Where supplementary information was also available, prevailing hours were adjusted to approximate actual hours. However, to the extent that prevailing hours even after adjustment are higher than actual hours worked during those years, this tends to overstate the rise in output per man-hour since the end of World War I. Estimates of average weekly hours were imputed for industries and years for which no data are available.

Statistics on average hours worked by employees other than production and related workers are not available. On the basis of qualitative information, it was assumed that average weekly hours worked by nonproduction workers followed a linear trend from a 50-hour week in 1919 to a 40-hour week in 1939; a continuance of the 40-hour week between 1939 and 1947; and a linear trend from a 40-hour week in 1947 to a 38-hour week in 1958.

Another possible assumption is that the trend in average weekly hours of nonproduction workers has been the same as for production workers. In effect, the two assumptions represent "reasonable" limits to the trend in average weekly hours worked by nonproduction workers. For the period considered, long-term rates of change in man-hours and, consequently, in

output per man-hour in factory production of farm food products are the same based on either assumption. Output per man-hour based on the assumed trend in average weekly hours worked by nonproduction employees, and used in the body of this report, shows an average annual rate of growth of 2.7 percent in the postwar period 1947-58, and 2.0 percent in the entire period 1919-58; the rates of growth were the same when estimates were based on the alternative assumption that average weekly hours worked by nonproduction

TABLE 11.—*Factory production of domestic farm food products, weighted man-hours, and production per weighted man-hour, United States, 1919-58*

[1947-49=100]

| Year      | Production <sup>1</sup> | Weighted man-hours <sup>2</sup> | Production per weighted man-hour <sup>3</sup> |
|-----------|-------------------------|---------------------------------|---|
| 1919..... | 53                      | 101                             | 52  |
| 1921..... | 47                      | 83                              | 56  |
| 1923..... | 55                      | 90                              | 62  |
| 1925..... | 58                      | 84                              | 68  |
| 1927..... | 60                      | 85                              | 70  |
| 1929..... | 65                      | 91                              | 72  |
| 1931..... | 60                      | 74                              | 80  |
| 1933..... | 55                      | 68                              | 80  |
| 1935..... | 60                      | 75                              | 81  |
| 1937..... | 68                      | 83                              | 82  |
| 1939..... | 72                      | 78                              | 93  |
| 1947..... | 101                     | 101                             | 100   |
| 1948..... | 99                      | 100                             | 98  |
| 1949..... | 100                     | 99                              | 101   |
| 1950..... | 103                     | 101                             | 102   |
| 1951..... | 106                     | 101                             | 104   |
| 1952..... | 108                     | 103                             | 105   |
| 1953..... | 112                     | 98                              | 114   |
| 1954..... | 113                     | 97                              | 117   |
| 1955..... | 117                     | 98                              | 119   |
| 1956..... | 124                     | 100                             | 123   |
| 1957..... | 124                     | 99                              | 125   |
| 1958..... | 126                     | 96                              | 130   |

<sup>1</sup> See table 1, footnote 1.

<sup>2</sup> Method of computing weighted man-hour index described in text.

<sup>3</sup> Unrounded figures used in computations.

<sup>4</sup> Interpolated on basis of data from Bureau of Labor Statistics.

workers were the same as for production workers. The results were the same because man-hours of production workers accounted for such a large proportion of all employee man-hours.

### Weighted Man-Hours

The index of weighted man-hours is based on man-hours series for production and nonproduction workers weighted by their respective average hourly earnings, by Census 4-digit industries. Wage and salary data for computing the weights are from the Census of Manufactures. Average hourly earnings for production and related workers were computed from wage data, and average hourly earnings for employees other than production workers are based on total payrolls for all employees minus wages of production and related workers.

The weighted man-hour index

was computed by using a modified cross-weighted (Marshall-Edgeworth) formula, similar to the one used in computing the factory production index. The weight years were also generally the same as those used in the factory production index (85). Specifically, the weights for computing the weighted man-hours index are averages of hourly earnings of the following pairs of weight years: 1909 and 1919, 1919 and 1929, 1929 and 1937, 1937 and 1939, 1939 and 1947, and 1947 and 1954. The weighted annual man-hour indexes were linked at terminal years of the weight periods and put on a base of 1947-49=100. Table 11 shows the indexes of production, weighted man-hours, and output per weighted man-hour for factories processing domestic farm food products for years in which the weighted man-hours index was calculated.

