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CHAPTER 1

# Trends in Output

So far studies have been completed of the outputs of six broad industrial groups containing scores of individual industries that produce a multitude of products. To obtain a broad view of the findings, we begin by analyzing the place of the six industry groups in the economy and proceed to estimate their aggregate output. The effects on aggregate output of changes in quality of product and the transfer of activities from the household to the market, and the problems of the measurement of output in the chief unexplored section of the economy—the service industries—are then discussed. Finally, we turn to changes in the composition of the output of the six industry groups and investigate their implications for several interesting questions concerning the theory and facts of economic development.

## *Total Output*

The net output of the economy consists of the production of commodities and services for current consumption plus the addition made to stocks of goods and resources that permits larger consumption in the future. This flow of output is the national income; so for a broad view of the change over time in the economy's net output we look at the movements of national income.

There are, however, two tall obstacles to the use of national income figures to measure net output in 'real' terms. The first is that national income is a series of aggregate money flows, whereas our interest is in the outputs of goods and services somehow divorced, or at least amicably separated, from fluctuations in the value of the dollar. This obstacle is surmounted by deflating national income in current dollars by one or a series of price indexes. These price indexes, however, are extremely difficult to construct on a basis appropri-

ate to the aim of measuring real national income. The necessary information on retail prices is scanty even for the fairly recent past. And even if we had the data, we would still have to surmount the difficulty that confronts all attempts to measure 'real' changes, the so-called index-number problem: we wish to achieve the inconsistent objectives of giving due weight to the relative importance of various commodities at any one time and yet, although this relative importance often changes rapidly, of maintaining comparability through time.

The second difficulty, for our purposes, in the use of national income figures is that prior to 1919 they are primarily series on physical output measured in current or constant prices. With the important exception of services (which are deflated by the prices of commodities), all components of Kuznets' series on national product (which goes back to 1869) rest largely upon the same underlying data as the output studies. Differences between the National Bureau series on physical output and the corresponding segments of real national income are therefore due in considerable part to differences in the way current prices are deflated. For this reason, and because of the considerable uncertainty surrounding estimates of national income in the earlier years,[1] we do not discuss the trend of national income since 1900. Kuznets' findings on the long-term movements of national product are summarized in the first volume of this series: *National Income: A Summary of Findings.*

We may use the national income data since 1919, when they are independent in source and detailed in composition, to get a general idea of the comprehensiveness of the productivity studies already published. About 40 percent of national income in the two interwar decades has been covered

[1]The uncertainty is illustrated, but not measured, by the fact that R. F. Martin's estimates for average national product in 1889-98 are about 12 percent larger than Kuznets', although the underlying methods and data are by no means independent. See Kuznets, *National Product since 1869* (National Bureau of Economic Research, 1946), p. 86; Martin, *National Income in the United States, 1799-1938* (National Industrial Conference Board, 1939).

in the productivity studies (see Table 1). The coverage is much greater for commodity- than for service-producing industries: indexes of output have been compiled for 90 percent of the industries (measured by their contribution to national income) producing physical commodities, but for only 11 percent of the industries that provide services.

TABLE 1

Scope of National Bureau Studies of Productivity, Measured by the Average Percentage of National Income Originating in Six Industries, 1919-1938

| *Industries Covered by Indexes of Output* | PERCENTAGE OF NATIONAL INCOME |
|---|---|
| Commodity-producing | |
| Manufacturing | 21.0 |
| Agriculture | 9.6 |
| Mining | 2.2 |
| Service-producing | |
| Electric Light and Power | 1.4 |
| Manufactured and Natural Gas | .2 |
| Steam Railroads | 5.4 |
| Total | 39.8 |
| *Industries not Covered* | |
| Commodity-producing | |
| Construction | 3.8 |
| Service-producing | |
| Other Public Utilities | 2.8 |
| Trade | 13.5 |
| Finance | 11.9 |
| Service | 12.6 |
| Government | 11.6 |
| Miscellaneous | 4.0 |
| Total | 60.2 |

SOURCE: Simon Kuznets, *National Income and Its Composition* (National Bureau of Economic Research, 1941), I, 166.

Inadequacies of data on weights render it impossible to construct an entirely satisfactory index of aggregate output of the six industries listed in Table 1. However, a rough approximation to such an index is obtained by using estimates of 'value-added' (sales minus purchases of current supplies from other industries) in the six industries (Table 2). Physical output nearly tripled between 1899 and 1939; almost the entire increase occurred in the first three decades. As popula-

tion increased 75 percent meanwhile, output per capita of population rose two-thirds.

TABLE 2

Indexes of Output of Six Industries and of Population, 1899-1939 (1899: 100)

| | PHYSICAL OUTPUT | POPULATION | OUTPUT PER CAPITA |
|---|---|---|---|
| 1899 | 100 | 100 | 100 |
| 1909 | 146 | 121 | 120 |
| 1919 | 195 | 140 | 139 |
| 1929 | 283 | 163 | 174 |
| 1939 | 289 | 175 | 165 |

The indexes of output were computed by the Edgeworth formula, using estimates of 'value-added' as weights (see Fabricant, *Output of Manufacturing*, p. 370), with each date the comparison base for the succeeding date. The estimates of value-added were:

MANUFACTURING: Value-added, as reported by the Census.

AGRICULTURE: Cash income plus value of food consumed on farms minus current expenses. (Net Farm Income and Parity Report, 1943; Bureau of Agricultural Economics, July 1944.) The value-added ratio for 1910 was applied to 1909 and 1899 gross income, extrapolated by data in Strauss and Bean, Gross Farm Income and Indexes of Farm Production (Department of Agriculture, *Technical Bulletin 703*).

MINING: Receipts minus materials, fuel, and power, as reported by the Census; the ratio of value added was interpolated for 1929, when petroleum was excluded from the Census.

STEAM RAILROADS: Operating revenues minus materials and supplies; average of fiscal years before 1919.

ELECTRIC LIGHT AND POWER: Revenue minus fuel, data from Gould, *op. cit.*, Appendix B. The values for the years in the table were interpolated by output. This industry entered the index in 1909.