## Appendix B: Comparison of Labor-Capital Productivity in Food Manufacturing and in Farming

The index of output per man-hour in factory processing of farm food products was constructed in order to study the relation between changes in hourly earnings per employee and unit labor costs, and to use, along with other information, for making long-term projections of unit man-hour requirements for food processing industries. The primary purpose of this appendix is to show that, on the basis of available data, there is no evidence that the growth of resource efficiency or of technology was any greater in farming than in food manufacturing during the period 1937-57 and the period 1919-57 as a whole. The important question of which of the two sectors experienced the greater increase in efficiency is still open; the answer requires more and better data. This also means that the use of the index of output per man-hour as an indicator of changes in effi-

ciency can result in very deceptive conclusions.

An index of labor-capital productivity (output per unit of labor and capital combined) for Food and kindred products (excluding Beverages) manufactures was constructed for selected years employing Creamer's estimates (7, 15) of the stock of total capital and estimates of weighted and unweighted man-hours. The index of labor-capital productivity, like the index of output per man-hour, is only a partial measure of changes in efficiency, as defined in the beginning of this report. Employing several critical assumptions discussed below, the index of labor-capital productivity can be viewed as a *somewhat* more comprehensive measure of changes in efficiency than the index of output per man-hour. In general, output per man-hour in factories processing farm food products has

been a tolerable indicator of long-term—but not short-term—trends of labor-capital productivity in food processing industries.

### Methods and Qualifications

The labor-capital input indexes for Food and kindred products (excluding Beverages) manufactures (table 12) were constructed by weighting the man-hour series by an estimate of average hourly compensation (average hourly payrolls plus an allowance for fringe benefits), and by weighting the stock of total capital by an estimate of net returns to capital (rents, profits, interest, etc.).<sup>22</sup> The weighting employs a cross-weighted index number formula using average hourly compensation and net returns to total capital for 1929 and 1957. The factory production index was then divided by the combined labor-capital input index to obtain the labor-capital productivity index.

As indicated in the introduction, changes in the stock of capital and in the man-hour series do not reflect changes in the quality (including

<sup>22</sup> Net returns to capital were estimated by subtracting total labor compensation from an estimate of income originating in Food and kindred products (excluding Beverages) manufactures.

new technology) of these factor inputs. Consequently, resources employed in increasing the quality of capital and labor inputs are not counted as resource inputs, but instead contribute an unknown proportion to the increase in labor-capital productivity. There is also the difficult accounting problem of realistically measuring depreciation of capital goods. The estimates of the stock of total capital exclude physical assets used in production which are rented or leased; however, there was no apparent trend in the use of rented capital by food manufacturers.

Besides these statistical and accounting problems, there is also the critical assumption that the flow of capital services used in production is proportional to the stock of total capital and that the flow of labor services is proportional to the number of man-hours worked. Conceptually, an index of labor-capital productivity should relate the flow of output to a flow of inputs of labor and capital services; the computed index of labor-capital productivity uses the stock of total capital and the assumption that the flow of capital services is proportional to the stock. Labor-capital produc-

TABLE 12.—*Labor-capital productivity in Food and kindred products (excluding Beverages) manufactures, United States, selected years 1919-57*

[1929=100]

| Year      | Factory production <sup>1</sup> | Labor-capital inputs <sup>2</sup> |                    | Labor-capital productivity <sup>3</sup> |                    |
|-----------|---------------------------------|-----------------------------------|--------------------|---|--------------------|
|           |                                 | Unweighted man-hours              | Weighted man-hours | Unweighted man-hours                    | Weighted man-hours |
| 1919..... | 52                              | 98                                | 104                | 84                                      | 79                 |
| 1929..... | 100                             | 100                               | 100                | 100                                     | 100                |
| 1937..... | 104                             | 91                                | 90                 | 114                                     | 116                |
| 1948..... | 161                             | 104                               | 110                | 155                                     | 146                |
| 1953..... | 180                             | 104                               | 108                | 174                                     | 167                |
| 1957..... | 200                             | 109                               | 116                | 183                                     | 173                |

<sup>1</sup> Based on Federal Reserve Board Index of Industrial Production (revised) for food manufactures after 1948.

<sup>2</sup> Based on the stock of total capital (fixed plus working capital) estimated by Daniel Creamer (7, 15) and weighted and unweighted man-hours.

<sup>3</sup> Factory production divided by respective capital-labor input indexes. Computations for labor-capital productivity are based on unrounded figures.

tivity indexes were computed using 1929 weights and 1957 weights separately, and the results were essentially the same. This suggests that the stock-flow assumption for food manufacturing industries may not be too restrictive for long-term comparisons. Also, the use of "prosperous" years to minimize the problem of under- or over-utilization of capacity is probably "reasonable" for long-term comparisons, but perhaps tenuous for short-term comparisons.