MANUFACTURED GAS: Revenue minus fuel, data from Gould, *op. cit.*, Appendix B.

NATURAL GAS: Revenue, data from *ibid.*, p. 160.

The output index of Table 2 can be divided into indexes for commodity- and service-producing industries.

| INDUSTRIES | *1899* | *1909* | *1919* | *1929* | *1939* |
|---|---|---|---|---|---|
| Commodity-producing | 100 | 140 | 180 | 267 | 277 |
| Service-producing | 100 | 186 | 312 | 400 | 374 |

The service industries are too poorly represented to admit of any generalization, but the commodity industries are so fully represented that the index would not be changed much if construction and minor industries now excluded were included. The output of the commodity industries—agriculture,

manufacturing, and mining—can be described in virtually the same terms as the aggregate index for the six industries, in which they of course dominate.

The over-all index in Table 2 displays extremely sharp retardation in the 'thirties: the output of the six industries, which had grown at an average rate of 3.5 percent per *year* between 1899 and 1929, now rose only 2.1 percent in a *decade*. In this the index faithfully mirrors its components, for the indexes of the industry groups (manufacturing, agriculture, and mining), we shall presently see, show little retardation between 1899 and 1929 but sharp retardation thereafter.[2] Two very different explanations have frequently been advanced for the failure of output to grow during the 'thirties. In the one view it is characteristic, indeed inevitable in a maturing private enterprise economy; in the other view it is a sort of economic fault, due to a special combination of political and economic circumstances which may be supplanted by more fundamental and persistent forces that dominated previous history, and which in any case were absent before the Great Depression. A useful discussion of this conflict would take us far beyond the scope of the studies under review, and we must be content to note one fact that bears on the contemporary discussion of the maturity thesis: there is no evidence of long-term retardation before 1929.

### *Improvements in Quality of Product*

We have been discussing indexes of physical output. But output of what? Of the automobiles of 1900, which were sometimes thoughtfully equipped with attachments for harness? Of the gasoline of 1914, which Colorado sought to improve by enacting a statute that set a maximum of 5 percent on solid matter? Clearly we wish an index of output that measures

[2]A longer survey might reveal a gradual downward drift in the rate of increase of output since 1870, but the retardation—if it was present at all—was small; see A. F. Burns, *Production Trends in the United States since 1870* (National Bureau of Economic Research, 1934), pp. 270 ff.

quality as well as quantity, but precisely what do we mean by quality, and how can it be measured?

In everyday discourse we usually understand quality to mean technical characteristics or operating properties. Thus we say the automobile tire of 1937 had eight times the mileage of the tire of 1921, or we say the incandescent lamp produced 3.4 lumens per watt (units of light produced per unit of power consumed) in 1906 and 14.7 in 1937. Occassionally we may tend also to view style changes as improvements but here we tread on dangerous ground: our tastes have altered enough to make the clothes of 1900 amusing to see and embarrassing to wear — as amusing and embarrassing as today's clothes would have appeared to the eyes of 1900.

Some estimate of the magnitude of changes in quality can often be made from changes in the technological properties of a commodity. For example, the tractive power of a steam locomotive is often used as a measure of its quality. In 1904 the average tractive power of a new locomotive was about 27,000 pounds, and in 1939 about 107,000 pounds.[3] Fabricant's index of output for steam locomotives declined from 366 in 1904 to 29 in 1939—a 92 percent drop. If the production data are corrected for changes in quality, the percentage fall is reduced to 69 percent.

Such technological measures of quality are subject to definite limitations, however. A single measure of quality is usually inappropriate: thus if locomotive quality is measured only by tractive power, other improvements such as fuel economy (the pounds of fuel required to haul 1,000 gross

[3]The 1904 figure is calculated as follows: the distribution by type of locomotives is estimated from the differences between the number of locomotives of each type reported in 1903 and 1904 in *Statistics of Railways in the United States,* which also gives their tractive power; the tractive power of locomotives installed in 1939 (for which the number of each type is given in *Statistics of Railways, 1939*) is estimated from information in R. P. Johnson, *The Steam Locomotive* (Simmons-Boardman, 1942). The estimate for 1904 is probably low because it is based on average tractive power, not on that of new locomotives.

freight ton-miles fell from 172 in 1920 to 112 in 1940) are ignored; yet we cannot add fuel economy and tractive power. Even if a single technical characteristic were a suitable measure of quality, it would often fail us when new types of product appeared: for example, tractive power is not an appropriate measure of the performance of Diesel and electric locomotives.

There is a second method of measuring changes in quality: to find the ratio of prices of new and old qualities of a product during a period when both are available. This is a direct application of the existing method of combining different goods in an index, except that different qualities are treated —as they should be—as different goods. The method may be illustrated by changes in the quality of gasoline. In 1940 the octane number of 'regular' gasoline rose from 70-72 to 72-74 (as a continuation of the rise from below 65 in 1931, when this system of gasoline rating was adopted by manufacturers). The improved grade sold for 12.9 percent more than the lower grade during the period when both were sold. In measuring the output of gasoline, 100 gallons of the superior grade may be treated as equal to 113 gallons of the inferior grade.

This second method of measuring quality is automatically followed in the construction of the National Bureau indexes of output when the underlying data on outputs are classified finely enough. For instance, by using values as weights, Fabricant counts 1.60 open passenger automobiles as the equivalent of one closed automobile in 1919. But the Census classifications are too broad for any large proportion of quality changes to be measured by this method: thus 1919 and 1939 open passenger automobiles are treated as identical.[4]

How widespread and important have these unmeasured quality improvements been? Fabricant's volume abounds

[4]The broadness of the Census classifications is emphasized by the fact that one cannot find in the highly detailed appendices of Fabricant's *Output of Manufacturing Industries* unequivocal evidence of the appearance of a single new manufacturing product between 1899 and 1937.

with descriptions of large technical improvements, and the absence of examples of quality deterioration is also eloquent. Barger lays less emphasis upon quality changes in agriculture and mining, but if systematic account were taken of the increasing rigor of sanitary requirements in milk production, improvements in the qualities of cotton, fruits, meat, etc., and the greater standardization and uniformity of mining products, the improvement of quality in these industries might also be found to be substantial. No enumeration of instances of quality improvement, however, will carry with our statistically-minded age the weight of a specific, over-all number, and quality improvements will continue to be undisputed but easily forgotten until they have been subjected to general measurement.