### Comparison With Farming

Labor-capital productivity (based on unweighted man-hours) in Food and kindred products (excluding Beverages) manufactures grew at an average annual rate of 2.5 percent from 1937 to 1957.<sup>23</sup> During this same period, which was marked by a large substitution of capital for labor in farming, the index of productivity estimated by Agricultural Research Service (table 13) rose 1.3 percent per year.<sup>24</sup> For the period 1919-57 as a whole, labor-capital productivity rose at an average annual rate of 2.2 percent in food manufacturing and at a rate of 1.3 percent per year in farming. These figures mean that the ratio of output to resource inputs which can be statistically measured—not total resource inputs—has grown at a faster rate in food manufacturing than in farming since the end of World War I and in the period after

1937. Thus, there is no indication that the growth in total resource efficiency or technological change has been greater in farming than in food manufacturing.

Differences between the explained proportion (measured inputs) and unexplained proportion of the rise in output in both food manufacturing and farming are too large to conclude whether efficiency rose faster in one sector than in the other. For the entire period 1919-57, only about one-fifth of the rise in factory production of Food and kindred products (excluding Beverages) can be accounted for by the rise in labor-capital inputs; four-fifths of the increase is accounted for by increased labor-capital productivity. Based on data constructed by Agricultural Research Service, increases in (measured) production inputs contributed about one-sixth to (gross) farm output; about five-sixths of the increase in output was accounted for by the rise in productivity. That is, most of the rise of output in food manufactures and

TABLE 13.—*Productivity in farming, United States, selected years, 1919-57*

| [1929=100]     |                          |                               |                           |
|----------------|--------------------------|-------------------------------|---------------------------|
| Year           | Farm output <sup>1</sup> | Production input <sup>2</sup> | Productivity <sup>3</sup> |
| 1919 . . . . . | 89                       | 93                            | 96                        |
| 1929 . . . . . | 100                      | 100                           | 100                       |
| 1937 . . . . . | 111                      | 96                            | 114                       |
| 1948 . . . . . | 141                      | 102                           | 137                       |
| 1953 . . . . . | 147                      | 105                           | 139                       |
| 1957 . . . . . | 154                      | 102                           | 150                       |

<sup>23</sup> Average annual rates of growth of labor-capital productivity were computed for years shown in tables 12 and 13.

<sup>24</sup> The index of productivity for farming compiled by ARS is based on gross output divided by a weighted sum of inputs of labor, capital, and intermediate goods and services used in farm production (25). Using a measure of net output ("gross national farm products") and the stock of tangible—not total—capital, Kendrick (12) estimated that "total factor productivity" in farming increased about 3.1 percent per year from 1937 to 1957. Both the ARS series and Kendrick's series differ conceptually from our index of productivity for food manufactures.

<sup>1</sup> Volume of farm production available for eventual human use. Includes non-farm inputs of intermediate goods and services consumed in farm production.

<sup>2</sup> Combined volume of farm labor; land and service buildings; machinery and equipment; fertilizer and lime; purchases of feed, seed, and livestock; and miscellaneous production items, in terms of constant dollars. Physical assets used in production are net of depreciation.

<sup>3</sup> Output per unit of production inputs.

Estimated by Agricultural Research Service (25).

farming since the end of World War I is due to a statistically unexplained residual (productivity). Since technology and labor skills employed in the two sectors are markedly different, the conclusion is that comparison of the rate of growth in efficiency in food manufacturing and in farming is still an open question.

### Output Per Man-Hour As an Indicator of Labor-Capital Productivity

In food manufacturing, the index of output per man-hour may be, for some purposes, an acceptable approximation for gaging long-term—but not short-term—trends in the index of labor-capital productivity. This can be illustrated by comparing yearly rates of growth between output per man-hour and labor-capital productivity in Food and kindred products (excluding Beverages) manufactures:

| Series   | Annual rate of growth during <sup>1</sup> — |          |          |
|--|---|----------|----------|
|  | 1919-57                                     | 1948-57  | 1953-57  |
|  | Per-cent                                    | Per-cent | Per-cent |
| Output per un-weighted man-hour-----                                     | 2.3   | 2.5      | 1.9      |
| Labor-capital productivity (total capital and unweighted man-hours)----- | 2.1   | 1.9      | 1.2      |

<sup>1</sup> Annual rates based on compound interest formula between terminal years shown in table 12.