### *Household vs. Market*

If our indexes of the economy's output have a downward bias because quality improvements are not measured completely, they have an upward bias because they cover a larger proportion of output as production within the household declines. The transfer of activities from household to market has often been mentioned, but it is doubtful that its extent is generally appreciated. A few comparative indexes of this trend suggest large shifts toward prepared foods and greater reliance upon laundries and apartment and hotel housing services (Table 3). There is little doubt (if also little evidence) that restaurant sales have risen substantially relative to total sales of food, and production of clothing in the household has declined.[5] The urban family is also buying in smaller units, and is transferring the storage and parceling of food to retailers.

Nor should only direct transfers of this sort be taken in

[5]Occupational statistics suggest that employees of eating places tripled or quadrupled between 1900 and 1940; population increased only 75 percent. The output of ready-to-wear apparel more than tripled, but factors such as the shift to more fashionable and less durable dress complicate the interpretation.

TABLE 3

Some Measures of the Transfer of Activities from the Household to the Market

| *Transfers to Manufacturing* | *1899* | *1939* |
|---|---|---|
| % of domestically consumed wheat flour used by commercial bakeries | 14.8 | 43.4 |
| Cases of canned vegetables produced per 100 persons | 27.5 | 139.1 |
| Cases of canned fruits produced per 100 persons | 4.8 | 57.3 |
| *Transfers to Service Industries* | *1900* | *1940* |
| % of families taking boarders and lodgers | 23 | 5 |
| Employees in commercial laundries and cleaning establishments per 1,000 persons | 1.4 | 3.6 |
| % of families in large cities in multiple-unit dwellings | 39.2 | 57.7 |

SOURCE: Employees in commercial laundries and cleaning establishments, estimated from Census data; all other data from Stigler, *op. cit.*, pp. 26 ff.

account. The washing machine and the vacuum cleaner, for example, have in effect reduced household work and expanded manufacturing activity.[6] Mechanical fuel systems provide another important example: in 1940, 21.3 percent of the nation's dwelling units were heated by gas or petroleum products, and 64.5 percent used these sources and electricity as cooking fuels.

The greater reliance on the market has been due in part to technological advances such as the invention and improvement of the washing machine. The move to the cities has increased the availability of market provision of processed foods, laundering services, and the like. The average family declined from 4.6 to 3.7 persons in the last 40 years, contributing to a relative growth of multiple-unit dwellings. The increase in the percentage of married women who were in the labor force from 5.6 in 1900 to 16.8 in 1940 was both a cause and an effect of the shift of production to the market. Relative prices have, at least for some commodities, become more favorable to processed goods,[7] and the rise in real in-

[6]The automobile reduced the effort of getting to work—where should one draw the line?

[7]The following data on changes in the relative consumption and prices of bread and flour in cities in four states are pertinent:

come made it possible for more families to buy goods and services (such as prepared baby foods and diaper services) that are time-consuming or unpleasant to perform.

The effects of these transfers upon commercial employment cannot be estimated precisely, but a very rough estimate is that a twentieth of the wage-earners in manufacturing alone were in 1940 providing commodities or services that in 1900 were produced within the household, and of course the shifts to the service industries have been even larger. In many cases the commercial service was no doubt higher in quality, but this transfer is yet another reason why indexes of output should not be confused with indexes of welfare. There may be substantial shifts of activities between household and market within a business cycle, as well as very large shifts during major wars; so even short-run movements of measured output may diverge materially from those of the output of all goods and services.

### *The Output of Service Industries*

As observed above, for only a small segment of service industries—steam railroads and gas and electric utilities—have indexes of output been calculated, whereas they are now available for the preponderant share of commodity-producing industries. This relative neglect of services is attributable in some degree to the absence of pertinent data, but in greater degree to conceptual difficulties, which we now discuss.

If we wished to construct an index of the aggregate output of retailing services, for example, we would have to know first the individual products of the industry: the amounts of stor-

| | Ratio: bread to flour consumed (pounds) | | Ratio: price of bread to price of flour | |
|---|---|---|---|---|
| | *1901* | *1935* | *1901* | *1935* |
| New York | 1.39 | 4.60 | 1.76 | 1.58 |
| Ohio | .57 | 1.58 | 1.98 | 1.65 |
| California | 1.06 | 2.76 | 2.42 | 1.69 |
| Louisiana | 3.26 | 6.87 | 1.34 | 1.38 |

Basic data from *Eighteenth Report of the Commissioner of Labor* (1903) and Bureau of Labor Statistics, *Retail Prices*, Bulletin 635 (1937).

age, selling, wrapping, delivery, credit extension, and similar services supplied to consumers. The problems that would be encountered in enumerating these quantities are not different in nature, and perhaps not in magnitude, from those already faced, and solved in varying degree, in the commodity-producing industries. But when one seeks the prices with which to weight these services in constructing a single index, a new problem arises. Rarely is there a separate and definite retail price differential for cash payments vs. a month's credit, delivery of specified frequency, or availability of rarely purchased items. These services are usually supplied jointly in variable amounts. It is as if, in manufacturing, the unit of sales were a variable combination of refrigerators plus toasters plus dishwashers plus washing machines. Indeed, because the 'terms of sale' (credit, promptness of delivery, guarantees, servicing, etc.) are in fact variable components of the output of commodity-producing industries, the same problem is present in measuring their output. But perhaps because it is believed that these 'terms of sale' are relatively unimportant—which is not intuitively obvious—the recorded price is attributed entirely to the physical product.

The types of data that must be enumerated are admittedly a serious obstacle to calculating indexes of service outputs.[8] Is the additional obstacle of the absence of an explicit price system insurmountable? I think not. There exists an implicit price system for the components of retailing service, to continue our example, and it could be uncovered by statistical analysis of appropriate data. By classifying retail stores of a given type with respect to these various services, we would be able to isolate the effect of a particular service on the retail margin. Fragments of information on this subject are already available. But to construct indexes of service outputs will be a very large task.[9]

[8]Indeed in certain industries such as domestic service this obstacle seems decisive.

[9]As a first approximation, we may measure (e.g.) retailing output by

A different type of price problem is confronted in public enterprise – governments and nonprofit institutions. The 'buyer's' common inability to determine freely the quantities he wishes to purchase of the products and services of such groups means that we cannot attribute proportionality of prices to marginal significances—the fundamental basis for combining heterogeneous economic quantities. It must suffice here to observe that this problem has received much careful attention from students of national income, and apparently has not yet been solved to their satisfaction.

In still other service categories even the specific content of output is debatable. We may cite as very different examples soldiers and teachers. In such fields it is not now possible even to enumerate the specific services that are sought. Perforce we adopt the convention that output is identical with input, or leave output unmeasured.

### *Composition of Output*

Perhaps the first discovery of a person who begins to investigate the composition of output is the existence of a vexing problem of classification. We expect the broadest classifications—manufactures vs. agricultural products, consumer vs. producer goods, and the like—to be difficult to define: the enormously diverse details of economic life offer innumerable challenges to classifications and invitations to arbitrary decisions. But the difficulties persist even in narrower classifications. There is no natural unit of analysis, unless it is the individual transaction, corresponding to the man in population studies or the isotope in chemistry: almost every 'product' can be subclassified by quality, location and time of production, use, etc.

Other difficulties are raised by the different interests of the

physical volume of goods sold, each type of goods being weighted by the retail margin per unit. This procedure is analogous to that used in measuring physical output of commodity-producing industries when quality changes are not taken into account.

data collector and the data user. The collector must report the complex details of economic life in few enough classes to be comprehended, and with due regard to comparability between classes and between times. The data user, on the other hand, commonly has much more specialized interests, and these interests are often dictated by problems that do not spring into prominence until a generation or more after the data have been reported.

The effects of the absence of a 'natural unit' in output studies and the reporting methods of data collectors may be illustrated with respect to stability of composition. We might wish to compare the relative stability of the composition of outputs of food and machinery in manufacturing (using, say, the coefficient of correlation between values-added by individual products within the two classes at two dates). The result, which would be that the composition of machinery output was much more stable than that of food, would be completely pre-determined by the classifications: almost all machinery is grouped into three or four classes so composition cannot vary much.

Certain significant aspects of composition, however, can be investigated with tolerable accuracy. Three are considered here: the relative growths of consumer durable and nondurable goods; the trends of output in the six major industry categories; and the interrelations between changes in outputs of broad categories and of more specific products of which they are composed.

### *The Flow of Consumer Goods*

It is not easy to form a general impression of the growth in the output of consumer goods from the numerous indexes of outputs of specific goods in the several National Bureau studies. To reduce the complexity of the picture, several indexes were combined (see Table 4). These indexes do not, of course, parallel exactly the corresponding consumption series. The former take no account of exports or imports or

TABLE 4

Output Indexes of Consumer Goods, 1899-1939

| | *1899* | *1909* | *1919* | *1929* | *1939* |
|---|---|---|---|---|---|
| *Productivity Studies* | | | | | |
| Food | 100 | 144 | 196 | 290 | 324 |
| Beverages | 100 | 147 | 53 | ..... | 251 |
| Tobacco products | 100 | 143 | 230 | 333 | 400 |
| Textiles | 100 | 158 | 176 | 263 | 313 |
| Shoes | 100 | 127 | 150 | 165 | 186 |
| Automobile, tires, and gasoline | ..... | 100 | 769 | 2,430 | 2,051 |
| Six industries | 100 | 146 | 195 | 283 | 289 |
| *W. H. Shaw's Study* | | | | | |
| Consumer perishables | 100 | 141 | 170 | 239 | 295 |
| Consumer semi-durables | 100 | 145 | 188 | 334 | 272 |
| Consumer durables | 100 | 148 | 318 | 622 | 551 |
| All consumer goods | 100 | 143 | 191 | 306 | 320 |
| Population | 100 | 121 | 140 | 163 | 175 |

SOURCES: Food consists of manufactured food plus potatoes, poultry and eggs, dairy products (weighted only by value of fluid milk), fruits, and noncommercial truck products. Barger's and Fabricant's indexes were combined by value of product, estimated from *Agricultural Statistics* and the *Census of Manufactures.*

Shoes are leather and rubber, combined by Census data on value.

Automobiles, tires and tubes (included after 1919), and petroleum refining were combined by Census data on value.

There is some duplication, as when fruits are included in both agriculture and manufactured products, some inclusion of producer goods (rugs for offices), and some omissions (food grown off farms). The indexes are therefore only rough measures.

Shaw's series are from Finished Commodities since 1879, *Occasional Paper 3* (National Bureau of Economic Research, 1941).

of inventory changes, and the outputs of durable goods in any year may bear little relation to the use of such goods during the year. More comprehensive indexes compiled by William H. Shaw, which do allow for exports and imports and make a finer allocation between producer and consumer goods, are also given.[10]

[10]See Finished Commodities since 1879, *Occasional Paper 3* (National Bureau of Economic Research, 1941). Shaw estimates (from independent evidence), the proportions of a commodity (e.g., coal) that are used by producers and consumers, whereas we do this only roughly by the system of weights. He eliminates price changes by the use of price indexes for 44 groups of commodities, whereas prices of individual commodities are used for this purpose in the productivity studies.

The output of food rose rapidly—to three times its 1899 level. Per capita consumption of food, measured by weight or calories, was probably more or less stable (indeed, falling gradually) during this period when per capita food output rose three-quarters. The rise in output reflects both the shift to more expensive foods (vegetables, dairy products, citrus fruits) and the further processing of food (flour into bread, the canning of vegetables) before it leaves manufacturing. The lesser importance of food grown and consumed on farms also raises the index. The increase in the output of food would be even larger if we could take account of the greater proportion purchased in restaurants.