This tabulation shows that if the annual rate of growth in output per man-hour was used to gage the annual rate of growth in labor-capital productivity (both based on un-weighted man-hours), the annual rate would have been overstated by about 10 percent for the 33-year period (1919-57); by about 30 percent for the 9-year period (1948-57); and by about 60 percent for the

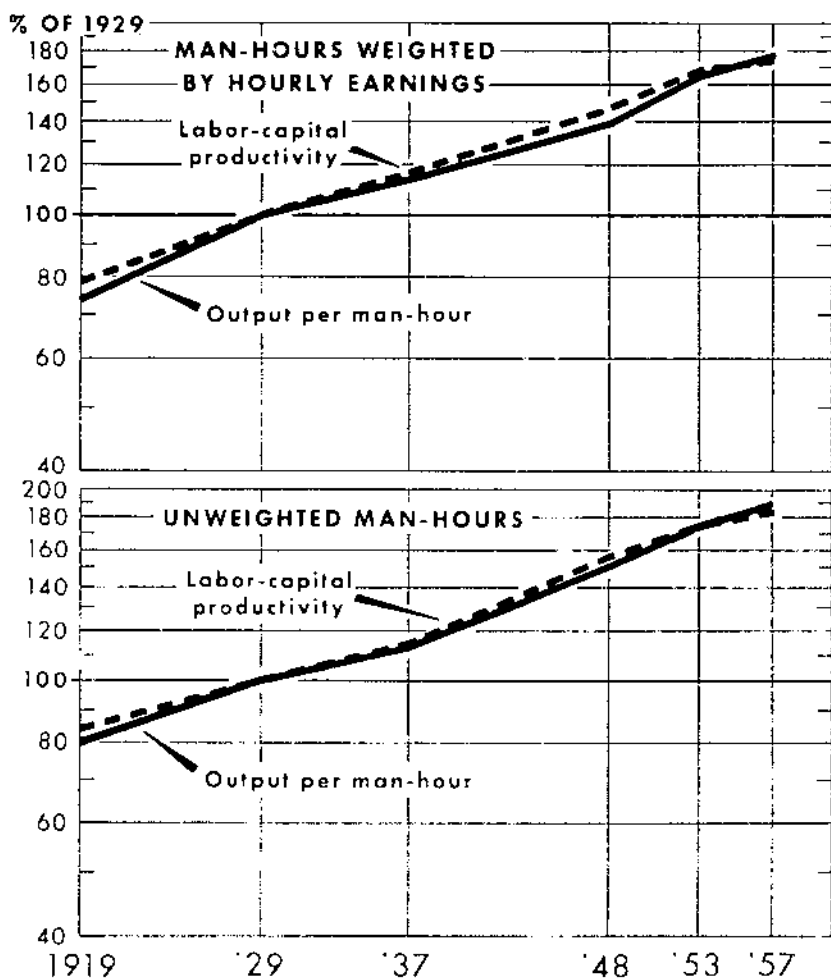
4-year period (1953-57). The conclusions are essentially the same if the comparison is made between output per weighted man-hour and labor-capital productivity using weighted man-hours (fig. 7).

The long-term rates of growth in output per man-hour and in labor-capital productivity in food manufactures are similar because labor accounts for a large fraction of total inputs, and the substitution of capital for labor has been relatively small in food manufacturing industries, particularly since 1929. In 1957, the weights for the man-hour index relative to the total capital index were about 4 to 1; the ratio was about the same in 1929. Also, between 1929 and 1957 the stock of total capital per man-hour rose only about 15 percent. From 1919 to 1929, when there was a large substitution of capital for labor, the rise in output per man-hour greatly overstated the rise in labor-capital productivity (fig. 7).

Indexes of output per man-hour are misleading indicators for comparing trends in labor-capital productivity between food manufacturing and farming. During 1937-57, output per man-hour rose at an annual rate of 2.7 percent in Food and kindred products (excluding Beverages) manufactures compared with 4.0 percent in farming (33).<sup>26</sup> As indicated above, during the same period the annual rate of growth in labor-capital productivity was greater in food manufacturing than in farming—just the opposite ranking shown by rates of growth of output per man-hour. From 1919 to 1937, output per man-hour rose faster in food manufacturing than in farming; but, for the period 1919-57 as a whole, the average annual rate of growth of output per man-hour was 2.3 percent in food manufacturing and

<sup>26</sup> Average annual rates of growth for output per man-hour were computed for years shown in tables 12 and 13.

## OUTPUT PER MAN-HOUR AND PER UNIT OF LABOR AND CAPITAL



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FIGURE 7

2.7 percent in farming. Thus, the rank of the 38-year rates of growth in output per man-hour between the two sectors was the reverse of the rates of growth in labor-capital productivity indicated above. On the assumption that the labor-capital productivity index can be treated as

a somewhat more comprehensive measure of efficiency than the index of output per man-hour, the above comparison indicates that indexes of output per man-hour are misleading indicators of trends in efficiency between food manufacturing and farming.

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