Of the four groups of nondurable goods in Table 4, all except one (alcoholic beverages) rose more than the aggregate output of the three commodity-producing industries covered by the productivity studies. Shaw's index of the output of nondurable consumer goods rose almost 200 percent from 1899 to 1939, and conforms fairly well with this finding of rapid growth. But his index of the total output of all goods rose considerably more than that of our three commodity-producing industries,[11] and yields the opposite conclusion, namely, that consumer perishables and semi-durables rose less rapidly than total output. Each approach has its shortcomings, so it is probably unsafe to conclude more than that the increases in nondurables and in total output were of the same order of magnitude. If the increases in productivity (relative to population) of commodity-producing industries lead to a relative decline in the share of consumer nondurables, as some believe, the tendency is relatively weak. But Shaw's indexes clearly demonstrate that consumer durables have increased more rapidly than nondurables (or than producer goods).

[11]The two series are:

| | *1899* | *1909* | *1919* | *1929* | *1939* |
|---|---|---|---|---|---|
| Three Commodity-Producing Industries | 100 | 140 | 180 | 267 | 277 |
| Shaw's Total Output | 100 | 144 | 206 | 323 | 331 |

### *Output of Six Industries*

The relative contributions of the six industries to the total 'value-added' of the group are presented in Table 5. The most striking results, which would survive in more accurate measures, are the rapid decline of agriculture after 1919, the approximately offsetting increases in manufacturing, and

TABLE 5

Composition of Output, Measured by Percentage of Value-Added, by Each of Six Industries, 1899-1939

| | *1899* | *1909* | *1919* | *1929* | *1939* |
|---|---|---|---|---|---|
| Agriculture | 30.8 | 31.5 | 29.8 | 18.8 | 15.9 |
| Manufacturing | 48.9 | 47.1 | 52.5 | 59.4 | 61.7 |
| Mining | 5.6 | 5.3 | 5.3 | 5.5 | 6.4 |
| Electric light and power | ..... | 1.0 | 1.4 | 3.6 | 4.9 |
| Gas | .8 | 1.1 | .7 | 1.3 | 1.8 |
| Steam railroads | 13.8 | 14.0 | 10.3 | 11.4 | 9.3 |
| Total | 99.9 | 100.0 | 100.0 | 100.0 | 100.0 |

the similar offset of the growth of electric light and power by the decline of steam railroads (Chart 1).[12]

The decade increases, summarized in Table 6, are somewhat misleading because of the effects of business cycles: 1899 was a peak year, 1909 a year of expansion, 1919 a year of both contraction and recovery, 1929 a peak year, and 1939 a year of expansion. Consequently, the increase from 1929 to 1939 is low relative to the underlying trend, and that from 1919 to 1929 high. From Chart 1, however, it appears that the secular rate of increase in manufacturing was virtually constant to 1929, and the rate of increase of output in agriculture and mining fell only slowly. The rates of growth in the other, less diversified, industries fell more rapidly.

The movements of output in the six industries are materially influenced by their definitions. We need not con-

[12]The annual data are given in the Appendix. The vertical scale in Chart 1 (and subsequent charts) measures only percentage changes in output; the reader may find it convenient to transcribe the scale to a separate strip of paper.

CHART 1

## Indexes of Output in Six Industries
## 1899 – 1940

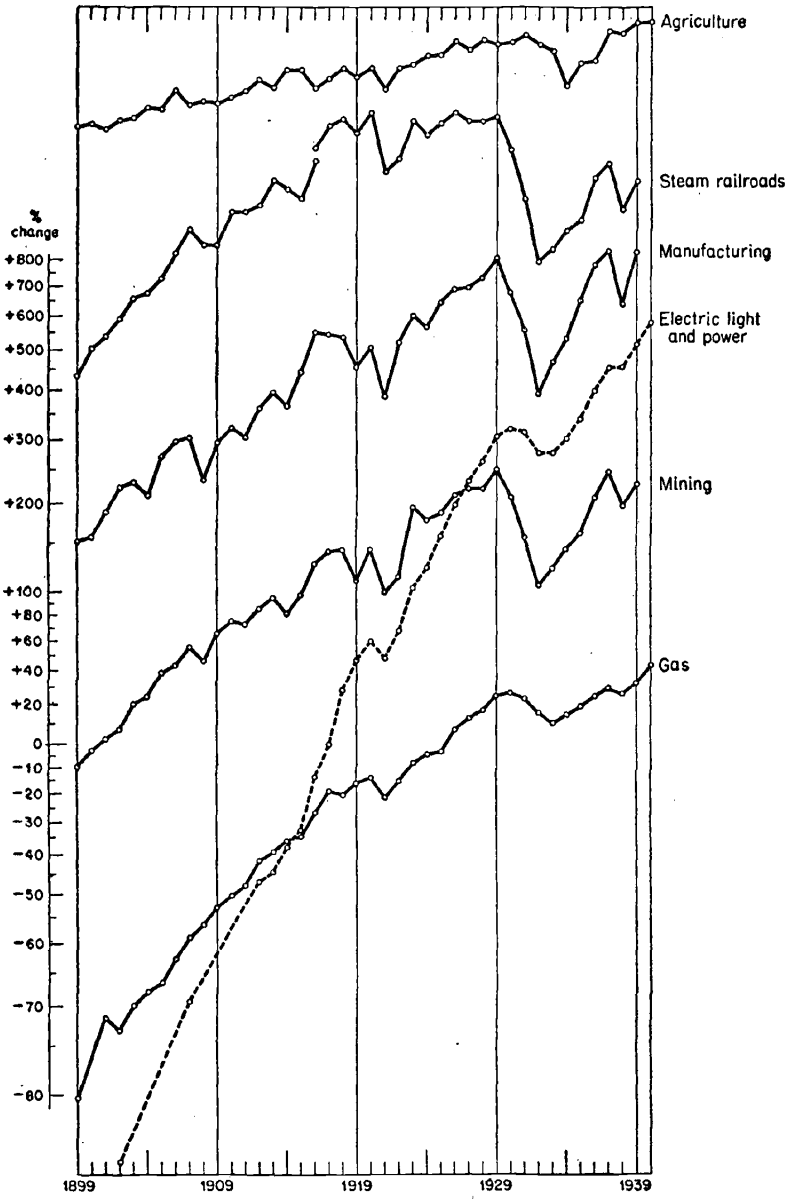


TABLE 6

Percentage Changes in the Outputs of Six Industries and in their Aggregate Output, by Decades, 1899-1939

| | *1899-1909* | *1909-1919* | *1919-1929* | *1929-1939* |
|---|---|---|---|---|
| Agriculture | 11.1 | 12.6 | 15.2 | 10.4 |
| Manufacturing | 57.8 | 40.6 | 63.9 | 2.7 |
| Mining | 84.0 | 27.3 | 66.1 | −5.9 |
| Electric light and power | ..... | 339.0 | 133.3 | 67.7 |
| Gas | 138.6 | 78.2 | 48.8 | 15.3 |
| Steam railroads | 80.6 | 66.1 | 7.5 | −25.0 |
| Aggregate output | 45.8 | 35.5 | 45.4 | 1.9 |

Index for electric light and power for 1909 estimated by linear interpolation.

cern ourselves with the propriety of the definitions at any given time. When a reasonably clear distinction between manufacturing and mining or between trade and services is sought, the conventional nature of these categories soon becomes apparent. It is more relevant to observe the effects of even minor changes in classification. For example, in 1909, 124,000 persons in power laundries were reported in manufacturing; in 1939, 254,000 persons in the same industry were reported in services. Again, in 1914, 17,700 persons were in automobile repair shops—in manufacturing; in 1939 the number was 134,000—in services. If the Census Bureau had retained these industries in manufacturing, its personnel would be about 2 percent higher in 1909, and about 5 percent higher in 1939. These variations in practice were easy to cope with, but have there been important shifts of activities between industries that are not so directly reported?

The distribution of productive activities among broad industry groups usually shifts slowly, but under the impact of changes in technology and mores the aggregate shift is sometimes large in even relatively short periods. When we are discussing the importance of a cultural-economic group such as farmers, the shift of activities to the factory requires no special treatment—the decline of agriculture is no less real whether due to a shift away of activities or the release of workers on farms due to technological progress. But if we are interested in the proportion of resources necessary to

provide food at a given level of preparation, a shift of activities leads us to misjudge changes in the relative share of resources necessary to satisfy our needs. To document the importance of such shifts, we examine in some detail the case of agriculture.

The movement of food processing away from the farm is as ancient as the growth of cities. The transfer had gone far in cheese and the slaughter of animals by 1900, as Table 7 indicates. Other industry boundaries were also shifting: the complementary percentages understate the relative growth of factory output because the processing of livestock by retailers also declined. The indexes of agricultural and manufacturing output and employment during our period would not be affected significantly by recognizing this shift.[13]

TABLE 7

Shift of Food Processing from the Farm, 1879-1939

| | *1879* | *1899* | *1939* |
|---|---|---|---|
| *Percentage of Production on Farms*[a] | | | |
| Cheese | 11.2 | 5.5 | |
| Butter | 96.4 | 71.8 | 21.3 |
| *Percentage of Slaughter on Farms*[b] | | | |
| Cattle | | 8.3 | 4.3 |
| Calves | | 17.5 | 8.5 |
| Hogs | | 26.7 | 20.7 |
| Sheep and lambs | | 4.2 | 3.1 |

[a]E. E. Vial, Producion and Consumption of Manufactured Dairy Products, Department of Agriculture, *Technical Bulletin 722* (1940); 1939 data from *Agricultural Statistics.*

[b]Barger and Landsberg, *op. cit.*, p. 9n.

A much more important shift is involved in the replacement of horses and mules by tractors and automobiles. In 1900 there were no automobiles on farms and virtually no tractors; in fact, both became prominent only during World War I. In 1940 there were 4,100,000 automobiles, 1,000,000 trucks, and 1,600,000 tractors on American farms. E. G.

[13]The labor requirements for these food-processing activities on the farm are not known. The food-processing industries required about 20,000 man-years in 1939 to handle the increase in the proportion of output that was done in factories compared with the proportion in 1899.

McKibben and R. A. Griffin estimated the saving in farm labor due to this shift, on the following assumptions:[14]

1) The tractor increased the output of a worker in field operations 50 percent, and is used 300 hours a year.
2) About 7 million horses and mules have been displaced, with annual savings of:
   a) 50 hours of labor caring for each animal;
   b) 35 hours of labor caring for each of 1,750,000 young horses required to replace the 7 million;
   c) 17.6 man-hours per acre in raising feed, with 3.5 crop acres and 1.8 pasture acres required per horse and half as much per colt.

The change to mechanical power thus reduced direct labor requirements about 1,200 million man-hours: The labor saved by the introduction of the automobile and truck was not estimated; if it is arbitrarily set at 100 hours per vehicle, another 500 million man-hours of agricultural labor was saved.

It is difficult to convert agricultural man-hours into man-years; much of the saving was no doubt reflected in shorter working hours and less help from the farm family. Yet it seems conservative to estimate that the farm labor force would have been 5 or 10 percent larger in 1940 had these shifts—which came within twenty years—not occurred.

### *The Whole and the Parts*

Subject to the pervasive limitations of information, one can subdivide the indexes of output almost endlessly. For example, we can follow Fabricant in classifying manufacturing industries under 17 major headings; then food, for example, can be subdivided into 25 subclasses such as flour; and this in turn into 7 products of flour mills. Nor need we stop here: wheat flour—one of the 7 products—can obviously be subdivided further.

[14] *Tractors, Trucks, and Automobiles* (National Research Project, Report A-9, 1938). Their results have been brought up to 1939.

As the products become more specific, we encounter greater variety of trend and amplitude of fluctuation, as we should expect. Shifts between kinds of flour will have little impact on all flour, and shifts between breadstuffs and vegetables will partly cancel, leaving the output of food relatively unaffected. The tendency toward stability as the industry coverage is extended is illustrated in Charts 2, 3, and 4, which portray trends of four kinds of flour, of the food industries that ranked among the first four in 1899 or 1939, and of the broad industry categories that ranked among the first four at either date.[15]

We are not surprised to find evidence of retardation in the outputs of virtually all established industries making a relatively narrow range of products. In *Production Trends in the United States since 1870* Arthur F. Burns amply demonstrated this retardation to be a characteristic of a progressive economy.[16] One may roughly generalize that we do not wish to have the old products if we can have the new ones. Nor is this ubiquitous decline in the rate of growth of outputs of individual products or industries incompatible with relative stability in the rate of growth of aggregate output, as the negligible retardation of output in manufacturing, mining, and agriculture before 1929 testifies.

It is a natural step to test the hypothesis: can we say that the greater the heterogeneity of the rates of growth in specific industries, the greater is the rate of growth of the industry group comprising them? There is strong evidence to suggest that the answer is 'yes'.

A first test of the hypothesis can be made by comparing the rates of growth (from 1899 to 1929) of the outputs of 36

[15]Each of the rankings was confined to industries for which indexes of output were available.

[16]Ch. IV. Burns relied chiefly on annual series, and although his indexes do not include as many products as the productivity studies, the period covered was longer and cyclical influences on estimates of trends could be minimized.

CHART 2

## Indexes of Output of Leading Flour Mill Products 1899–1939

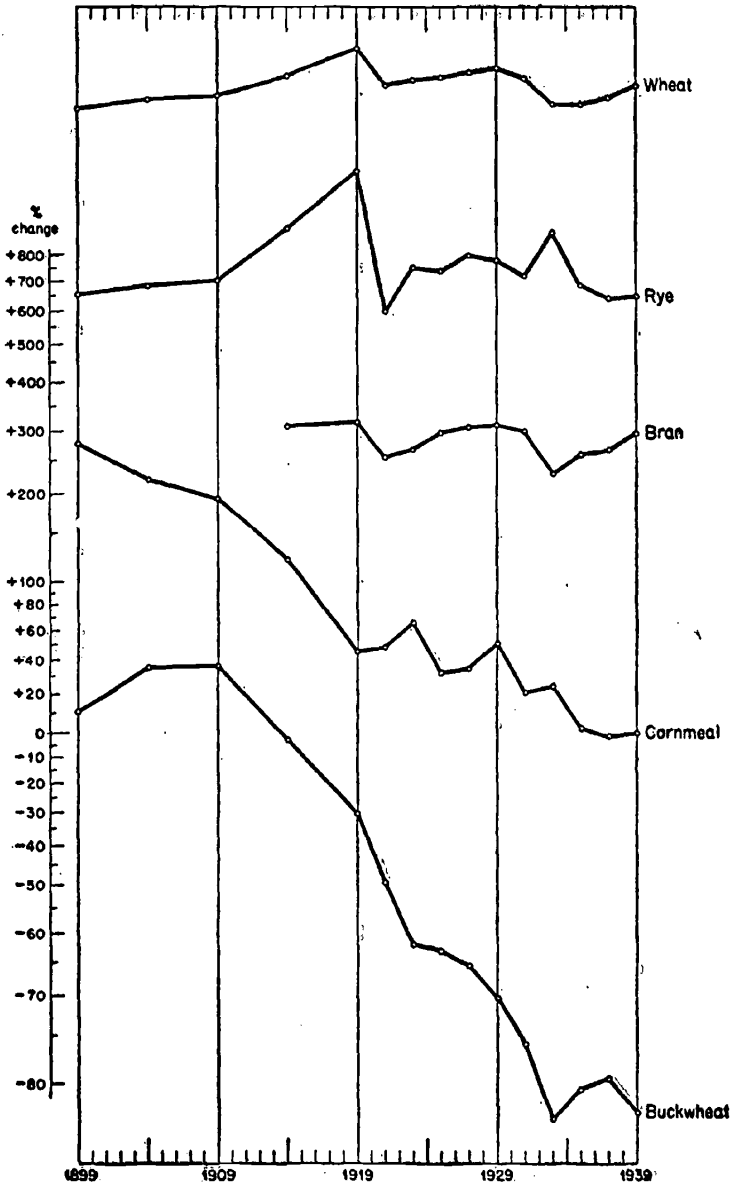


CHART 3

## Indexes of Output of Leading Food Industries
## 1899 – 1939

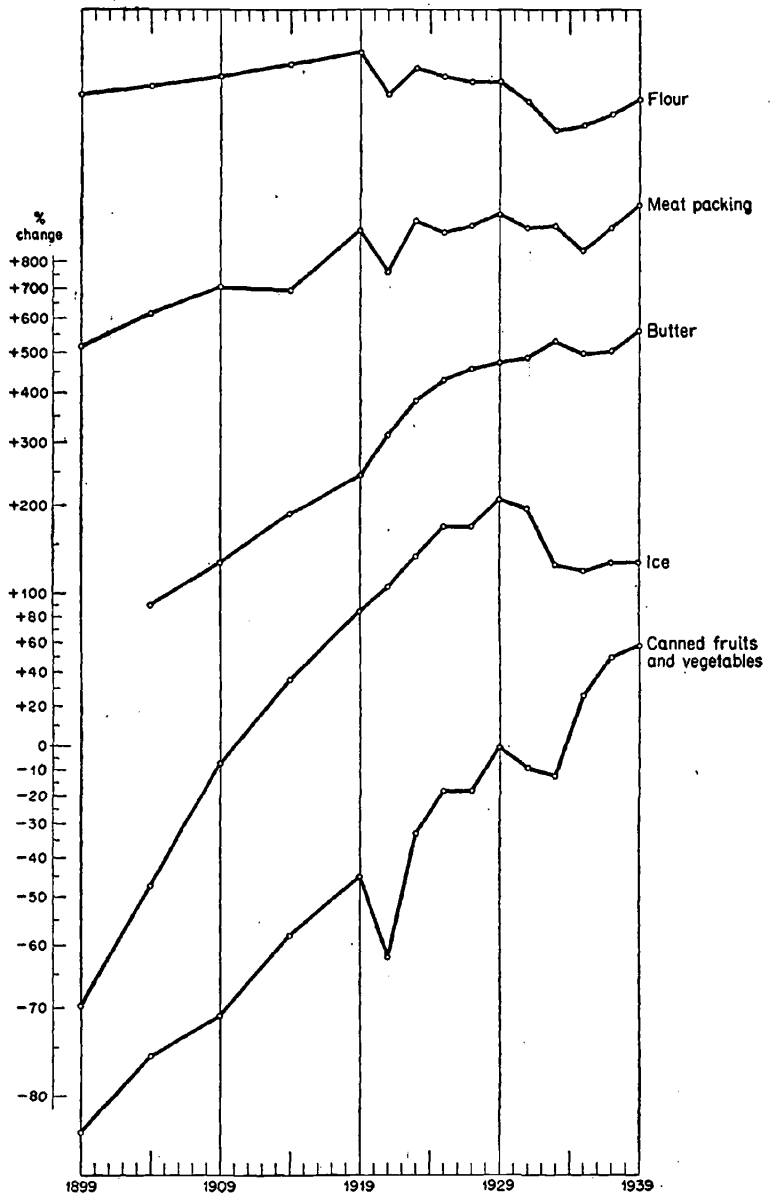
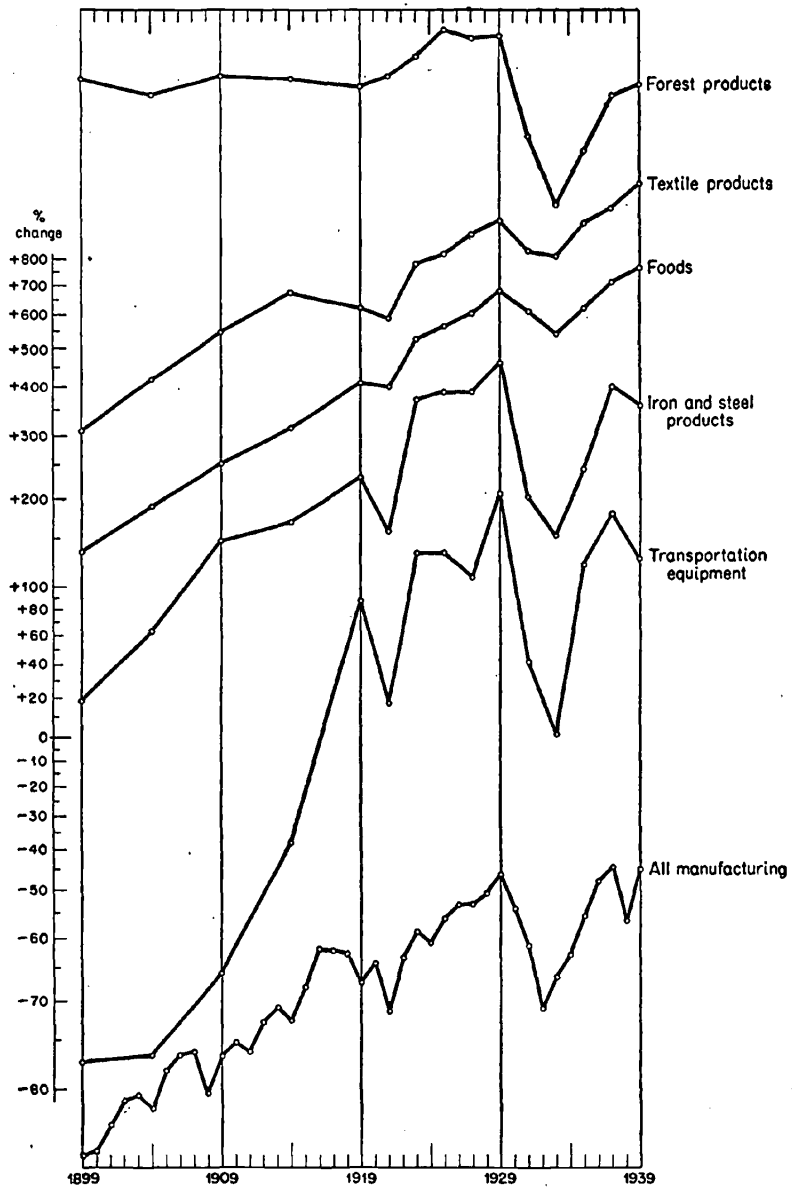


CHART 4

## Indexes of Output of Five Industry Groups and All Manufacturing 1899–1939



agricultural products with the rates of growth of 28 food products in manufacturing.[17] The comparison is congruent

| | AGRICULTURE | MANUFACTURING |
|---|---|---|
| Percentage increase in aggregate output | 44 | 233 |
| Number of products | 36 | 28 |
| Percentage increase in outputs of individual products: | | |
| First Quartile | 17 | 54 |
| Second Quartile | 79 | 154 |
| Third Quartile | 215 | 608 |
| Inter-Quartile ratio $\frac{Q_3 - Q_1}{Q_2}$ | 2.51 | 3.60 |

with the hypothesis: both variability and the average rate of increase were larger in manufacturing than in agriculture.

Burns' study of production trends for a longer period also revealed greater variability in the growth of outputs in the more rapidly growing industry sectors. Moreover, the same correspondence of growth and variability occurred through time: the trends of the outputs of individual products showed greater divergences in periods when average growth was more rapid.[18]

Rapidity of the growth of total output is, it seems, associated with wide dispersion of trends in individual industries. This suggests a concrete sense in which one may speak of the clash between security and progress: the rapid growth of aggregate output implies the even more rapid growth of new and the decline of old industries. It was as inevitable that the rapid growth of the radio industry should virtually destroy the player piano industry (the output of which fell from 144,000 in 1925 to 1,690 in 1931) as that the rapid growth of the automobile industry should virtually destroy the carriage industry (the output of which fell from over 900,000 in 1899 to 3,600 in 1929). We should like to have both a rapid increase in aggregate output and stability in

[17]The agricultural products are those for which Barger gives outputs since 1899. In manufacturing the criteria for inclusion were: (a) data back to 1899, (b) a value of product of at least $5 million in 1899 or $20 million in 1929.

[18]*Op. cit.*, pp. 61-2, and 243.

its composition—the former to keep pace with expanding wants, and the latter to avoid the losses of specialized equipment of entrepreneurs and crafts of employees and creating 'sick' industries in which resources are less mobile than customers. It is highly probable that the goals are inconsistent.